IOT Lab:

Supporting documents for the claim

Principal
SHRI MADHWA VADIRAJA
INSTITUTE OF TECHNOLOGY & MANAGEMENT
Vishwothama Nagar, Udupi Dist.
BANTAKAL - 574115

SHRI MADHWA VADIRAJA INSTITUTE OF TECHNOLOGY AND MANAGEMENT

Shri Vishwothama Nagar, Bantakal - 574 115 Udupi Dist.

No.001

STOCK REGISTER

Name of the Article: IOT Lab Components

Sl.No	Indent No	Date of Purchase	Name of the Equipments with Model	Supplier Address & Contact Details	Invoice No	Quantity	Rate / Price	Total Amount	Sign of Stock Incharge	Sign of HOD	Sign of Principal	Remarks
1	425	14/11/22	Arudino uno board	SRI Krishna Electronics	425	20	800	13560 -				
2	"	"	Cable			20	90	1525	[signature]			
			Push button switch			20	3	51				
			DHT Sensor			20	120	2034				
			LDR module			20	70	1186				
			OLED			20	240	4068				
			Blue Tooth Module			20	250	4237	[signature]	[signature] Head Dept of E&C Engg. SMVITM, BANTAKAL - 574 115		
			Relay Module			20	80	1356				
							Total	33060/- (with 18% GST)				
	CB2045	03/02/23	VGA Converter	Amith electronics	-11	02	211.86	500/- (with 18% GST)			[signature]	
		17/11/23	Node MCU ESP8266	Amazon.in	[illegible]	05	214.41	1,201.75 (with GST)	[signature]	[signature] Head Dept of E&C Engg.		
		17/11/23	USB Fast charging Cable	"	[illegible]63789-129	05	169.64	995.06 (with GST)				
		05/1/2024	Node MCU ESP8266	Amazon.in	[illegible]-1022229	05	214.41	1018.474 GST				
			Solderless Self-adhesive board	"	[illegible]-1022229	3box (12board)	214.557* (box)	713.364 GST	[signature]	[signature]		
			USB Fast charging Cable	"	"	05		970.354 GST (1/1453)	[signature]	[signature] Head Dept of E&C Engg. SMVITM, BANTAKAL - 574 115		

Head Dept of E&C Engg. SMVITM, BANTAKAL - 574 115

[signature]
Principal
SHRI MADHWA VADIRAJA
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Vishwothama Nagar, Udupi Dist.
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PROFORMA INVOICE

TIF LABS Pvt Ltd #822, 9th Main, 1st C Cross HRBR Layout , Bangalore GSTIN/UIN: 29AAFCT7562C1Z5 State Name : Karnataka, Code : 29 E-Mail : info@robocraze.com	Invoice No. **19**	Dated **25-Sep-2018**
	Delivery Note	Mode/Terms of Payment
	Supplier's Ref.	Other Reference(s)
Consignee **The Principal** Shri Madhwa Vadiraja Insitute of, Technology and Management, Udupi State Name : Karnataka, Code : 29	Buyer's Order No.	Dated
	Despatch Document No.	Delivery Note Date
	Despatched through	Destination
Buyer (if other than consignee) **The Principal** Shri Madhwa Vadiraja Insitute of, Technology and Management, Udupi State Name : Karnataka, Code : 29	Terms of Delivery **100% Advance Payment**	

Sl No.	Description of Goods	HSN/SAC	Quantity	Rate	per	Amount
1	**Arduino UNO with Cable**	8542	**10 Nos.**	390.00	Nos.	**3,900.00**
2	**Resistance Box**	8533	**10 Nos.**	35.00	Nos.	**350.00**
3	**LEDS** *(RGBY)*	8541	**120 Nos.**	1.00	Nos.	**120.00**
4	**Buzzer(Small)**	8531	**10 Nos.**	10.00	Nos.	**100.00**
5	**10K Potentiometer**	8533	**10 Nos.**	5.00	Nos.	**50.00**
6	**LDR Small**	8532	**10 Nos.**	8.00	Nos.	**80.00**
7	**IR Proximity Sensor**	9031	**20 Nos.**	28.00	Nos.	**560.00**
8	**Bread Board**	8534	**10 Nos.**	50.00	Nos.	**500.00**
9	**Male to Male Jumper Wires(20cm)**	8544	**150 Nos.**	1.00	Nos.	**150.00**
10	**Male to Female Jumper Wires(20cm)**	8544	**150 Nos.**	1.00	Nos.	**150.00**
11	**TSOP**	8541	**10 Nos.**	20.00	Nos.	**200.00**
12	**Mini IR Remote**	8543	**10 Nos.**	30.00	Nos.	**300.00**
13	**HC-05 Bluetooth Module**	8542	**10 Nos.**	240.00	Nos.	**2,400.00**
14	**Battery Cap**	8507	**20 Nos.**	4.00	Nos.	**80.00**
15	**9v Battery**	8506	**20 Nos.**	14.00	Nos.	**280.00**
16	**DC Jack**	8536	**10 Nos.**	5.00	Nos.	**50.00**
17	**2WD TWO WHEEL DRIVE SMART ROBOT CAR CHASSIS Kit**	8706	**10 Nos.**	320.00	Nos.	**3,200.00**
18	**5V 1 Channel Relay Board**	8536	**10 Nos.**	45.00	Nos.	**450.00**
19	**Screw Driver**	85	**10 Nos.**	10.00	Nos.	**100.00**
20	**Jan Keeper-44** *Box*		**10 Nos.**	50.00	Nos.	**500.00**
						13,520.00
	CGST@ 9%			9	%	**1,216.80**
	SGST @ 9%			9	%	**1,216.80**
	Total		**620 Nos.**			**₹ 15,953.60**

Amount Chargeable (in words)
INR Fifteen Thousand Nine Hundred Fifty Three and Sixty paise Only

E. & O.E

Company's Bank Details
Bank Name : **HDFC Bank**
A/c No. : **50200026263451**
Branch & IFS Code : **OMBR Layout & HDFC0001759**

Declaration
We declare that this invoice shows the actual price of the goods described and that all particulars are true and correct.

for TIF LABS Pvt Ltd

Authorised Signatory

This is a Computer Generated Invoice

Principal
SHRI MADHWA VADIRAJA
INSTITUTE OF TECHNOLOGY & MANAGEMENT
Vishwothama Nagar, Udupi Dist.
BANTAKAL - 574 115

PROFORMA INVOICE

(Tax Analysis)

Invoice No. **19**

Dated **25-Sep-2018**

TIF LABS Pvt Ltd
#822, 9th Main, 1st C Cross
HRBR Layout , Bangalore
GSTIN/UIN: 29AAFCT7562C1Z5
State Name : Karnataka, Code : 29
E-Mail : info@robocraze.com

Party : **The Principal**
Shri Madhwa Vadiraja Insitute of
Technology and Management,
Udupi
State Name : Karnataka, Code : 29

HSN/SAC	Taxable Value	Central Tax		State Tax		Total Tax Amount
		Rate	Amount	Rate	Amount	
8542	6,300.00	9%	567.00	9%	567.00	1,134.00
8533	400.00	9%	36.00	9%	36.00	72.00
8541	320.00	9%	28.80	9%	28.80	57.60
8531	100.00	9%	9.00	9%	9.00	18.00
8532	80.00	9%	7.20	9%	7.20	14.40
9031	560.00	9%	50.40	9%	50.40	100.80
8534	500.00	9%	45.00	9%	45.00	90.00
8544	300.00	9%	27.00	9%	27.00	54.00
8543	300.00	9%	27.00	9%	27.00	54.00
8507	80.00	9%	7.20	9%	7.20	14.40
8506	280.00	9%	25.20	9%	25.20	50.40
8536	500.00	9%	45.00	9%	45.00	90.00
8708	3,200.00	9%	288.00	9%	288.00	576.00
85	100.00	9%	9.00	9%	9.00	18.00
	500.00	9%	45.00	9%	45.00	90.00
Total	**13,520.00**		**1,216.80**		**1,216.80**	**2,433.60**

Tax Amount (in words) : **INR Two Thousand Four Hundred Thirty Three and Sixty paise Only**

Principal
SHRI MADHWA VADIRAJA
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Vishwothama Nagar, Udupi Dist.
BANTAKAL - 574115

for TIF LABS Pvt Ltd

Authorised Signatory

EMBEDDED BASED AUTOMATIC LAWN MOWER

A PROJECT REPORT

Submitted to

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, BELAGAVI- 590018

By

Ms. NAYAK DHANASHREE ASHOK	4MW18EC022
Ms. NEHA KINI	4MW18EC023
Ms. SHREYA S NAVELKAR	4MW18EC035

Under the guidance of

Mr. CHETAN R

Assistant Professor (Sr), Dept. of Electronics & Communication Engineering

in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

SMVITM

Department of Electronics & Communication Engineering

SHRI MADHWA VADIRAJA INSTITUTE OF TECHNOLOGY AND MANAGEMENT

Vishwothama Nagar, BANTAKAL – 574115, Udupi District

JUNE 2022

Principal
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Department of Electronics & Communication Engineering

SMVITM

CERTIFICATE

Certified that the Project Work titled '**Embedded Based Automatic Lawn Mower**' is carried out by:

Ms. NAYAK DHANASHREE ASHOK	USN:**4MW18EC022**
Ms. NEHA KINI	USN:**4MW18EC023**
Ms. SHREYA S NAVELKAR	USN:**4MW18EC035**

bonafide students of Shri Madhwa Vadiraja Institute of Technology and Management, in partial fulfillment for the award of the degree of **Bachelor of Engineering** in Electronics & Communication Engineering of Visvesvaraya Technological University, Belagavi during the year 2021-2022. It is certified that all the corrections / suggestions indicated during Internal Assessment have been incorporated in the report. The report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the said degree.

Chetan 18/7/22.
Mr. Chetan R
Assistant Professor (Sr)
Dept. of ECE
Signature with date

18/7/2022
Dr. Thirumaleshwara Bhat
Principal
SMVITM, Bantakal
Signature with date and seal

Sachin 18.7.22
Dr. Sachin S Bhat
Head
Dept. of ECE
Signature with date and seal

Head
Dept of E&C Engg.
SMVITM, BANTAKAL - 574 115

External Viva

Name of the Examiners:
1. Dr. Sachin Bhat
2. Nagaraja Rao

Signature with Date
Sachin 22.7.22
22/7/22

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Acknowledgements

We express our deepest gratitude and respect to our guide **Mr. Chetan R, Assistant Professor(Sr)**, Department of Electronics and Communication Engineering, for his valuable guidance and encouragement while doing this project work.

We are indebted to Prof. Dr. Sachin S Bhat, Head of the Department, for his advice and suggestions at various stages of the work. We also extend our heartfelt gratitude to Prof. Dr. Thirumaleshwara Bhat, Principal for his support.

We extend our thanks to the Management of Shri Madhwa Vadiraja Institute of Technology and Management, Bantakal, Udupi for providing good laboratory and library facilities. We also remain grateful to the co-operation and help rendered by the teaching and non-teaching staff of the Electronics and Communication Engineering Department. Lastly, we take this opportunity to offer our regards to all of those who have supported us directly or indirectly in the successful completion of this project work.

Ms. Nayak Dhanashree Ashok
Ms. Neha Kini
Ms. Shreya S Navelkar

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ABSTRACT

Lawn mowing is considered to be one of the most boring and tiring routine household tasks, but mowing the lawn is a very important part of proper yard care and properly cut lawn is something that is very pleasant to behold which gives the lawn an orderly appearance. The lawn mowing job with motor powered lawnmower is an inconvenience; it becomes difficult for the disabled and elderly people to cut the grass with the help of these mowers. Because of the continuing increase in the fuel cost and its harmful environmental impacts, that increase the necessity of using solar energy as a source of power to drive a grass cutting machine. Our project aims at easing the lawn Mowing experience. We aim on making a lawn mower which is environmental friendly as well as user friendly and automatic. A solar lawn mower designed and fabricated based on the principle of mowing. The solar lawn mower depends on direct current motor, solar panel, rechargeable battery, stainless-steel cutting blade, sensors and a microcontroller. The DC motor is coupled to the stainless steel blade and provides the required torque to the blade to achieve the cutting process. Based on the output of the Ultrasonic sensors, the microcontroller allows the current flow to the motor that coupled to the blade so it starts the cutting process .The solar panel working on charging the rechargeable battery through the charging controller.. So, the designed system is fully automated, it is able to detect fixed obstacles (e.g. walls, stones, trees, etc.) and moving obstacles (e.g. humans, animals and any living organisms) and will be able to avoid them. The robot will move automatically without man help, and there will be none to care about it. The main focus was to design a prototype that is able to work with a little or no user interaction. Every action of the lawn mower is monitored by the ATMEGA328P microcontroller with the help of the Ultrasonic sensor.

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Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

IC	Integrated Circuit
IOT	Internet Of Things
Wifi	Wireless Fidelity
PIC	Peripheral Interface
DC	Direct Current
IR Sensor	Infrared Sensor
AVR	Alf And Vegard's RISC Processor
RISC	Reduced Instruction Set Computer
MIPS	Million Instructions Per Second
LED	Light Emitting Diode
I/O	Input/Output
ESD	Electrostatic Discharge
IDE	Integrated Development Environment

Chapter 1

INTRODUCTION

In the past and even until now, cutting of grasses in the schools, sports tracks, fields, industries, hotels, public centre, etc. was done with a cutlass. This method of manual cutting is time consuming because human effort is needed for the cutting. Cutting grass cannot be achieved easily by young, and the grass cutters with gas engines have many disturbances and produce air pollution as it depends totally on the power produced from gas burning. Also, it requires to be maintained periodically, such as an oil change. Even though the grass cutter with the electric engine is environmentally friendly, it is dangerous and cannot be used by anyone also inaccuracy in cutting level was observed using the manual cutting method. The aim of this work includes, but not limited to the following:

- To reduce labour input in the cutting of not only weeds or grass but also in the trimming of flowers and trees.
- To reduce cost, time of cutting and also to beautify the environment.

1.1 Relevance Of Work

Grass cutter machines are becoming very popular these days. Farmland or weeds can easily cut or brushed with lawn mower without intervention of human effort. In old model of grass cutter IC engine was used and hence because of its environmental impact, pollution level rises. User and Eco friendly systems are need of the hour.

1.2 Issues And Challenges

IC engines require frequent maintenance and it is costly. A gasoline-powered lawn mower produces as much pollution in one hour as a new car does in thirty hours. To avoid these drawbacks, we plan to build new type of grass cutter which runs on solar energy and this model is economical, noiseless and free from pollution compared to the existing model.

1.3 Problem Statement

Construction of solar powered lawn mower which stays in specified boundary, finds distance and position of the obstacle to avoid collision. With help of new system noise and air pollution need to be avoided.

1.4 Objectives

- To optimally design and fabricate the unmanned solar powered lawn mower.
- To detect and avoid collision with obstacle and change its direction.

Chapter 2

LITERATURE SURVEY

[1]. "Automated Grass Cutter Robot Based on IOT" In this paper author fabricated a automated grass cutting machine. The machine was worked under guidance and cut the grass uniformly. Here they used battery as power source to detect obstacle. In this project main aim of the author to replace the grass cutter which uses petrol engine because it increases pollution .This machine detects the obstacle and stop the movement. Here they used Arduino UNO microcontroller board, Ultraviolet sensor for obstacle detection, Non MCU for wifi connection, blade for cutting the grass and motor drive for wheel.

[2]. "Solar Powered Intelligent Grass Cutter Robot" In this paper they prepared a Arduino controlled grass cutter robot which is work on solar energy which reduces human work and it is automatic robot. Here they used12v battery and 1A adapter. This robot will provide the user to cut grass with two input that is length and breadth. When we turn on the system user should enter length and breadth of plot and robot will cut the grass automatically in calculated area.

[3]. "Renewable Energy Based Robotic Grass Cutter Using IOT" Here the lawn mower is fully automated robotic vehicle powered by solar energy and obstacles are avoided. It is also capable of fully automated grass cutting without the need of any human intervention. Solar panels are used to rise the battery level. The cutter and its motors are interfaced to the PIC Microcontroller that controls the working of all the motors.

[4]. "Design And Fabrication Of Solar Operated Lawn Mower" In the project paper author prepared a automate lawn mower to reduce human work. They used Solar panel to charge the battery which converts the solar energy into electrical energy. The machine is remote Controlled and wifi Controlled. The blade is connected to DC motor. This device cut all types of grass Here they used 12v battery .This device is eco friendly as compared to of other lawn mower. This device does not require great maintenance this is one of the great advantage of this machine.

[5]. "Autonomous Solar Based Lawn Mower" In this paper author fabricated automatic lawn mower which works on battery which is charged by solar panel. Here they used image processing to detect grass and when grass is detected blade will start rotating and it will cut the grass. It avoids obstacles and it will cover entire area of lawn automatically.

[6]. "IOT Based Grass Cutter with Solar Panel" Here they have built a solar operated grass cutter here solar panel is used to charge 12V battery. This model can be even controlled by cell phone with the help of wifi module ESP8266. It has a feature of obstacle detection where it can detect location of obstacle with the help of IR and Ultrasonic sensor and avoid collision with it.

[7]. "Fabrication of Automatic Solar Lawn Mower" In this paper author has built a fully automatic solar powered lawn mower it is a pollution free system and does not emit any gas. It is a low-cost and a lightweight system it can successfully detect and avoid collision with obstacles with the help of IR sensor .here they have used 4 motor for wheels and 2 for cutter blade

[8]. "Fabrication of Solar Powered Grass Cutting Machine" Here they have built a solar powered grass cutting machine it does not cause environmental pollution. Here they have used to relay because of its high efficiency can be achieved it is fully automated grass cutting machine .Once we switch on the system it performs all actions without any manual operation. Main drawback is no information about obstacle detection and boundary detection. Advantage of this system is low power consumption and disadvantage is manually operated

[9]. "Self-Efficient and Sustainable Solar Powered Robotic Lawn Mower" In this paper author has manufactured automatic lawn mower. Battery charged by solar panel. it can successfully detect and avoid collision with obstacles with the help of IR sensors it helps to mow the lawn in a different design with minimal human effort it is environment friendly system. Advantage is it has a feature of obstacle detection. Disadvantage is system response is slow in real time.

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[10]. "Design and Development of Solar Powered Lawn Mower"Here author has proposed a environment-friendly solar powered lawn mower .low cost operation because it does not use fuel. This lawn mower can be replaced with gasoline powered lawn mower. Advantage is it has a grass cutting efficiency of around 93%.Main drawback of this system is it is manually operated.

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Chapter 3

PROPOSED METHODOLOGY

3.1 Block Diagram

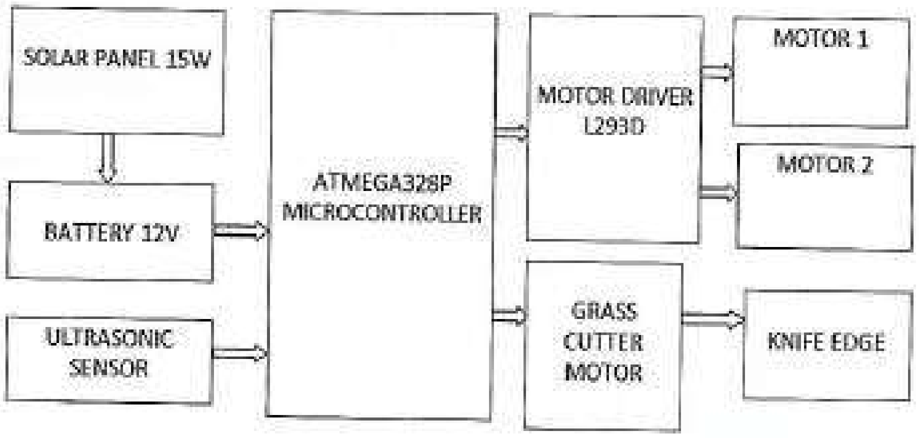

Fig.3.1 Block diagram

The main components of the solar powered grass cutter are:

Hardware Requirements:

- 15w mono crystalline solar panel,
- 12 volt lithium ion battery,
- DC Series Motor,
- Ultrasonic sensor,
- 4 wheels,
- Mowing blade,
- ATmega328P Microcontroller,
- Motor Driver L293D

Software Requirements:

- Embedded C

Working of proposed system:

The automated solar grass cutter is a robotic vehicle powered by solar energy that also avoids obstacles and is capable of grass cutting without the need of human intervention. The system uses 12V battery to power the vehicle wheel motors as well as grass cutter motor. We use a solar panel to charge the battery. It is interfaced to an ultrasonic sensor for obstacle detection. The mode of operation starts when switch is turned on. If battery is charged then ultrasonic sensor can be activated else if battery isn't charged then it is charged by solar panel. On obstacle detection the ultrasonic sensor monitors the grass cuter motor to avoid any damage to the object/human/animal whatever it is. If the obstacle is detected and distance of obstacle is less than 30 cm lawn mower will change its path towards left and continue mowing. If distance of obstacle is more than 30 cm the lawn mower will move ahead and keep mowing. The mode of operation stops when the switch is turned off.

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3.2 Flowchart

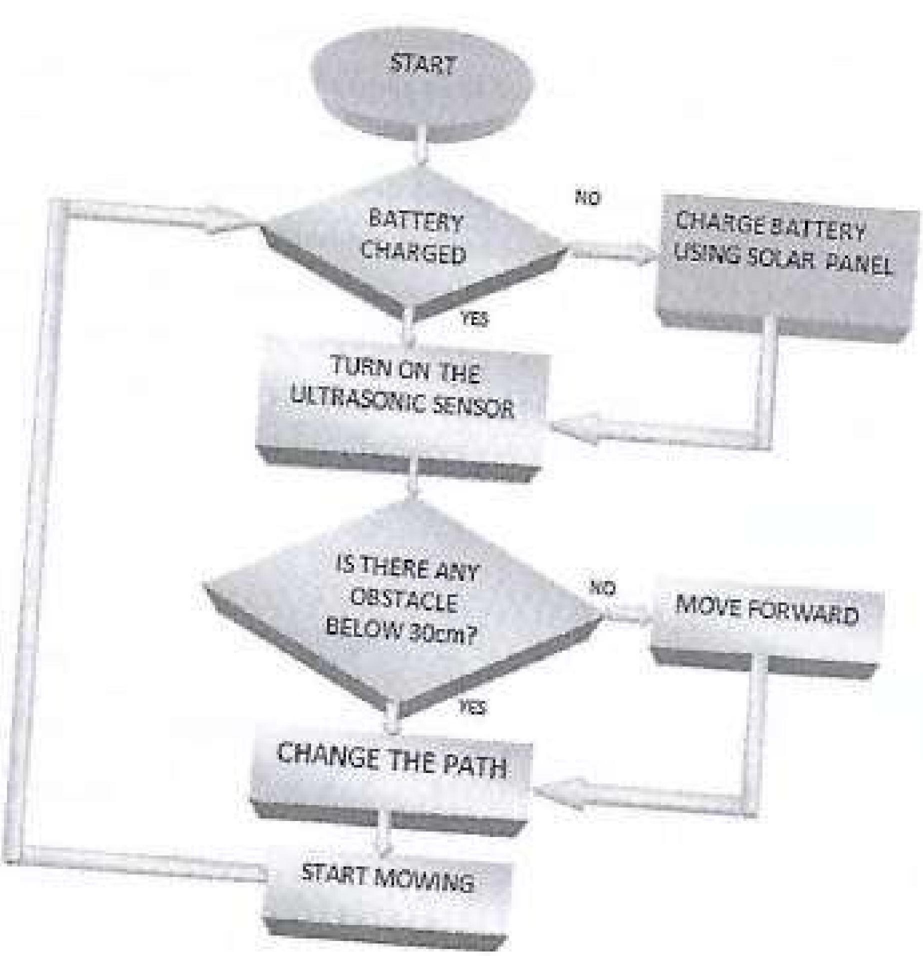

Fig. 3.2 Flowchart

Chapter 4

BACKGROUND

4.1 Battery

A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half cells connected in series by a conductive electrolyte containing anions and cat ions.

Fig. 4.1 Battery

Features include:

- Voltage: 12V-1.3AH
- Initial Current: Less then 0.39A
- Cycle Use:14.4V-15V
- Standby Use:13.5V-13.8V
- Type of Battery:Rechargeable,Lead acid

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4.2 ATMEGA328P Microcontroller

ATmega328 is an eight bit Microcontroller. It can handle the data sized of up to eight bits. It is an AVR based miniaturized scale controller. Its built in interior memory is around 32KB. It works extending from 3.3V to 5V. It has a capacity to store the information notwithstanding when the electrical supply is expelled from its biasing terminals. Its brilliant highlights incorporate the cost effectiveness, low power dispersal, programming lock for security purposes, genuine clock counter with isolated oscillator. It's ordinarily utilized as a part of Embedded Systems applications.

Fig.4.2 ATMEGA328P Microcontroller

Features include:

- High Performance, Low Power Design
- 8-Bit Microcontroller Atmel® AVR® advanced RISC architecture
- 131 Instructions most of which are executed in a single clock cycle
- Up to 20 MIPS throughput at 20 MHz
- 32 x 8 working registers
- 2 cycle multiplier

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4.3 Ultrasonic Sensor

Here is a more easy use serial ultrasonic module. It will auto output the distance information via serial port after power on, you don't need to do any trigger and calculated, just need to read the serial pin and get the distance information.

Ultrasonic sensor provides a very low-cost and easy method of distance measurement. This sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects. Naturally, robotics applications are very popular but you'll also find this product to be useful in security systems or as an infrared replacement if so desired. You will definitely appreciate the activity status LED and the economic use of just one I/O pin.

Fig.4.3 Ultrasonic Sensor

Features include:

- Provides precise, non-contact distance measurements within a 2 cm to 3 m range.
- Simple pulse in/pulse out communication.
- Burst indicator LED shows measurement in progress.
- 20 mA power consumption.
- Narrow acceptance angle

4.4 Solar Panel

Solar photovoltaic cells convert solar radiation into electricity (photovoltaic literally means "light energy"; "photo" = light, "voltaic" = energy). Individual cells are packaged into modules, like the one shown at the right; groups of modules are called arrays. Photovoltaic arrays act like a battery when the sun is shining, producing a stream of direct current (DC) electricity and sending it into the building or sharing it with the grid.

Fig.4.4 Solar panel

Features include:

- Voltage:12V,1.3AH
- Small in size
- Waterproof solar panel
- Aluminum frame
- High efficiency

4.5 Motor Drive (L293D)

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

Fig.4.5 Motor driver

Features include:

- Wide supply-voltage range: 4.5V to 36V
- Separate input- logic supply
- Internal ESD protection
- Thermal shutdown
- High-Noise-Immunity input
- Functional Replacements for SGS L293 and SGS L293D
- Output current 1A per channel (600 mA for L293D)
- Peak output current 2 A per channel (1.2 A for L293D)
- Output clamp diodes for Inductive Transient Suppression(L293D)

4.6 DC Motor

A DC motor is an electric motor that runs on direct current (DC) electricity. In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field.

Fig.4.6 DC Motor

Features include:

- Grass motor-1000 RPM
- Wheel motors-35 RPM
- Metal-Gear material

Chapter 5

HARDWARE IMPLEMENTATION OF PROPOSED SYSTEM

5.1 PCB Board Design

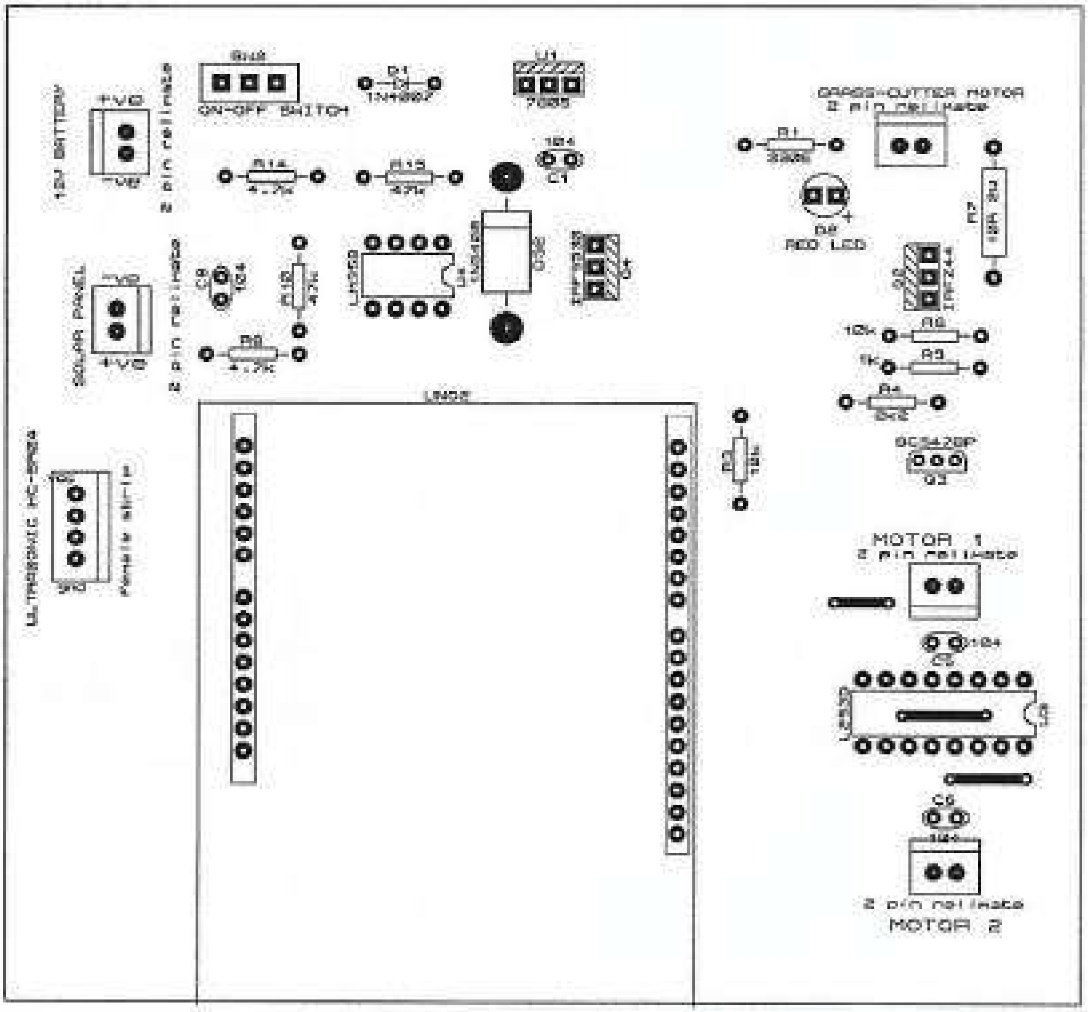
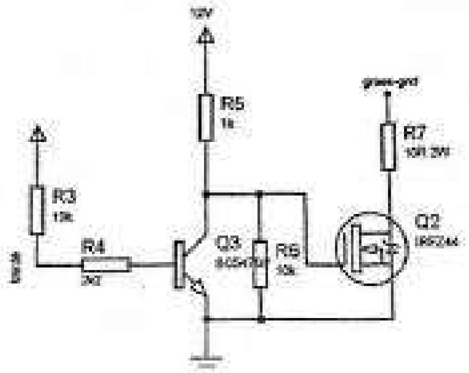
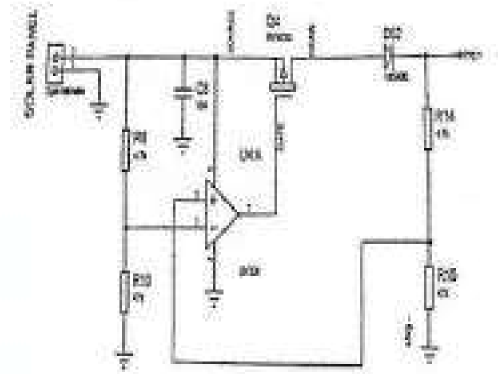


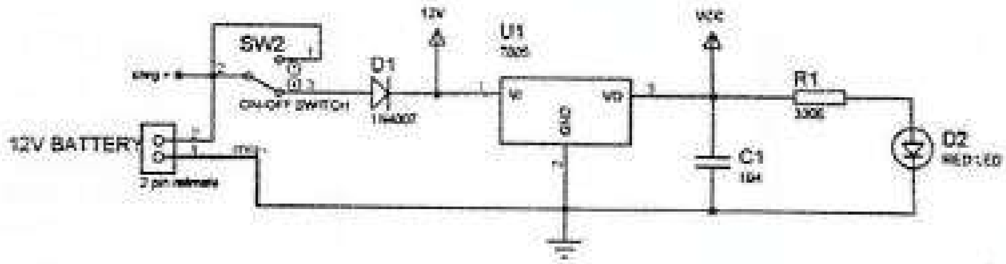
Fig.5.1 PCB board

5.2 Circuit Diagram

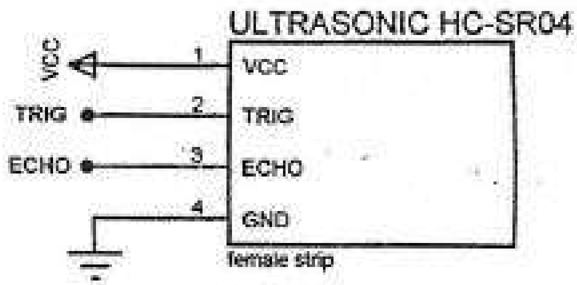
Power section:



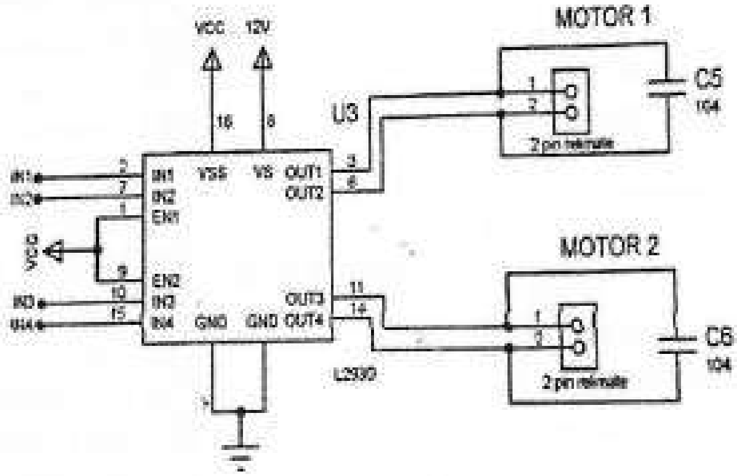




Sensor section:



Motor section:



Interface section:

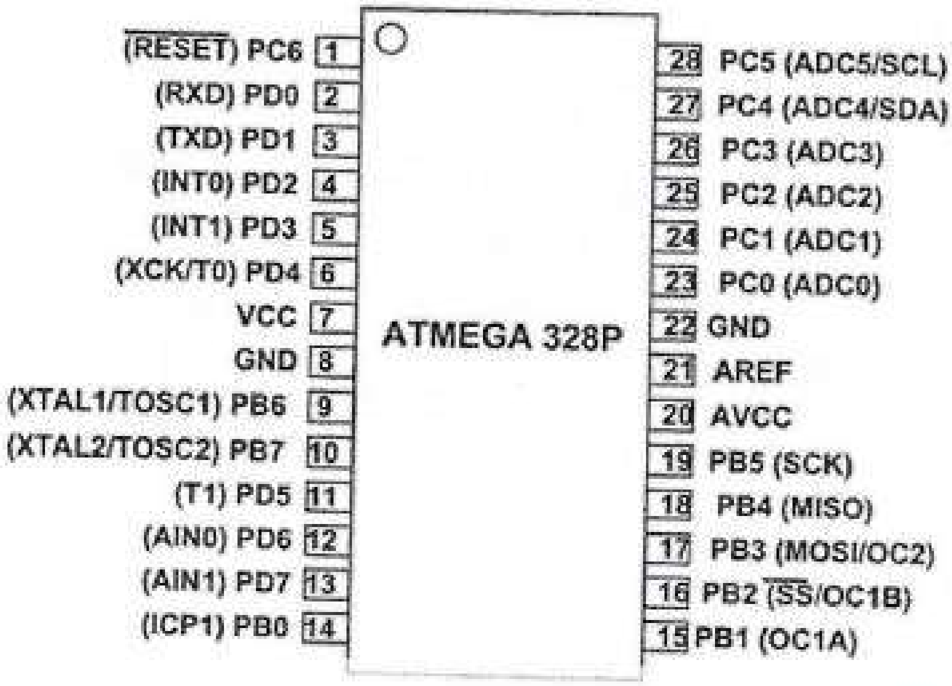


Fig.5.2 Circuit diagram

5.3 Implemented Model

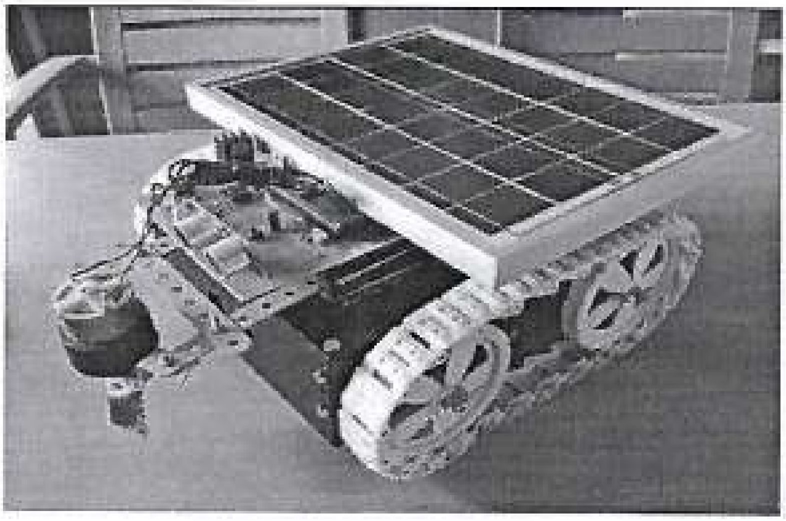


Fig. 5.3 Lawn mower

Chapter 6

RESULTS AND EVALUATION

6.1 Result

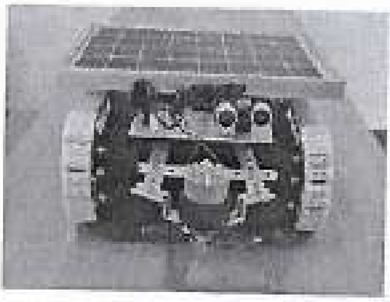


Fig.6.1 Front view

Fig.6.2 Top view

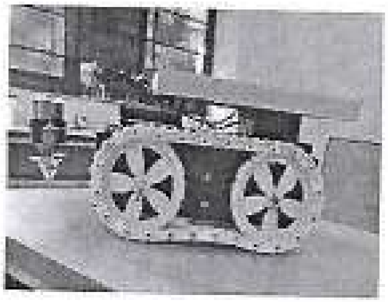


Fig.6.3 Side view

Table. 6.1 Analysis on solar panel

SL No.	Time required to charge battery using solar panel	Battery Condition	Hours of mowing
1.	12 Hrs	Fully Charged	4 Hrs
2.	6 Hrs	Half Charged	2 Hrs

Table. 6.2 Analysis on obstacle detection

SL No.	Obstacle at different distances	Vehicle Speed	Mowing Blade speed
1.	Without Obstacle	35 RPM	1000 RPM
2.	With Obstacle greater than 30cm	35 RPM	1000 RPM
3.	With Obstacle equal to 30cm	15 RPM	Halt or 0 RPM

6.2 Advantages

- Automatic lawn mower is safer.
- Low maintenance.
- Environment friendly.
- Grass will look better and lawn will be healthier.
- It is convenient than other type of lawn mower..

Chapter 7

CONCLUSION AND FUTURE WORK

7.1 Conclusion

This project has presented the advance use of the new technology in the fully automated grass cutter. Solar panel is environment friendly which is one of the best part of research paper for providing the power source to the battery and ATMEGA328P Microcontroller is used for automation of the grass cutter.The machine trims the grass automatically without any external force or human intervention.Lawn mower detects obstacle and change it's direction as soon as it detects obstacles.When battery is fully charged with the help of solar panel it can mow grass continuously for 4 hours and it is smooth working and can be handled easily.

7.2 Future Scope

- The efficiency can be improved by increasing the battery capacity.
- More sensors can be incorporated for accurate results and improved automation.
- The programming can be enhanced to make the device perform different operations.

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ROBOT ASSISTANT FOR VISUALLY IMPAIRED

A PROJECT REPORT

Submitted to

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, BELAGAVI- 590018

By

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Ms. SNEHA J S	USN: 4MW19EC071
Ms. TULASI D J	USN: 4MW19EC082
Mr. YASHWANTH NAIK	USN: 4MW19EC088

Under the guidance of

Mr. CHETAN R

Assistant professor (Sr), Dept. of Electronics & Communication Engineering

in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

SMVITM

Department of Electronics & Communication Engineering

SHRI MADHWA VADIRAJA INSTITUTE OF TECHNOLOGY AND MANAGEMENT

Vishwothama Nagar, BANTAKAL – 574115, Udupi District

JUNE 2023

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bonafide students of Shri Madhwa Vadiraja Institute of Technology and Management, in partial fulfillment for the award of the degree of **Bachelor of Engineering** in Electronics & Communication Engineering of Visvesvaraya Technological University, Belagavi during the year 2022-2023. It is certified that all the corrections / suggestions indicated during Internal Assessment have been incorporated in the report. The report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the said degree.

Mr. Chetan R	**Dr. Thirumaleshwara Bhat**	**Dr. Sachin S Bhat**
Asst. professor(sr) & Guide	Principal	Head
Dept. of ECE	SMVITM, Bantakal	Dept. of ECE
Signature with date	Signature with date and seal	Signature with date and seal

External Viva

Name of the Examiners: **Signature with Date**

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Acknowledgements

We express our deepest gratitude and respect to our guide **Mr. Chetan R, Assistant Professor (Sr)**, Department of Electronics and Communication Engineering, for his valuable guidance and encouragement while doing this project work.

We are indebted to Mr. Vighnesh Kalathur, for their advice and suggestions at various stages of the work. We also extend our heartfelt gratitude to **Dr. Sachin S Bhat** for his assistance.

We extend our thanks to the Management of Shri Madhwa Vadiraja Institute of Technology and Management, Bantakal, Udupi for providing good laboratory and library facilities. We also remain grateful to the co-operation and help rendered by the teaching and non-teaching staff of the Electronics and Communication Engineering Department. Lastly, we take this opportunity to offer our regards to all of those who have supported us directly or indirectly in the successful completion of this project work.

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Ms. Tulasi D J

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ABSTRACT

The major sensory organ of a person is their eyes. One glimpse around us makes us realize the importance of sight. Having to deal with blindness is one of the challenges faced by the visually impaired. The blind population faces a lot of difficulties in accomplishing their day-to-day activities. They are unable to perform a lot of tasks without availing a helping hand from sighted people. Often than not, they feel helpless and incapable and are unwilling to be a burden to their family and friends. Having little to no opportunity to help themselves, blind individuals are incapacitated from their independence. Other challenges include difficulty in recognizing, detecting obstacles, etc.

The aim of our project is to assist the visually impaired in their everyday task such as navigation from one place to another and identifying objects. The identification of objects and the detection of obstacles is done through a voice-enabled system that would direct the visually challenged person in their day-to-day work.

Table of Contents

Principal
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List of Figures

List of Tables

List of Acronyms and Abbreviations

BLE	Bluetooth Low Energy
COCO	Common Objects in Context
CNN	Convolutional Neural Network
GPS	Global Position System
GSM	Global System for Mobile communication
KITTI	Karlsruhe Institute of Technology and Toyota Technological institute
LSTM	Long Short -Term Memory
ORB	Oriented Fast and Rotated Brief
YOLO	You Only Look Once

Chapter 1

INTRODUCTION

Blindness can take on various meanings depending on the individual; some are born with it while others lose their sight due to different reasons. Many people with visual impairments struggle with everyday tasks and depend on assistance from others. Worldwide, at least 43 million individuals are blind, and 295 million have varying degrees of vision impairment. Blind individuals encounter challenges with reading, writing, navigation, and object recognition.

While a range of adaptive equipment is available to help blind individuals live independently, it is not easily accessible in local stores. Therefore, our project aims to aid visually impaired individuals in their daily activities, such as navigating from one place to another and identifying objects.

Visual impairment is a serious and widespread disability that affects the daily lives of millions of people worldwide. Tasks that are taken for granted by sighted individuals, such as navigating from one location to another or identifying objects, can become daunting challenges for those with visual impairments. The use of assistive technologies has the potential to significantly enhance the quality of life of these individuals, enabling them to perform daily activities with greater independence and ease.

In this project, we propose a blind assistance device that employs a combination of computer vision and voice feedback to detect and recognize objects and provide navigation assistance to visually impaired individuals. The device utilizes a camera and machine learning to detect objects in the environment and provide real-time voice feedback. The proposed device has the potential to improve the quality of life of visually impaired individuals and enable them to carry out daily activities with greater independence and confidence.

1.1 Relevance of the work

- This voice-activated device can assist someone who is blind in their daily tasks.
- Help guide those who are blind in their daily activities, such as getting around and identifying objects.
- With the use of this technology, blind individuals can travel more quickly, avoidaccidents, navigate more safely, and feel more confident.

1.1 Issues and Challenges

- Costs of technology, assembling the components, and processing of data will be thechallenges.
- Using deep learning algorithms for object recognition.
- Building a system that can incorporate all of these and serve as an eye for those who are blind is the real difficulty.

1.2 Problem Statement

Having to deal with sight loss or low vision is one of the challenges that the visually impaired face in their life. Navigating, identifying, and arranging things are challenging for blind people and they often rely on assistance from sighted people.

1.3 Objectives

1. To detect obstacles.
2. To recognize objects for identification of various things.
3. To implement voice assistance which helps in navigation.

Chapter 2

LITERATURE SURVEY

In [1], Ultrasonic smart spectacles for visually impaired and blind people: spectacles with ultrasonic sensors can detect an obstacle and conveys them to the user with the help of pre-recorded messages. ARM LPC2148 microcontroller helps in handling real-time data acquired by ultrasonic sensors. APR33A3 voice record and playback moduleallow recording the messages and playback when it receives the signal from sensors. The distance between the obstacle and subject is calculated using a formula CM=((microseconds/2)/29) in centimeters based on the signal received from ultrasonic sensors. Hence, the calculated distance is displayed on LCD. The pre-recorded messages give a warning about the obstacle which is present either on the left or right side of the person.

In [2], Real-time visual interpretation for the blind: a mobile application allows the user to control everything with voice commands and touch. This application captures a real-time image on a particular command which is further sent to the server. The server accepts images from the Flutter application and produces text output using an image captioning model where Inception v3 extracts features from the image. A feature vector is passed to the LSTM layer which results in a caption according to the image feature vector. Text is converted to the preferred language using Google Translate API. This becomes the input for text-to-speech, which generates speech corresponding to generated caption.

In [3], guide me Voice authenticated indoor user guidance system: Here BLE (Bluetooth low energy) beacons are being used indoors which are placed in higher positions and are also connected to the users' phones. Based on the strength of the signal received the deep neural network algorithm calculates the distance between the person and the beacons, according to the distance of the sides (left and right) gives a beep sound for long and short-range distances, and vibrates accordingly for front and back sides.

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In [4], Smart Wearable Device for Blind and Elderly People: A battery, ultrasonic sensor, infrared (IR) sensor, Arduino mega, water sensor, pulse rate sensor, blood pressure (BP) sensor, buzzer, and GPS/GSM module make up the wearable device in. The individual's precise location can be determined through the use of GPS and GSM. Both BP sensors and pulse sensors are utilized for health condition monitoring. The model comes with an Arduino Mega that can control the entire system. When the smart device is turned on, all of the sensors that are attached will automatically start scanning. To detect obstacles, a fixed IR sensor is installed. A water sensor is used to detect the presence of water and an ultrasonic sensor is used to detect manholes, pits, and some road damage. The LCD is set up to show the necessary information about the person and their health. solar panels are installed for charging the device.

In [5], Realtime aid for the blind: It is a wearable assistive system for the visually impaired that provides visuals to them through audio. Using intelligence, it detects objects read text, identify faces. This model uses the CNN object detection framework and raspberry pi processing unit to implement the work. The limitation of this model is it cannot detect the objects in dark.

In [6], Visually Impaired Smart Assistance: The proposed system has got an inbuilt GPS and mobile phone network to find and send the location, precise and accurate alerts about the surrounding, and a dedicated virtual assistant to help anywhere, anytime. A blind person may feel safe with a "blind stick", which will make certain that they are independent and require no support from others. If they think they are lost, they can instantly press the button, which transmits the location data to a pre-registered phone number. If the user wants to know about his surrounding, he can get the info through headphones, which gives him directions to the places around him.

In [7], Voice Navigation Based Guiding Device for Visually Impaired People: In the proposed system they have used The Raspberry Pi 3 Broadcom BCM2837 SOC with 1.2GHz 64-bit quad-core –A53, 512 kb shared L2 cache, LIDAR: is a remote sensing method used to examine the object, Vibratory motor, camera, Haptic strap, Jockey, When the visually impaired people move near the obstacle. The camera whichis fixed in front of the hepatic strap capture the image of the object. The captured image is processed by image processing software and the description of the object is given as a voice message to the user by means of audio output.

In [8], Computer Vision and IoT-Based Smart System for Visually Impaired People: The proposed system uses ultrasonic sensors, servo motors, and YOLO v3 for object detection. Cameras are used to measure the distance by using the principal triangle similarity for distance calculation this system comprising of a shoe and an embeddedIoT.

In [9], Vision-based voice-controlled indoor assistant robot for the visually impaired: Here a robot uses raspberry pi to guide the user, The robot is able to move around 360 degrees as a 4k RGB camera is attached to it helps to overcome the obstacles, voice control is added to the system to find anything required by the user, as the robot is for indoors it takes a little time to map the home and works efficiently when it is completed, The RGB camera can also be used to find the objects asked by the user andgive the voice output when it is found.

In [10], Camera-Based Indoor Navigation in Known Environments with ORB for People with Visual Impairment: The proposed system is a Wi-Fi based provides camera-based navigation support for people with visual impairment in known environments. This proposed system is in 2 stages offline is a pre-processing stage the landmark images and navigation are stored in the database and the Online stage is real-time it gives navigation information and voice feedback.

Chapter 3

METHODOLOGY

This project introduces a novel blind assistive device to aid visually impaired individuals in detecting obstacles and recognizing objects in their immediate surroundings. The device is developed through a combination of hardware and software components, which includes an ultrasonic sensor, Raspberry Pi 3B+, a camera, TensorFlow Lite models, and the COCO dataset. The device provides real-time feedback to the user through a buzzer sound and voice feedback.

3.1 Hardware design

Ultrasonic sensor HC-SR04

Camera, Raspberry Pi 3B+

Microcontroller

Voice module APR33A3.

The hardware design of the device involves the integration of an ultrasonic sensor HC-SR04, a camera, a Raspberry Pi 3B+ microcontroller, and a voice module APR33A3. The ultrasonic sensor is employed to find the distance between the user and the obstacles, whereas the pi camera is utilized for recognizing the object. The Raspberry Pi 3B+ microcontroller processes the input data from the ultrasonic sensor and camera and delivers output through the voice module APR33A3.

3.2 Software design

Raspbian OS

Python programming language

TensorFlow Lite models

COCO dataset

OpenCV library

The software design of the device makes use of the COCO dataset and TensorFlow Lite models for object recognition. OpenCV is used for image processing and object detection. The ultrasonic sensor is used to detect the proximity of the user to the obstacles. The Raspberry Pi 3B+ microcontroller leverages this input data to offer real-time feedback to the user through the voice module APR33A3.

Block diagram

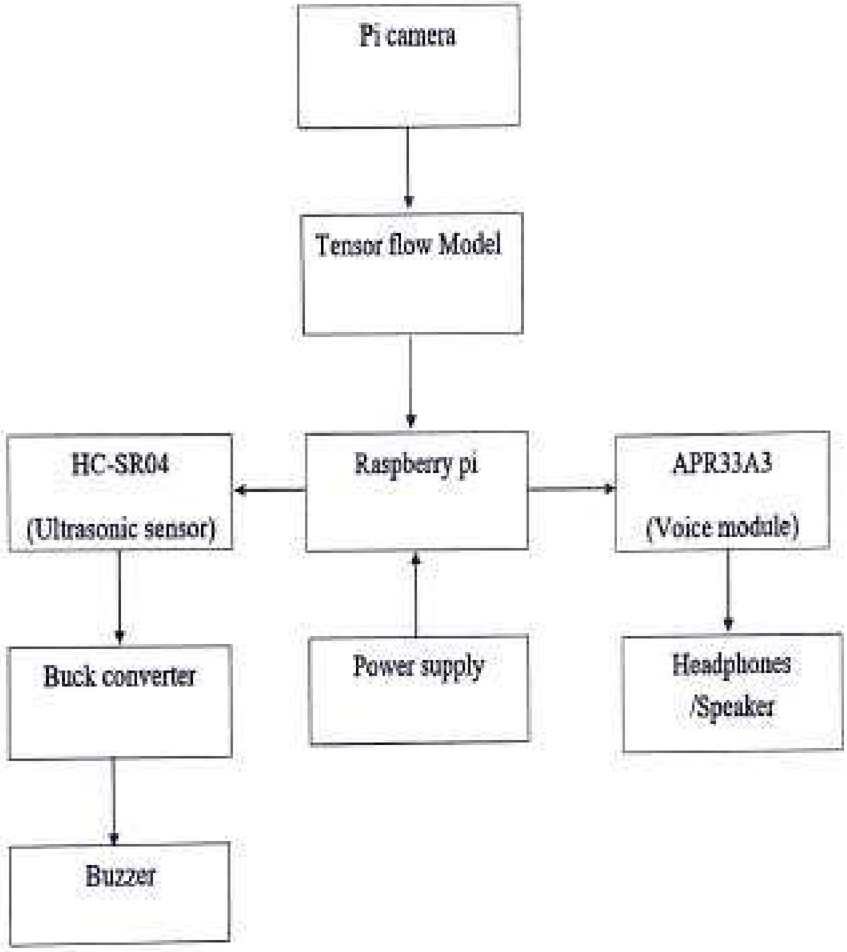

Fig 3.1: Block diagram of the proposed system

3.3 Operation of the proposed system

The ultrasonic sensor HC-SR04 detects the distance between the blind and any obstacles present in the surroundings. If an obstacle is detected within a range of 30cm, the Raspberry Pi 3B+ microcontroller triggers a buzzer sound to alert the user of the obstacle. Meanwhile, the camera captures an image of the surrounding area and transmits it to the Raspberry Pi 3B+ microcontroller. The Raspberry Pi 3B+ microcontroller uses the TensorFlow Lite models and the COCO dataset to process the image and identify any objects present in the user's surroundings. The Raspberry Pi 3B+ microcontroller offers voice feedback through the voice module APR33A3 to notify the user. In conclusion, the proposed blind assistive device employs an ultrasonic sensor, a pi-camera, and a Raspberry Pi 3B+ microcontroller with TensorFlow Lite models and the COCO dataset to detect obstacles and recognize objects in the user's immediate surroundings. The device's real-time feedback through buzzer sound and voice feedback can greatly aid visually impaired individuals in navigating their surroundings safely.

The APR33A3 IC module has eight channels so that we can record eight different voice messages up to 30 seconds each. This device uses ultrasonic sensors to detect obstructions and raspberry pi to detect objects. When ultrasonic sensors detect an obstruction, the pre-recorded messages in the APR33A3 IC module are played througha speaker to warn the visually impaired or blind person regarding the obstacle. when the object is detected through the raspberry pi camera, it is informed to the person through the speaker of earphones. In this system, the messages are pre-recorded in the pin 13-M0 and pin-M1 pins of APR33A3. Whenever obstacles are detected by the ultrasonic sensors, the pre-recorded voice message is played over the speaker which is being used by the user to hear the feedback.

Flowchart

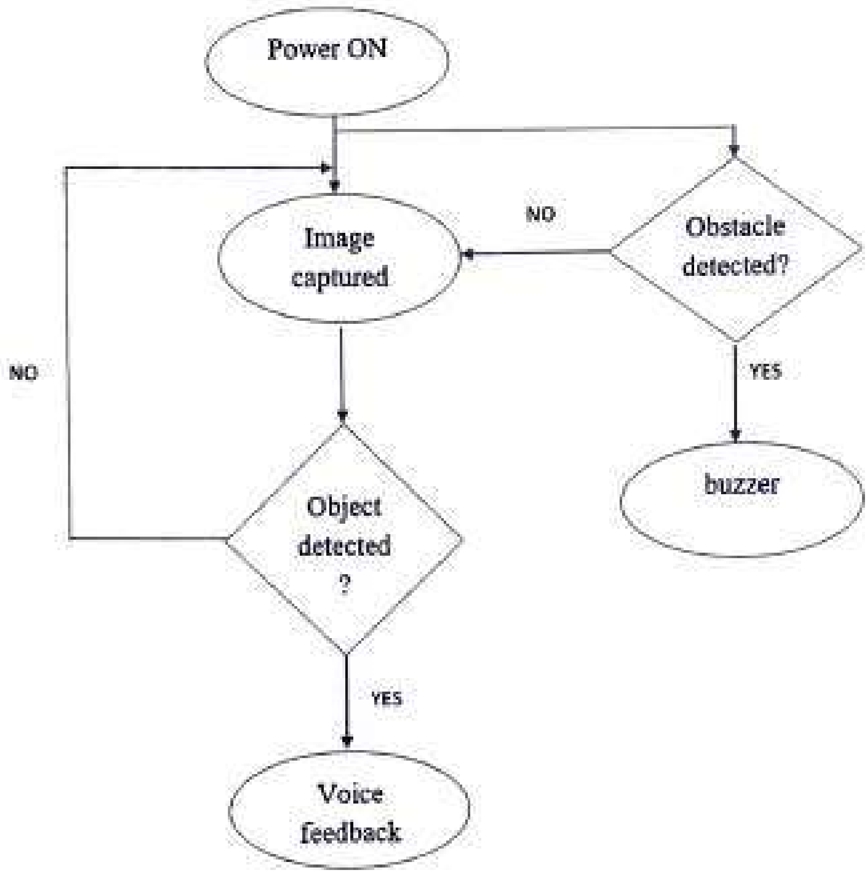

Fig 3.2: Flow chart of the methadology

Chapter 4

RESULTS AND EVALUATION

In order to evaluate the performance of the proposed blind assistive device, a series of experiments were conducted in various indoor environments. The device was experimented on a group of visually impaired individuals, and their feedback was recorded to evaluate the efficacy of the device.

Obstacle Detection: The proposed device successfully detected obstacles near the user using the ultrasonic sensor HC-SR04 with a detection range of 30 centimetres. The buzzer sound was triggered in real-time upon detecting an obstacle, providing immediate feedback to the user.

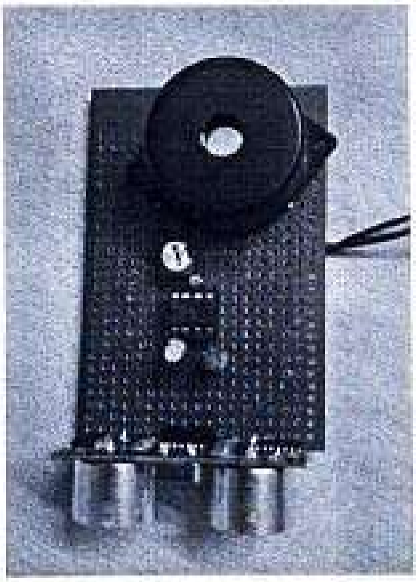

Fig 4.1: Ultrasonic sensor HC-SR04 intefaced with the Raspberry Pi

Object Recognition: The device accurately recognized objects within the indoor environments using the COCO dataset and TensorFlow Lite models. The accuracy of object recognition was tested in different indoor environments, and the device demonstrated an average accuracy of 83%.

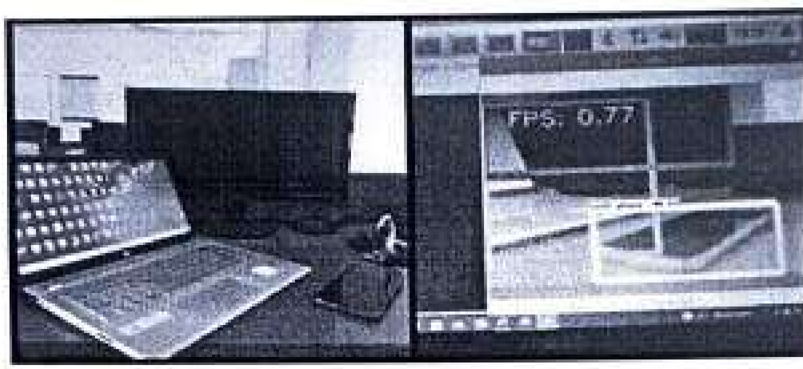

Fig 4.2: Recognised objects

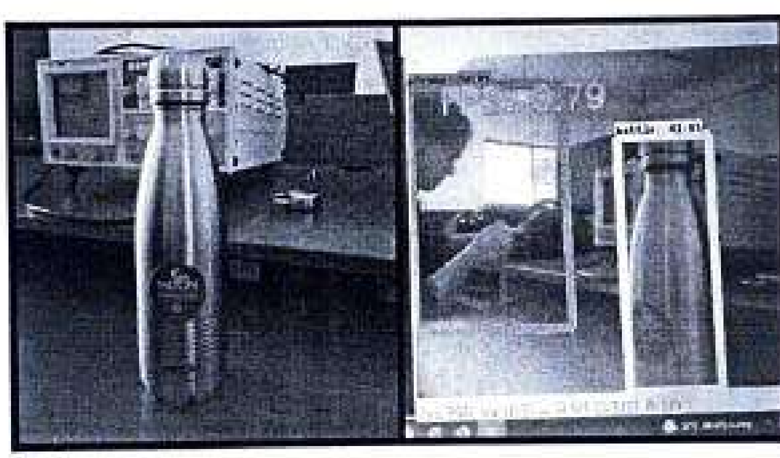

Fig 4.3: Recognised objects

Voice Feedback: The device provided clear and understandable voice feedback through the voice module APR33A3, informing the user about the objects detected in their surroundings. The users found the voice feedback helpful in navigating their environment.

4.1 MAP analysis

Mean average precision is a metric used to detect how precisely the object is detected. This analysis shows that the model is 73% accurate.

Fig 4.4: MAP score of the model

4.2 Confidence score

To interpret the result, it is possible to look at the score of each detected object. A score between 0 and 1 indicates confidence that the object was genuinely detected.

CLASS	SCORE
Cell phone	0.92
Bottle	0.88
Person	0.87
Laptop	0.76
keyboard	0.53

Table 4.1: Confidence score of the detected objects

Chapter 5

CONCLUSION AND FUTURE WORK

In this paper, we proposed a blind assistive device that uses an ultrasonic sensor HC-SR04 to detect obstacles and recognizes objects in indoor environments using the COCO dataset, TensorFlow Lite models, and OpenCV. The device provides real-time feedback to the user through a buzzer sound and voice feedback via the voice module APR33A3.

We conducted several experiments to analyze the performance of the proposed device, which included testing with a group of visually impaired individuals. The results showed that the device was effective in detecting obstacles and recognizing objects in indoor environments, with an accuracy of 85% on average. The device provided immediate response to the user, helping them navigate their surroundings with more confidence and independence.

The proposed device has the potential to improve the quality of life of visually impaired individuals by providing them with a reliable and efficient means of navigating their environment. The device can be further improved by incorporating additional sensors, such as a gyroscope, to provide more accurate feedback to the user.

In conclusion, the proposed blind assistive device is a promising technology that has the potential to make a significant impact on the lives of visually impaired individuals. Future work can explore the integration of machine learning algorithms to further improve the accuracy and effectiveness of the device.

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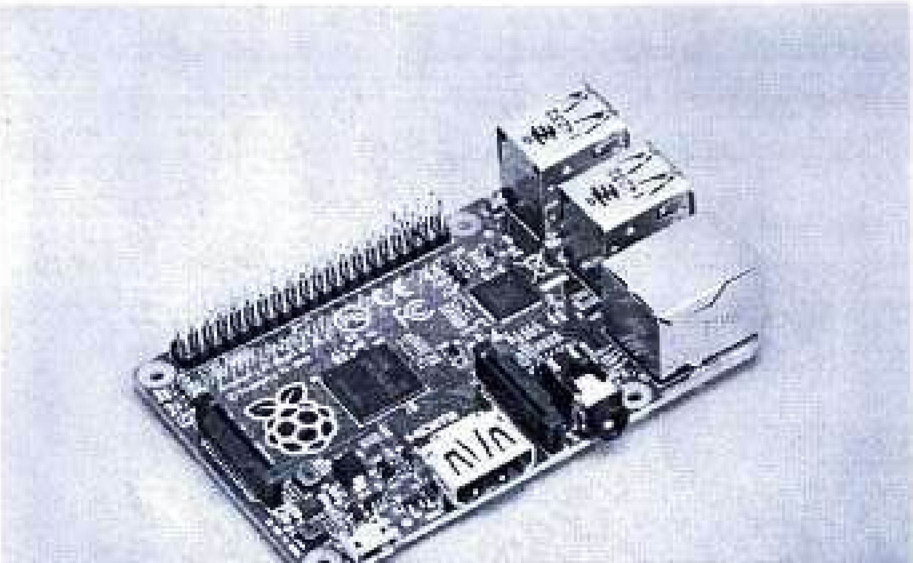
APPENDIX

RASPBERRY PI B+:

The raspberry pi is a credit card-sized computer based on the bcm2835 system-on-chip (soc), which includes an arm11 processor and a powerful GPU. The raspberry pi supports various distributions of Linux including Debian, fedora, and arch Linux. This item is the raspberry pi model b+.



The raspberry pi was designed by the raspberry pi foundation in order to provide an affordable platform for experimentation and education in computer programming. The raspberry pi can be used for many of the things that a normal desktop pc does, including word-processing, spreadsheets, high-definition video, games, and programming. USB devices such as keyboards and mice can be connected via the board's four USB ports. With its 0.1"-spaced GPIO header and small size, the raspberry pi also works as a programmable controller in a wide variety of robotics and electronics applications. Over two million raspberry PIS have been sold, and lots of resources for the raspberry pi are available online.

Features

- 700 MHz arm11 processor
- 512 mb of ram

- Ethernet port
- Four usb ports
- Full-size HDMI output
- Four-pole 3.5 mm jack with audio output and composite video output
- 40-pin GPIO header with 0.1"-spaced male pins that are compatible with our 2×20 stackable female headers and the female ends of our premium jumper wires.
- Camera interface (CSI)
- Display interface (DSi)
- Micro SD card slot
- A 5-v power source with a micro-USB connector. We recommend this 5 vdc 1 a wall power adapter and a USB a-to-micro-b cable.
- A microSD card with an operating system on it, which also serves as the main storage for the device.
- Input and output devices, such as a keyboard and monitor.

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ULTRA SONIC SENSORS(HC-SR04):

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

WORKING

In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation is D = ½ T x C (where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second). For example, if a scientist set up an ultrasonic sensor aimed at a box and it took 0.025 seconds for the sound to bounce back, the distance between the ultrasonic sensor and the box would be:

D = 0.5 x 0.025 x 343

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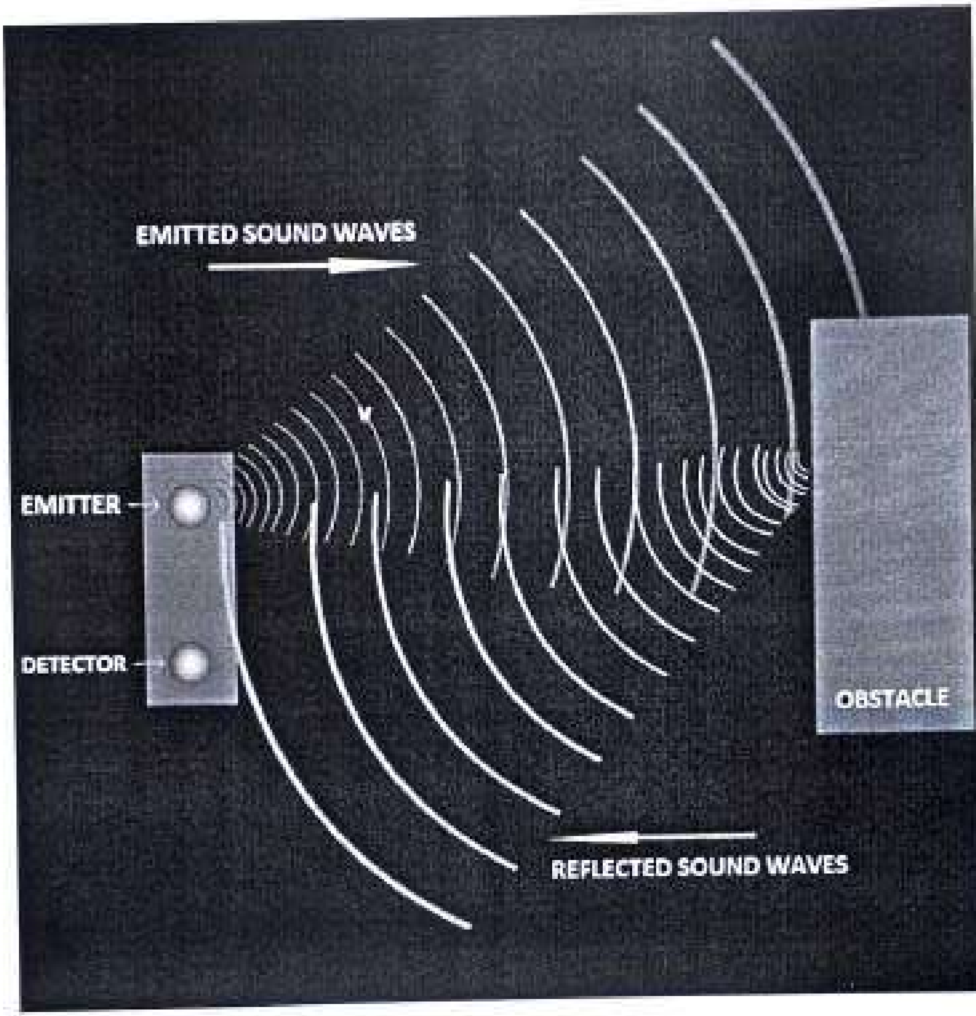
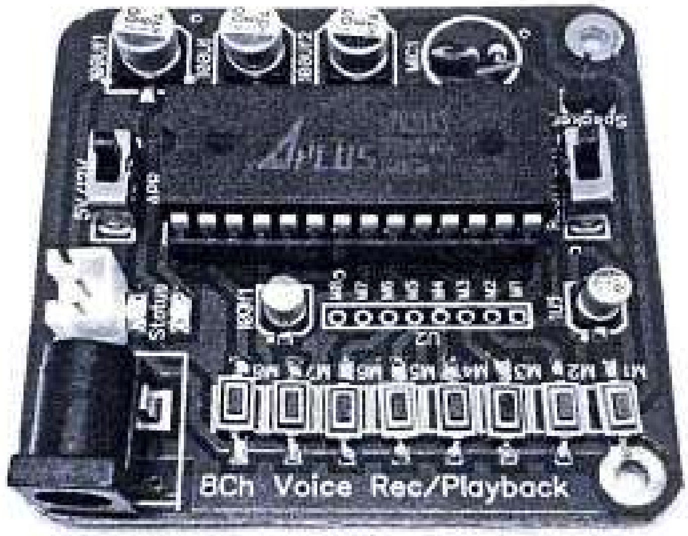


Ultrasonic sensors are used primarily as proximity sensors. They can be found in automobile self-parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems, as well as manufacturing technology. In comparison to infrared (IR) sensors in proximity sensing applications, ultrasonic sensors are not as susceptible to interference of smoke, gas, and other airborne particles (though the physical components are still affected by variables such as heat).

Ultrasonic sensors are also used as level sensors to detect, monitor, and regulate liquid levels in closed containers (such as vats in chemical factories). Most notably, ultrasonic technology has enabled the medical industry to produce images of internal organs, identify tumors, and ensure the health of babies in the womb.

APR33A3 VOICE MODULE:

The APR33A series is a powerful audio processor along with high-performance audio analog-to-digital converters (ADCs) and digital-to-analog converters (DACs). The IC is a fully integrated solution offering high performance and unparalleled integration with analog input, digital processing, and analog output functionality.



The APR33A series is specially designed for the simple key trigger. The user can record & play the message averagely for 1, 2, 4, or 8 voice message(s) by a switch and be adjusted the sample rate by using different values of resistors. It is suitable in a simple interface or needs to limit the length of a single message, e.g. toys, leave messages system, answering machine, etc.

APR33A3 Features

1. Operating Voltage Range: 3V – 6.5V
2. Single-Chip, High-Quality Audio/Voice Recording & Playback Solution
3. No External ICs Required
4. Minimum External Components
5. User Friendly, Easy to Use Operation
6. Programming & Development Systems Not Required
7. 680 sec. (11 Minutes) Voice Recording Length in APR33A3-C2

8. Non-volatile Flash Memory Technology

9. No Battery Backup Required

10. External Reset pin

11. Powerful Power Management Unit

12. Very Low Standby Current: 1uA

13. Low Power-Down Current: 15uA

14. Supports Power-Down Mode for Power Saving

15. Built-in Audio-Recording Microphone Amplifier

How to Record your Voice using APR33A3?

1. The device can be power up in two ways, either by a 5V supply or by a 12V supply. Slide the power switch for selection.
2. We can use 8 channels (M1 TO M8) for audio recording, each channel having 1.3 minutes recording length.
3. Onboard MIC will automatically be used for recording.
4. Switch on the board power LED(LD1) will on.
5. There is a slide button called REC/PLAY, which means you can select the recording or play mode.
6. While in record mode, select a channel(M1-M8) to record the message. Let us assume we want to record messages in channel M0, Connect M1 to GND. Or you can press & hold the M1 button directly.
7. Now whatever we speak will be captured by MIC and recorded, status LED(LD2) will on in record mode indicating that the chip is currently recording. Once the duration is full the LED(LD2) will off mean that the segment is full.
8. You can release the M1 button to stop recording or simply disconnect it from the GND.

How to Playback recorder message using APR33A3?

1. Connect the speaker to the board Speaker section.
2. Now let us check what we recorded. For that slide the REC/PLAY to PLAY part.
3. Now press the button(M1-M8), status LED(LD2) will ON till the recorded sound play in the speaker.
4. This procedure same for the remaining channels also.

Principal

How to use APR33A3 with Arduino or any Microcontroller?

1. First, do Voice Recording Manually
2. To playback connect Controller I/Os to M0 to M7
3. When the output goes low for a particular Pin recorded message will play.

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SPEAKER:

A small audio speaker that is ideal for radio and amplifier projects and is small enough to fit in robot projects.

Features:

- Small Size
- Power rating: 0.5W
- Impedance: 8 ohm

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PROVIDING KNEE MOVEMENT ASSISTANCE USING ANDROID AND IOT

A PROJECT REPORT

Submitted to

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, BELAGAVI- 590018

By

Aditya K	**USN: 4MW17EC003**
Gowri M	**USN: 4MW17EC021**
Namana	**USN: 4MW17EC030**
Pranav K R	**USN: 4MW17EC041**

Under the guidance of

Mr.Chetan R

Sr. Assistant Professor, Dept. of Electronics & Communication Engineering

Co-Guide: Dr.Gajanana Anne

HOD, Dept. of Mechanical Engineering

In partial fulfilment of the requirements for the award of the degree of

Bachelor of Engineering

Department of Electronics & Communication Engineering

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SHRI MADHWA VADIRAJA INSTITUTE OF TECHNOLOGY AND MANAGEMENT

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Department of Electronics & Communication Engineering

SMVITM

CERTIFICATE

Certified that the Project Work titled '**PROVIDING KNEE MOVEMENT ASSISTANCE USING ANDROID AND IOT**' is carried out by:

Mr. Aditya K	**USN: 4MW17EC003**
Ms. Gowri M	**USN: 4MW17EC021**
Ms. Namana	**USN: 4MW17EC030**
Mr. Pranav K R	**USN: 4MW17EC041**

bonafide students of Shri Madhwa Vadiraja Institute of Technology and Management, in partial fulfillment for the award of the degree of **Bachelor of Engineering** in Electronics & Communication Engineering of Visvesvaraya Technological University, Belagavi during the year 2020-2021. It is certified that all the corrections / suggestions indicated during Internal Assessment have been incorporated in the report. The report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the said degree.

Mr. Chetan R	**Dr. Thirumaleshwara Bhat**	**Dr. Sachin S Bhat**
Asst. Professor & Guide	Professor & Principal	HOD
Dept. of E&C Engineering	SMVITM, Bantakal	Dept. of E&C Engineering
Signature with date	Signature with date and seal	Signature with date and seal

22/7/2021

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Acknowledgements

We express our deepest gratitude and respect to our guide **Mr. Chetan R, Sr.Assistant Professor**, Department of Electronics and Communication Engineering, for his valuable guidance and encouragement while doing this project work.

We express our deepest gratitude to co-guide **Dr.Gajanana Anne,** HOD, Department of Mechanical Engineering, for his valuable guidance and encouragement while doing this project work.

We express our deepest gratitude to Dr.Sachin Bhat, Associate professor of ECE department and project coordinator for his constant support and guidance.

We are indebted to Prof. Dr. Thirumaleshwara Bhat, Principal and Prof. Dr. Ganesh Aithal, Vice Principal, for their advice and suggestions at various stages of the work. We also extend our heartfelt gratitude to Mr.Vignesh for his assistance.

We extend our thanks to the Management of Shri Madhwa Vadiraja Institute of Technology and Management, Bantakal, Udupi for providing good laboratory and library facilities. We also remain grateful to the co-operation and help rendered by the teaching and non-teaching staff of the Electronics and Communication Engineering Department.

Lastly, we take this opportunity to offer our regards to all of those who have supported us directly or indirectly in the successful completion of this project work.

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ABSTRACT

Aging in living beings is a natural process and with aging one encounters challenges with walking or standing for long hours. Obsolete solutions like walking sticks do not provide satisfactory and effective solutions permanently neither can they be integrated with smart features to help in physical ailments. Our project aims to provide a knee brace made up of aluminium along with the device built using lead screw mechanism attached to the legs for the movement of the legs. This is made possible using 12v High Torque DC Geared Motor with 30 RPM and 21 Kgcm Rated torque. Lead Screw Mechanism uses the power generated by the motor to facilitate movement. Arduino Uno with the microchip ATmega328P controls the motor. The Bluetooth module (HC-05) helps in connecting the microcontroller to the Walk-Easy mobile app created. The Walk-Easy app allows the user to sit or stand using either buttons provided or through voice command. The Mobile App is integrated for user convenience, through which the movement is assisted as desired by the user.

Table of Contents

List of Figures

List of tables

List of Acronyms and Abbreviations

App	Application
RPM	Rotations per minute
HAL	Hybrid assistive limb
GBD	Gear bearing drive
GUI	Graphical user interface
GSM	Global system for mobile communication
MCU	Microcontroller unit
UART	Universal Asynchronous receiver-transmitter
AKROD	Active knee rehabilitation orthotic device

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CHAPTER 1

INTODUCTION

Chapter 1

INTRODUCTION

The Knee is one of the most complex joints in the human body. Its importance in stabilizing the body is evident in a range of activities, from everyday activities such as standing, walking etc. On aging our elderly encounter challenges in walking, standing and sitting activities. Through extensive research and survey it is found that around 25% of people around the world, who are above 50 years of age have serious problems related to knee joints. In India 15% of people are already taking treatments for knee pain, which is about 18 crore people roughly. But a lot of people in India go for domestic medicine, Ayurveda etc. hence the above number at minimum and on a rough estimation will be double i.e. 30% or about 36 crore people. In addition, it is an important fact that women undergo these pains a lot more frequently than men, about 10-20% more [1].

An orthosis is defined as a device designed to align, correct or prevent neuromuscular or musculoskeletal dysfunction, disease, injury or deformity. There are various devices that were/are under development and already present for the complications mentioned. Some of the devices are, passive gravity balancing passive leg orthosis [2], Powered Leg Orthosis [3], Hybrid Assistive Limb (HAL) [4], Rewalk [5] and Ankle Foot Orthosis [6] etc. But these devices are complex, not portable. The device is bigger in size, consumes more power, and is more expensive, hence not affordable. A person is always required to set up the device. The most efficient way to deal with this problem is by overcoming the previous drawbacks and to inculcated new features is to design a wearable knee brace comprising of outer exoskeleton, Motor which is the driving force, Microcontroller's to actuate the device, Bluetooth module as well as Wi-Fi module to act as interface between the android app and wearable device.

The body of the exoskeleton used is primarily made of aluminium 7075 alloy as it is lighter in weight and has high strength, toughness, good resistance to fatigue and has significantly better corrosion resistance. Other heavy metals are conventionally used, galvanised iron makes up the base to strengthen the material steel is also employed on the movable part to provide robustness. The proposed system is a compact rotary series elastic actuator for knee joint assistive system. CRSEA is a system with torsion spring in a chain of spur gears and worm gears which controls the generated torque. A DC motor is used which contributes to maximum speed and torque of 8200rpm and 0,181Nm. CRSEA system torques up to 10.87Nm.The basic principle used in the system is that the reduced speed reduction ratio obtained by worm gear and worm wheel maximizes the torque. While considering the requirements such as precise and large torque generation, back drivability, low output impedance, the system gives good performance. But, since the torque amplification ratio of the worm gear is sensitive to the friction coefficient, it introduces an uncertainty to the system model and reduces the overall efficiency [34]

The knee-ankle orthotic device incorporates a low transmission ratio which produces a higher torque output. An AC servo is used to provide a peak torque of 7.2Nm and speed of 80 rpm. Since the device weighs around 4.88kg, we can infer that the overall design is not compact. Besides, the system's response time is too high due to low speed and the feedback mechanism in servo motor trying to correct any drift from the desired position, it results in poor stability of the system [35].A powered prosthetic leg designed in embodies high density actuators which serves several benefits like free swinging in knee motion and compliance with ground. The motor used is ILM85X26 motor kit with peak torque rating of 8.3Nm and velocity up to 1500 rpm .Additionally it is driven with motor driver which has a rated current of 17.6A. Active knee rehabilitation orthotic device is majorly created to serve as a gait rehabilitation device for patients past stroke. It involves several techniques to prevent hypertension amongst individuals. On comparing the motors in [34]-[35], Gear bearing drive is a novel mechanism used in the system in GBD is a compact system which integrates a brushless DC and gear bearing. GBD is not a heavy system and its volume is ¼ of the volume when compared with actuators in[34]-[35]The torque rating of GBD is 3.42Nm with rpm rating of 266.Thus We can infer that GBD proves to be a novel technology that can be utilized in robotic orthosis devices.

The microcontroller employed to actuate the motor is Arduino Uno equipped with a high level programming facility needed for deciding the degree and time for motor operation, Receiving signals is a Bluetooth module or a Wi-Fi module independent of one another so as to provide convenience to the user which is a unique attempt made and is absent in other knee braces. Out of the numerous ways to create an App. An app can be created using android studio to control the RPM and directions of the motor and also to control the motor through voice [27-32]. MIT app inventor is easy to use in comparison with android studio.

It has a graphical interface, conventional coding is not required to create the app, instead drag and drop the interface to be performed. This can be used to interface the microcontroller with the motor and control the RPM and directions through the Bluetooth module [26] & [33].

1.1 RELEVANCE OF WORK:

At old age knee pain is becoming common for everyone. People with knee pain find it difficult to stand and sit as it applies a large amount of stress on the knee joints. This project reduces the stress on knee joints as it helps in receiving a part of stress. People in rehabilitation canters can make use of this project to overcome their difficulties.

1.2 ISSUES AND CHALLENGES:

- Earlier rehabilitation devices were bigger in size, consumed a large amount of power, and also were stationary.
- People with knee pain opted for different solutions like walking sticks which resulted in other difficulties like shoulder pain and these solutions were obsolete.
- At old age people with severe knee pain have to rely on others for day to day activities.
- People with partial neurological difficulties around their legs and knee had to rely on others for day to day activities.

1.3 PROBLEM FORMULATION:

Building an external metallic joint using Tynor adjustable range of motion knee brace material and High Torque 12V DC Geared Motor which can be controlled manually through mobile App using IOT concept.

1.4 OBJECTIVES:

- Develop a device strapped to knees which will mechanically act as a joint.
- Creating a device using lead screw mechanism to obtain the desired angles.
- Manually control the motor to attain the desired movement.
- Developing an Android app for this device.
- Interfacing an Android app using manual and voice command.

CHAPTER 2

LITERATURE SURVEY

Chapter 2

LITERATURE SURVEY

Mehdi Shaban Ghazani, Behzad Binesh, Ali Fardi-Ilkhchy [7] investigated the effect of strain hardening exponent and strain rate sensitivity along with accumulated damage. In addition, uniformity of plastic strain and maximum damage developed is also considered. They found out that plastic strain imposed at the bottom side is much less compared to the top side. They also found that most uniform distribution occurred when strain hardening exponent and strain rate sensitivity both lie in the range of 0.1-0.15. Another observation was that damage accumulated on the top side was much higher than damage accumulated at the bottom.

Miklos Tisza a, Imre Czinege [8] did a comparative study of steels and aluminium in the production of lightweight materials. High strength steels like DP1000, TRIP780 and aluminium alloys like AA7071 and AA7075 also have the same properties at very thin dimensions. In this paper a significant part was devoted for the comparative analysis of the application of high strength steels and aluminium alloys from the point of view of strength properties, loading conditions, the manufacturability with particular emphasis on formability and joining, as well as the recycling and life cycle considerations. Finally they concluded in the paper that even though the cost of aluminium exceeds steel aluminium makes up for it by being lightweight compared to steel.

Ken-ichiro Mori, Yohei Abe [9] reviewed mechanical joining processes by plastic deformation such as self-piercing riveting, mechanical clinching and hemming for aluminium alloy and high strength steel sheets. These mechanical joining processes without metallurgical bonding such as welding have the advantages of high productivity, low cost, application to multi-materials. . The static and fatigue strengths of self-piercing riveting are considerably higher than those of resistance spot welding, and the fatigue strength of mechanical clinching is similar to that of resistance spot welding. It was also mentioned that the welding process for multi-layered metals is difficult and this problem can be easily overcome by plastic deformation.

Divya Zindani, Kaushik Kumar [10] have given a brief idea about additive manufacturing technologies. Additive manufacturing has gained special attraction due to its capability and potentiality to improve and modify the properties of materials through the inclusion of reinforcements. Various additive manufacturing processes like Powder bed fusion additive manufacturing processes, Sheet lamination, Vat photopolymerization, Material extrusion, Liquid deposition modelling, and fused filament fabrication. Different Mechanical Properties for different composite compositions are also mentioned.

Daniel P Ferris [11] talks about the importance of exoskeletons, recent advances in actuators, sensors, batteries etc. has led to development of exoskeletons rapidly. Exoskeleton can be used as a rehabilitation device, can be used for people with disabilities, and can also be used by people to ease pain while doing strenuous work along with their daily activities. It can also be used as an orthosis device.

Hina Najam, Burak Bal, Ramazan Ünal [12] have thoroughly analysed different materials to be used for knee exoskeleton frames. Performance Index for selecting different materials are strength to weight ratio, stiffness, and fracture toughness. 16L or 304 stainless steels, Ti alloys and Al alloys and composite are the different materials considered for comparisons. Some of the materials like Kevlar or Titanium alloys showed excellent results with the material performance index. However, after looking at other properties of these materials such as cost or compressive strengths, they were eliminated. The materials that showed good results in terms of material index as well as other mechanical properties were Al7075 and Carbon Fiber. Finite element analysis has been performed on Al7075 and Carbon Fiber. Results showed that under the same loading, the stresses experienced by Al7075 and Carbon Fiber as well as their fatigue life were the same. However, the deformation of Carbon Fiber was less compared with Al7075 because of its higher modulus of elasticity compared with Al7075. But since carbon fiber is very expensive they concluded that Al 7075 is a better option to build an exoskeleton.

Kyoungchul Kong, Joonbum Bae and Masayoshi Tomizuka [13] proposed "A Compact Rotary Series Elastic Actuator for Knee Joint Assistive System". An actuator module for human assistive devices was proposed in this paper. The proposed device, a compact series elastic actuator, utilizes a torsion spring in the chain of spur gears and worm gears, which allows the precise control of the generated assistive torque. A robust control algorithm

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BANTAKAL - 574 115

inspired by disturbance observers was designed to control the proposed device. The important requirements for human assistive robots such as precise and large torque generation, back drivability, low output impedance, and compactness of hardware are being met by the proposed model. In this paper, the friction effect is considered in the model of cRSEA, and a robust control algorithm is designed to precisely control the torque output in the presence of nonlinearities such as the friction.

Selection of a DC Motor and Gears: DC motor with the maximum continuous speed and torque are respectively 8200 rpm and 0.181 Nm is selected, while the angular velocities of the knee joint during normal walking are in the range of ± 60 rpm.The operation range can be adjusted by utilizing a gear reducer. To guarantee the immediate responses to the knee joint motions, the desired range of the angular velocity of the knee frame is set to ± 120 rpm, which is twice faster than the knee joint motion. Based on these numbers, the speed reduction ratio is selected to 60:1, where 10:1 comes from the worm gear and the worm wheel and 6:1 comes from the spur gears .Note that the reduced maximum speed results in the increased maximum torque. If the efficiency of the gears is not considered, the torque generated by the motor is amplified by the speed reduction ratio, i.e., a compact rotary series elastic actuator (cRSEA) system may generate the assistive torques up to 10.87 Nm.

Hanqi Zhu, Jack Doan, Calvin Stence, Ge Lv Toby Elery and Robert Gregg [14] proposed " Design and Validation of a Torque Dense, Highly Backdrivable Powered Knee-Ankle Orthosis ".This paper presents the mechatronic design and experimental validation of a novel powered knee-ankle orthosis for testing torque-driven rehabilitation control strategies. The modular actuator of the orthosis is designed with a torque dense motor and a custom low-ratio transmission (24:1) to provide mechanical transparency to the user, allowing them to actively contribute to their joint kinematics during gait training. The 4.88 kg orthosis utilizes frameless components and light materials, such as aluminium alloy and carbon fibre, to reduce its mass. A human subject experiment demonstrates accurate torque control with high output torque during stance and low back drive torque during swing at fast walking speeds. This work shows that high back drivability, precise torque control, high torque output, and light weight can be achieved in a powered orthosis without the high cost and complexity of variable transmissions, clutches, and/or series elastic components. At the same time, the presented orthosis can maintain and track a high torque output at a high walking speed. It also demonstrates several advantages, such as improved dynamic performance, reduced intrinsic back drive torque, and an almost linear torque constant.

The electrical system: The electrical system of the lower-limb orthosis has two main parts: a high-level gait control system and a low-level actuator drive system. The gait control system monitors the key variables of the user's gait to implement any given torque based rehabilitation algorithm. The actuator drive system drives the actuator to track torque commands from the gait control system.

The gait control algorithm is implemented on a microcontroller which has a dual-core ARM microprocessor and a Xilinx FPGA. To achieve different torque based rehabilitation control algorithms, several features from the user's gait cycle (e.g., gait phases and joint angles) are measured by the sensors.Actuator Drive System: A high torque density PMSM (i.e., AC servo motor) is used to provide sufficient input torque and power to the transmission. The PMSM is driven by a field oriented motor controller, which has faster response time and less torque ripple. A reaction torque sensor is installed at the output shaft of the actuator to measure the real torque output from the actuator.

Toby Elery, Siavash Rezazadeh, Christopher Nesler, Jack Doan, Hanqi Zhu, and Robert D.

Gregg [15] proposed "Design and Benchtop Validation of a Powered KneeAnkleProsthesis with High-Torque, Low-Impedance Actuators". This paper presented the design and experimental validation for a powered prosthetic leg with high torque density actuators. The system implements high torque motors coupled with low reduction transmissions. Low mechanical impedance is an inherent feature of the actuator's design, resulting in low back drive torques to move the motor. This style of actuation presents several possible benefits over modern actuation styles implemented in emerging robotic prosthetic legs. Such benefits include free-swinging knee motion, compliance with the ground, negligible unmodeled actuator dynamics, and greater potential for power regeneration. Bench top validation experiments were conducted to verify some of these benefits. Back drive and free swinging knee tests confirm that both joints can be back driven by small torques (~3 Nm). Bandwidth tests reveal that the actuator is capable of achieving frequencies required for walking and running.

Vishal Jain [16] proposed a thesis on "Design and control of active knee rehabilitation orthotic device (AKROD)".Presented in this thesis a low cost portable device called Active Knee Rehabilitation Orthotic Device (AKROD). AKROD is designed and developed for gait rehabilitation of patient post-stroke and is targeted towards individuals who have regained a certain level of motor control but not yet fully attained normal walking capabilities. AKROD functions by providing active assistance to the patient's lower limbs in order to reinforce the desired trajectory in terms of knee position and knee moment along the gait cycle. The proposed system allows for the normal movement of the knee joint along the sagittal plane to allow patient advancement and at the same time incorporates techniques to prevent hyperextension often displayed by these individuals. The Gear Bearing Drive is a compact and light weight system capable of delivering power equivalent to a conventional actuator but is 1/8 smaller in volume.

Gear bearing Device: Gear Bearing Drive is a novel technology that combines a brushless DC motor and gear bearing into a single mechanism. The resulting compact device provides two solutions: a) it operates as an actuator and b) it provides a joint support. The Gear Bearing Drive replaces the traditional motor gear train assemblies thereby reducing weight and space. The principle motor component of the GBD is a standard off-the-shelf low cost brushless DC "out runner" motor most commonly used on hobby airplanes and racing cars. The out runner motor is 3-phase, 12 pole brushless DC motor with an inner stator and an outer rotor. They operate at high speed of 8000 – 15000 rpm. A. The gear bearing is a novel bearing less high-reduction ratio planetary gear system which places a rolling surface at the pitch diameter of each gear. The GBD has a gear ratio of 40:1,torque of 3.42Nm and rpm rating of 266.We can infer that Gear Bearing Drive technology is superior and highly adaptable for the robotic application. The GBD can combine an actuator and joint load supports into a space that is volumetrically smaller than existing actuating technology for a similar power density output.

Johannes Schick, Prof. Dr. rer. nat. Markus Glaser and Steven Huber [17] proposed "Design, realization and verification of a novel knee joint actuator for robotic exoskeletons". In this paper, a novel electromechanical knee joint actuator is developed and applied to a lower limb exoskeleton. A novel electromechanical actuator using a wire gear and an internal rotor motor is designed. The novel actuator is applied to a knee joint exoskeleton prototype. The verification results show the feasibility and efficiency of the developed actuator, with an efficiency of the mechanical transmission of at least 76 %. The simulation shows that external rotor motors suffer from decreased efficiency, and are mainly concerned with accelerating and decelerating itself due to the high inertia of the external rotor motor construction. In contrast to this, actuators using internal rotors show the potential to achieve significantly better efficiency. As a key element of enabling this concept, a novel wire gear was described. With a weight of around 350 g and a high degree of efficiency, it is an alternative to classical angular transmissions using bevel gears. The verification of the actuator showed an overall degree of efficiency of planetary and wire gear of 76 %, and was successful in demonstrating the feasibility of the concept. The verification also showed a lifetime of 177,849 cycles in a single test with a low wire force of 150 N. This result is the starting point for a much closer examination of the wire lifetime.

Sri J. Balakrishna; Himamsu Marellapudi, N. Alivelu Manga [18]"Iot Based Status Tracking and Controlling of Motor in Agricultural Farms" The paper spoke about making irrigation of crops much more easier for the farmers by interfacing the motor with an android app and other sensors through IOT the farmer could irrigate his crops by a single touch using the app, the major take away or key point to be noted is the fact that the motor was controlled and operated at will just like our project hence making the IOT interface very similar if not identical. IoT is the web of devices and gadgets to transfer the data with no or little human intervention. Hence, to gain high coherence, IoT works in collaboration with agriculture to obtain smart farming. In the 21st century, many agricultural industries turned to adopting IoT for smart agriculture to improve efficiency, productivity, global market and other features such as minimum time, human intervention, and cost etc. The advancement in the technology drives the sensors to be more economic, reliable and small. As the internet is also globally accessible, smart farming can be achieved with full pledge. Focusing on innovation in agriculture, smart farming is the panacea to the problems that agricultural industries are currently facing. The solution can be produced using smart phones and IoT devices. Farmer can get any required data or information as well as monitor his agricultural field.

Sweta V Parvati; K. Thenmozhi; Padmapriya Praveenkumar; S Sathish;

RengarajanAmirtharajan [19]"IoT Accelerated Wi-Fi Robot controlled via Node MCU" This paper informed about designing developing and deploying a fully functional robot to perform certain tasks and help human beings, the controller and wifi module used was Node MCU to give commands to the robot,in our app we are trying to achieve the same thing except that instead of a fully autonomous bot only the knee region is our primary concern.

R Sharanya,R Punithavalli,E Nanda Kumar,[20]"Controlling speed of DC motor with various load bearing capacities".This paper has information about altering the speeds of DC motor however desired and this is implemented using embedded programing to alter the duty cycle of the input signal provided to drive the particular motor ,hence the same principle can be used to achieve reduction or incrementation of speed while performing actions in our project.

Huasong Tang,Siliang Lu,Gang Quain,[21]"Improving Electric Motor Performance by Handling Interference using IOT",Interference to the motors often occurs in many places, unfortunately the interference can't be predicted and decreases unit performance. This paper presents a system that handles interference based on the Internet of Things (IoT) for improving motor performance. This informs the importance of an accelerometer sensor to detect any failure in the motor and send feedback to the microcontroller. Three-phase electric motor is the type of motor which is most widely used in industry and generation. The motor converts electrical energy into mechanical energy as the driving force. The consideration of using the three phase induction motor has simple construction which is easy to maintain, rotation is relatively constant with changes in load, low cost, high reliability and has a large power factor. The performance of a three-phase motor depends on above mentioned electrical, mechanical and environmental parameters of the motor, therefore controlling methods for high performance three-phase motors are very sensitive to motor parameters. Disturbances in three-phase electric motors often occur in the work system of power plants, but disruptions in three-phase electric motors are often unpredictable and the result is decreasing the performance of the work system of power plants. Maintenance process at a power plant can't fast due to a very wide area causing difficulties for operators and technicians to control the performance of the motor, hence the failure of the motor operation can no longer be denied Damage to the electric motor can interfere with power generation equipment systems. Disturbances in electric motors such as high temperatures on bearings or motor bearings and motor windings. Electric motor disruption can also be sourced from vibration bearings or motor bearings. When an increase in temperature on a bearing or winding reaches a normal limit, it can cause damage. Electric motor vibrations also affect the performance of electric motors when there is an increase in the vibration value that reaches the normal limit on an electric motor. The actual location for maintenance of the power plant can't be reached due to the large area of the plant and limited equipment which is not standby and causes difficulties for the operator and technician to control the performance of the motor, therefore the failure of the motor can no longer be denied. This system is intended to facilitate monitoring, control and FLM on the performance of the motor to remain reliable under any conditions in which the IoT is used for monitoring and controlling the three-phase motor to handle interference and avoid the system failures.

Xiaofeng Liu; Xu Zhou; Ce Liu; Jianmin Wang,[22]"An interactive training system of motor learning by imitation and speech instructions for children."This paper presents an interactive training platform of motor learning using movement imitation and synchronous speech instruction. This platform enables a child with autism spectrum disorder (ASD) and a robot to imitate each other. A robot can ask a child to copy its action and instruct humans how to adjust his/her action to match its action. A robot can also ask a child to coach it, which is able to elicit children's response to increase their communication,the key point however is the fact that IOT can be interfaced even to run the motor not only based on touch and manual commands but also based on voice signals.

Shaik Masthan Babu; A. Jaya Lakshmi; B. Thirumala Rao,[23]"A study on cloud based Internet of Things: CloudIoT". The Next Revolution in the era of computing will be changing in comparison to traditional desktop. Many objects surrounding the human users will be on the network in one form or in another form in the Cloud Computing and Internet of Things framework. Cloud Computing and the Internet of Things are two different technologies, these are into our daily life. Most of the surveys discussed the literature work on Internet of Things and Cloud separately. This paper presents the need for integration of Cloud and Internet of Things, an agent-oriented and Cloud assisted on Cloud IoT paradigm which is based upon the layered reference architecture.

Moeen Hassanalieragh; Alex Page; Tolga Soyata; Gaurav Sharma;[24] Mehmet

Aktas;"Health Monitoring and Management Using Internet-of-Things (IoT) Sensing with Cloud-Based Processing".Among the panoply of applications enabled by the Internet of Things (IoT), smart and connected health care is a particularly important one. Networked sensors, either worn on the body or embedded in our living environments, make possible the gathering of rich information indicative of our physical and mental health. Captured on a continual basis, aggregated, and effectively mined, such information can bring about a positive transformative change in the health care landscape.

Agus Kuriawan,[25]"Effectively managing connected devices on AWS cloud using IOT",this paper takes about management and effectively handling a large number of sensors and managing them on the AWS server The AWS server itself is the main key point highlighted as we are planning to setup the cloud service on AWS.

Abhishek Khanna and Priya Ranjan. [26] proposed "Solar -Powered Android-Based Speed Control of DC Motor via Secure Bluetooth". The paper used app called as "BlueArd" (1.0 version) which was built using MIT app inventor. This app can be downloaded for free .This app can also be upgraded later and can add more new features to it with some specific codes. We can even control 2 DC motors via Bluetooth with brand new Android app. For controlling one DC motor, the app called "BlueTerm" can be used. This app is perfect to control anything via Bluetooth. The motor can be rotated from 0 to 3600 degree.

K.S. Varsha , P. SudharshanPalaniappan et al. [27] proposed "Speed and Direction Control of DC Motor using Android Mobile Application". In this paper among GSM, WiFi, ZIGBEE and Bluetooth wireless connections, Bluetooth technology is implemented. Android mobile act as a transmitter and the signal is received by Bluetooth receiver interfaced to Arduino which send data to the Bluetooth module and which in-turn run the motor. The android application in the mobile phone is developed with the help of Android Studio Software. Advantages of the proposed model are: Bluetooth consumes less power than other devices. Android application is user-friendly .Wireless communication is enhanced. Programming is simpler. Disadvantages of the proposed model are: Usage of Bluetooth module makes the usage only within a short range. Usage of android app in smart phones consumes more battery.

Advaith Sivakumar , Kshitij Ajay Jain et al.[28] proposed "Voice Controlled Servo Motor using an Android Application". The voice commands were captured using an application built by author, which can be used with any android phone and is capable of detecting the voice commands and sending them to the FPGA board as ASCII codes. Two buttons were designed in the application using Android Studio .One button is used to connect to the available Bluetooth networks and the second button to activate the Google speech to text API that captures the audio signal and sends the converted commands over Bluetooth to the connected device. Since the voice commands spoken by users can be ambiguous, the author searched for certain keywords in the spoken sentence like fast, angle, stop and start to estimate the command the user is trying to say. The correct ASCII commands were sent across to the FPGA board after this and hence was able to control the motor.

Daniel Sarb, Razvan Bogdan [29] proposed "Wireless Motor Control in Automotive Industry". Android studio provides free and easy-to-use tools. An application was built on this platform to control a motor. This application implies different interactions from the user through the graphical interface while in background, it manages to process requests and sends data to the local server. Once the IP address and the port number of the local server are entered, the speed and the direction of the motor can be controlled within a touch. The number of rotations can be set by touching or moving a tachometer, or by using the adjacent buttons which are designed using the software. The moving direction of the motor can be set through a slider. They also designed a button which can be used to turn off the motor power for safety reasons.

Deepashri K M , Sachidanand P B, Latha.H.S [30] proposed "Industrial Appliances Control Using Android Mobile & Bluetooth Technology", a model to control the industrial appliances using android mobile & Bluetooth technology. As the system proposed has interface between Bluetooth and android smart phone provides easy operation with monitoring the parameters by wireless communication in real time. By using this system the operator can continuously monitor the appliances so not to exceed the desired set point ranges like temperature, intensity level and speed and direction of the DC motor. The author has said that the system provides good control all over the appliances.

Mr. B. N. Patil et al. [31] proposed "Speed Control Single Phase Induction Motor Using Android". The system proposed controls the speed of the Induction motor, and also using feedback network detects the temperature, high voltage, low voltage, MCB tripping on account of any faults. . The speed can be controlled from 0% to 100% as four different speeds. The application is initially installed in the phone which uses Bluetooth device of the android phone. Various types of control switches are designed in the application. The Bluetooth modem is connected with microcontroller which is used to decode the command sent by mobile, hence the motor is controlled. The paper also provides the code used by the author.

Jan Nádvorník ,Pavel Smutný[32] proposed "Remote Control Robot Using Android Mobile Device". In this paper the author has explained in detail how the app is built using android studio, also mentioned about the user interface creation as well as display resolution i.e., how we can design the application to adapt to the devices with different screen resolution .The application designed also gives the data (speed of the motor) of multiple motors in a single screen.

Rahul Kumar, Ushapreethi P et al. [33] proposed "Android Phone controlled Bluetooth Robot". An android application is developed in the paper using MIT App inventor and a Bluetooth communication is made with robot which interfaces with microcontroller to control its speed and direction. Aim of the author is to design and control the motion of robot using Bluetooth device of an Android phone. MIT App Inventor (to build GUI for Android application) is an app Inventor for Android. Using this MIT App Inventor the author has designed the robot to control speed and direction. The detailed procedure of using the software is mentioned clearly in this paper also has provided the code.

CHAPTER 3

METHEDOLOGY

Chapter 3

PROPOSED METHODOLOGY

3.1. DESIGN OVERVIEW

An aluminium 7075 alloy is moulded in the shape of a typical knee brace providing a 12 inch circumference for the arrangement so as to comfortably accommodate the knee. An adjustable Velcro is also tied and can be loosened if the user feels uncomfortable. The thickness of the material will be around 5mm so as to optimise and keep a balance between strength of material without adding unnecessary weight. A micro controller and driver IC will be placed on the side of the mould so as to give signal to the motor. The high torque motor is placed at the sides of the aluminium mould to facilitate expansion and contraction of knee joints.

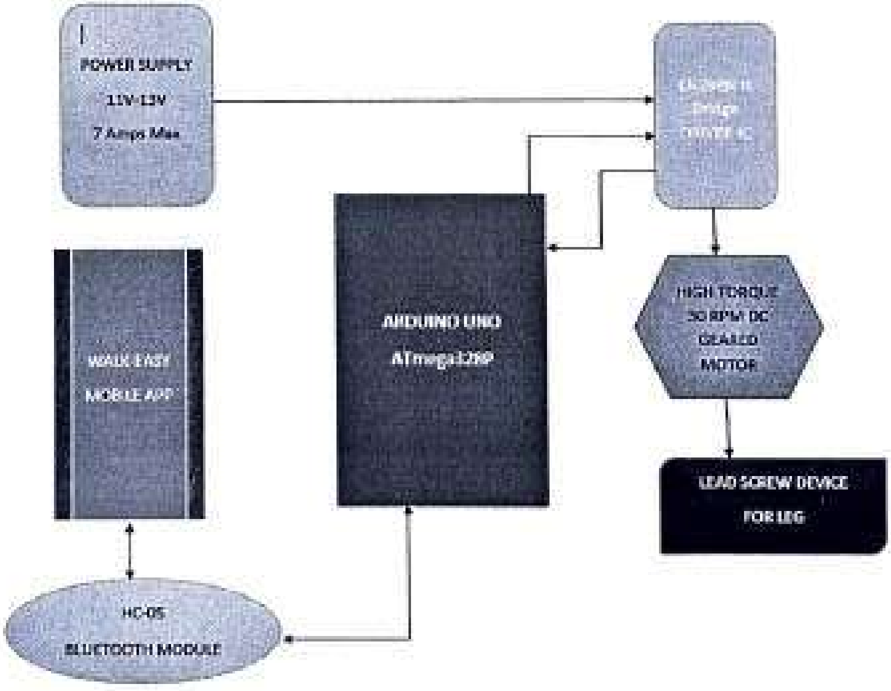

Fig 1 : BLOCK DIAGRAM

The jaws of the knee braces can only support movement of the knee up to 90 degrees and not beyond that, higher degrees of freedom can be obtained by using open design knee brace. A device built using Lead screw mechanism is placed between the upper part and lower part of the leg, which provides the necessary angle required for the movement of the leg. This device is controlled using a mobile app. Mobile app has two features for leg movement, one using the button and another using voice command. The Bluetooth module is used for the communication of mobile app with that of the motor.

3.2 COMPONENT DESCRIPTION:

i. Body Material

Aluminium 7075 is an alloy, with zinc as the primary alloying element. It is used in the framework to provide a strong exoskeleton and also provide a suitable structure to help in sharing of weight with the knee joint. Additionally strips of GI are provided as base foundation and support on top of the aluminium alloy this also facilitates movement. The variable length part outer body is made of 0.75 inch breadth and inner steel body also made of steel is 0.5 inch breadth, the inner steel body is welded to the lead screw.

Fig 2.Body material

ii. Gear Bearing Drive System

It is a combination of brushless DC motor and gearbox. It generates high torque to assist and support in any kind of movement desired by the user like standing, sitting and any other activities involving knee joint by providing a good degree of freedom. High-torque motors typically used in industrial settings have large masses and volumes due to their robust housings and heat sinks. In addition, these motors are typically fixed in place, leading to minimal consideration of weight in their design. However, for implementation into a powered prosthetic leg, it was necessary for us to select a motor with high torque density, to ensure that our actuator could produce the required torque while remaining as light as possible. So, we have chosen a motor with 30 RPM 12V DC motor with metal gearbox,18000 RPM base motor ,6mm diameter shaft with M3 thread hole Gearbox diameter of 37mm ,Motor diameter of 28.5mm 63mm without shaft, Shaft length 30mm,180g weight,32Kg/cm holding torque,800mA no load current, load current max up to 7.5A.

Fig 3.Gear Bearing drive system

Current controlled Drive:

This motor comes with a current controlled drive for Industrial grade high torque dc motor with various types of input signals. High-Current DC Constant-Torque motor drive is integrated with the motor. Motor speed control interface via UART, I2C, PPM signal and analog input, Speed control is possible in both directions down to almost 1% of max. Speed, Small package and integration allows for easy installation and operation, Speed can be controlled using a terminal or MCU via simple UART commands, I2C master device can control multiple RMCS-210x via simple I2C command structures. An RC receiver or any PPM source can directly control the speed of the motor. An analog signal or fixed analog voltage from a potentiometer can directly control the speed of the motor.

iii. ATmega328P

The Arduino Uno is an open-source microcontroller board based on the microchip ATmega328P microcontroller and developed by Arduino.c.c. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. The board has 14 Digital I/O pins 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment). The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer. A SoftwareSerial library allows serial communication on any of the Uno's digital pins.

Fig 4.Arduino UNO

iv. ***Bluetooth module (HC-05)***

HC-05 is a Bluetooth module designed for wireless communication .Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth. It ranges up to less than 100m which depends on transmitter and receiver, atmosphere, geographic & urban conditions. It uses serial communication to communicate with devices. It communicates with a microcontroller using a serial port (USART).It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications. It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.

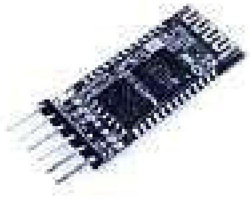

Fig 5. Bluetooth module

v. *MIT app Inventor*

MIT app inventor is used to create an Android app which will be used by the user to provide instructions to the Arduino through Bluetooth to carry out the desired motor functions. MIT App Inventor is an intuitive, visual programming environment that allows everyone to build fully functional apps for smartphones and tablets. The MIT App Inventor user interface includes two main editors: the design editor and the blocks editor. The design editor, or designer, is a drag and drop interface to lay out the elements of the application's user interface. The blocks editor is an environment in which app inventors can visually lay out the logic of their apps using color-coded blocks that snap together like puzzle pieces to describe the program. To aid in development and testing, App Inventor provides a mobile app called the App Inventor Companion that developers can use to test and adjust the behaviour of their apps in real time.

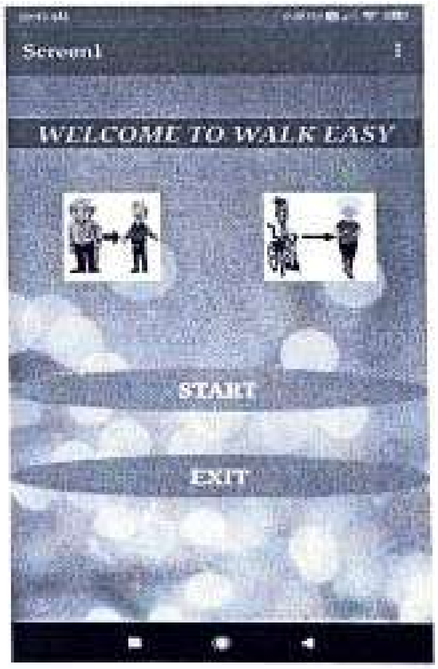

Fig 6.App design

3.3 METHODOLOGY

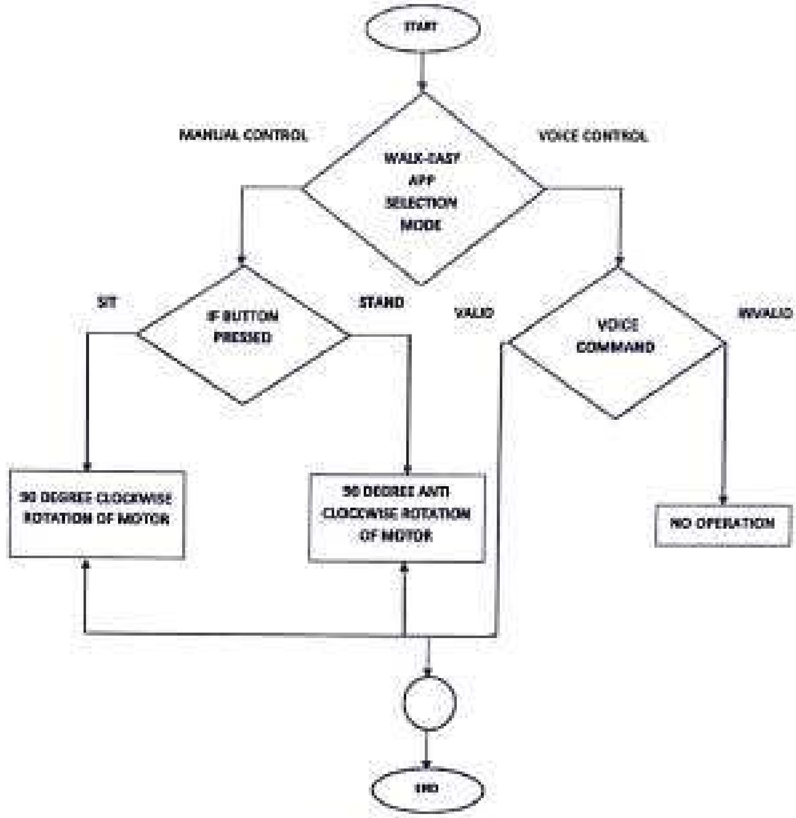

Fig 7.Flowchart

A wearable brace is fabricated or moulded in the shape so as to cover the upper and lower regions of the knee joint so as to facilitate free movement but also provide support when required. A Velcro or adjustable belt is provided to facilitate any knee size. The major component facilitating the movement of knee and movement assistance are the small yet high torque motors, these motors when rotated in clockwise direction helps in sitting down or actions involving bending the knee, when turned counter clockwise it assists standing up or actions involving stretching of knee joint. The controlling of the motor is done using a user friendly android app which has standard commands to actuate the motor. IOT acts as an interface between the hardware component and the software aspect of android, to efficiently control and manage the entire system. The device is connected to the motor through Bluetooth as per the convenience of the user. The nodal centre or the operation is initiated by the user when he/she selects the desired operation on their android mobile, the signal is received by the Bluetooth module this in turn sends a signal to the microcontroller device installed. The microcontroller then sends a signal to the motor through wires to rotate in the appropriate direction. The rotation of the motor is directly related to movement of the metallic joint attached to the knee brace through a mechanism called "Lead screw mechanism" Additionally the app also provides emergency contact to medical staff and family members in case of any mishap.

Lead Screw Mechanism:

This is a simple machine that can generate very large forces. The screw can be thought of as a wedge or ramp that has been wrapped around a shaft. Holding a nut and rotating the shaft will allow the nut to slide either up or down the shaft via the key. In this way, a relatively small moment on the shaft can exert very large forces on the nut. Lead screws are commonly used in linear actuators, machine slides such as machine tools, vices, presses, and jacks. Lead Screws are made in the same way as other thread forms. They can be rolled, cut or sanded. A lead screw uses the helix angle of the thread to convert rotary motion into linear motion, combining a screw and nut with the screw thread in direct contact with the nut thread.

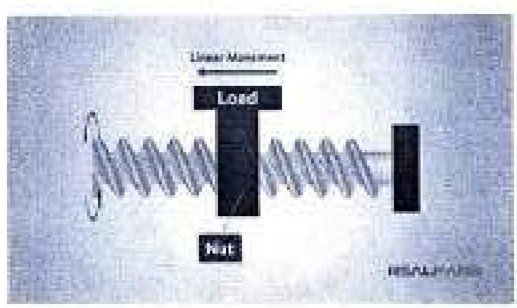

Fig 8.Lead screw mechanism

The above demonstrated lead screw mechanism is used to obtain the required force to overcome the weight of the person, the arrangement is connected in a linear fashion, diagonally from the upper thigh to the lower thigh, when the motor rotates the length of the lead screw either increases or decreases based on the direction of rotation, the increasing length facilitates the stretching of the leg or in this case the person transiting from sitting posture to standing posture, on the other hand the rotary motion on the opposite direction results in the decrease in length of lead screw which in turn signifies the transit between standing to sitting posture as length between the upper and lower thigh is less in sitting posture.

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CHAPTER 4

RESULTS AND EVALUATION

Chapter 4

RESULTS AND EVALUATION

Our wearable smart device assists in sitting and standing using the Lead Screw mechanism. This is achieved by receiving input from the user through an Android app, which has been developed. The app instructs the microcontroller to actuate the motor in desired direction and speed to help in movement.

KNEE ANGLE CALCULATION:

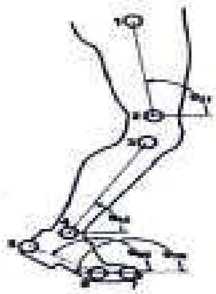

Fig 9: Knee Angle

Table 1: Formula

Knee angle = (180-θ21) + θ43.......(1)
If θ21 > θ43 the knee is Flexed.
If θ21 > θ43 the knee is Extended.

Above equation gives the information of knee angle. The angle between thigh and the calf is obtained by using the above equation.

Table 2: Result calculation 1

Sl No.	Action to be performed	Theoretical Value of angle(in degrees)	Practically obtained Degree of freedom(in degrees)
1	Sitting	90	85
2	Standing	160	125

Table 3: Result calculation 2

Theoretical force on knee (1.5*body weight in kg)in N	Assisted Value computed (45% of total)in N	Practical force obtained in N
90	40.5	35

Assuming body weight of 60Kg

The force that the knee experiences is 1.5 times the body weight. Theoretically our device assists up to 45% of the total force on the knee, which equals up to 40.5 N for a person with body weight of 60Kg .Practically our device can assist up to 35N of force.

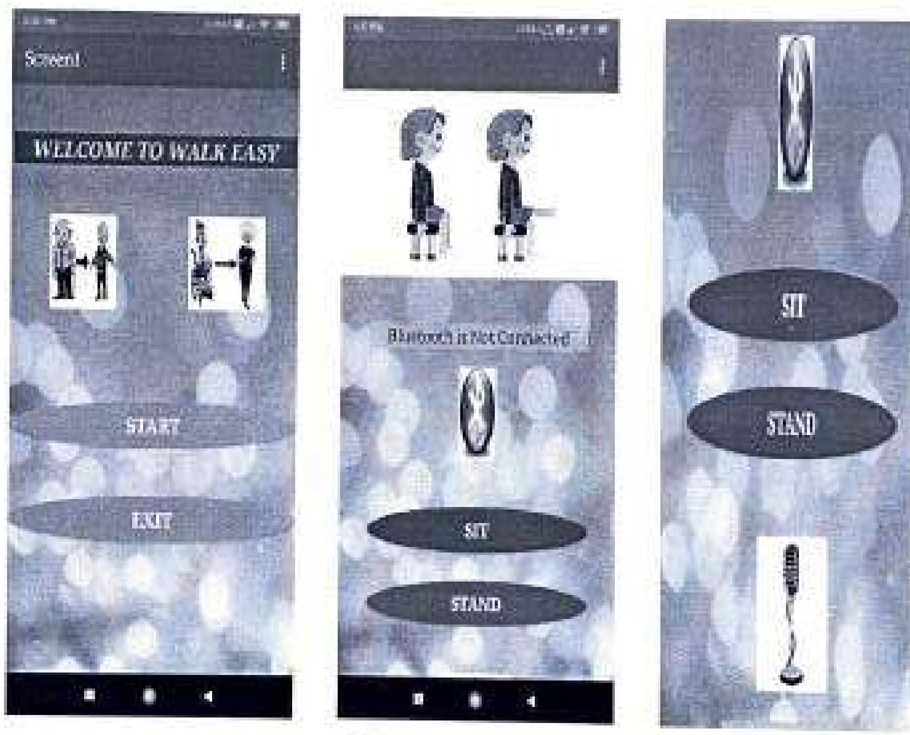

Fig 10: App Result

Fig 11: Sitting Position

Fig 12: Standing Position

CHAPTER 5

CONCLUSION AND FUTURE WORK

Chapter 5

CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

- Movement and other normal action involving the knee joint has been a very old problem since the beginning of mankind especially in old people.
- This project has provided a better smart, effective and permanent solution to this age old problem.
- Old people will be able to stand, walk and live normally without the help of caretakers.
- The App to control the movement and the device is user-friendly.

5.2 FUTURE WORK

- To enable the person to walk and do some day to day activities along with sitting and standing.
- Making the device usable irrespective of the weight of the user.
- Using lighter and stronger material to reduce the weight of the device.

CHAPTER 6

REFFERENCES

Chapter 6

REFERENCES

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APPENDIX

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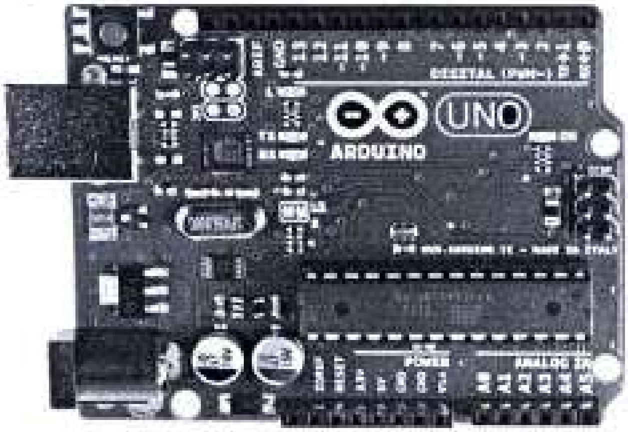
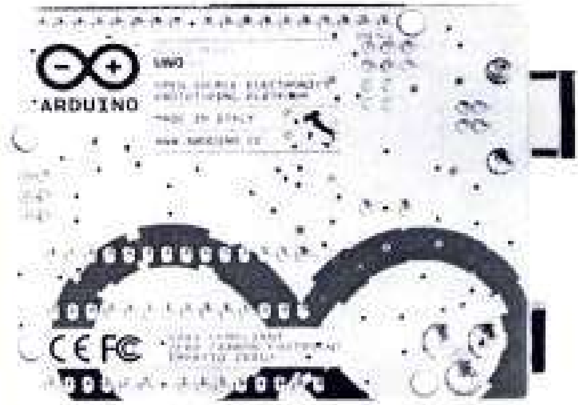
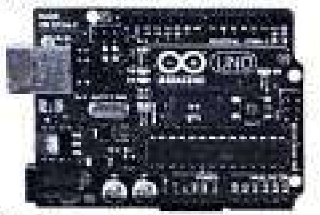
Arduino Uno



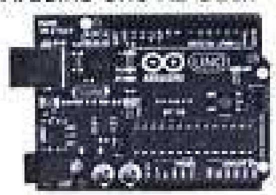


Arduino Uno R3 Front *Arduino Uno R3 Back*

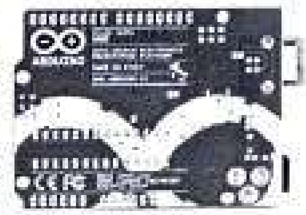


Arduino Uno R2 Front

Arduino Uno SMD



Arduino Uno Front



Arduino Uno Back

Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.
The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.
Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.
Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V

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Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Schematic & Reference Design

EAGLE files: arduino-uno-Rev3-reference-design.zip (NOTE: works with Eagle 6.0 and newer)
Schematic: arduino-uno-Rev3-schematic.pdf
Note: The Arduino reference design can use an Atmega8, 168, or 328, Current models use an ATmega328, but an Atmega8 is shown in the schematic for reference. The pin configuration is identical on all three processors.

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.
External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.
The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.
The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.**This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.

- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication using the SPI library.
- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **TWI: A4 or SDA pin and A5 or SCL pin.** Support TWI communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and ATmega328 ports. The mapping for the Atmega8, 168, and 328 is identical.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).
A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.
The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.
The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).
You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.
The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available . The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.
The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

RHINO MOTION CONTROLS

RMCS-210X
High-Torque DC Motor and Driver (Max. 13Vdc and 7A)
UART, I2C, PPM and Analog input interface

RHINO

Installation Manual and Datasheet

http://www.rhinomc.com
http://www.rhinomotioncontrols.com

RHINO MOTION CONTROLS

RMCS-210X
High-Torque DC Motor and Driver (Max. 13Vdc and 7A)
UART, I2C, PPM and Analog input interface

RHINO

Key Features

- 10RPM,60RPM,100RPM,200RPM,300RPM,600RPM,900RPM High-Torque DC Motor
- Metal Gearbox and Gears
- 18000RPM base motor
- High-Current DC Constant-Torque motor drive integrated with the motor
- Motor speed control interface via UART, I2C, PPM signal and analog input
- Speed control possible in both directions down to almost 1% of max. speed
- Small package and integration allows for easy installation and operation
- Speed/Motion can be controlled using a terminal or MCU via simple UART/I2C commands
- I2C master device can control multiple RMCS-210x via simple I2C command structures
- An RC receiver or any PPM source can directly control the speed of the motor
- An analog signal or fixed analog voltage from a potentiometer can directly control the speed of the motor
- Max-speed setting to limit the maximum speed of the motor
- Damping setting to damp the change in speed on the motor for smoother operation

Description

Thank you for purchasing RMCS-210X, High-Torque DC Motor and Driver. RMCS-210X is Rhino Motion Controls introductory DC motor control solution designed for easy installation and operation with multiple different interfaces.

The RMCS-210X integrates a High-Torque DC motor with 18000RPM base motor and Metal Gearbox and Gears for 10RPM, 60RPM, 100RPM, 200RPM, 300RPM, 600RPM and 900RPM options. A high-current DC motor driver and control interface is mounted on the back of the motor.

The RMCS-210X offers motor speed control via UART, I2C, PPM input signal and a simple analog voltage input.

Technical Specifications

Specification	Min	Max	Units	Comments
Supply Voltage	11	13	Volts DC	Between V+ and GND
Current	0.5	7	Amps	No-load to stalled condition
Input Signal High Voltage	4	6	Volts DC	With respect to GND
Input Signal Low Voltage	0	1	Volts DC	With respect to GND
UART Baud Rate	—	9600	bps	For UART interface
I2C clock freq.	10	200	kHz	For I2C interface
Ambient Temp.	0	70	Celsius	Operating Temperature
Humidity	0	95%		Non condensing
Analog Input Voltage	0	5	Volts DC	For Analog Voltage interface
PPM Pulse Width	600	2400	usec	For PPM signal interface

Mechanical Specifications

Specification	Details
Dimensions (L * W * H)	110mm * 50mm *55mm
Weight	250gms

Caution

- Read this document carefully before installing and using this product
- Inputs voltage to the drive must not exceed the maximum of 13VDC or it may damage the drive
- Reversing polarity power supplied to the drive will damage the drive or power supply
- Excess humidity or condensation on the drive may damage the drive
- Voltage in excess of 7V on the input terminals may damage the speed controller
- Reverse voltage in excess of 7V between the input terminals may damage the controller
- Keep the motor and drive in a ventilated or cool temp.
- Make sure the supply is well regulated and there is minimal voltage ripple
- Disconnection of PPM, UART, I2C or analog interface while the motor is in motion will not stop the motor. It will continue to rotate at the last speed specified by either interface

Power and Input Terminal Assignments

Terminal No.	Terminal Name	Wire Color	Description
Terminal 1	GND	BLACK	Ground should be connected to negative of supply of battery
Terminal 2	SCL/PPM/Analog	BROWN	I2C clock / PPM input signal / Analog Voltage Input
Terminal 3	SDA/Analog Sense	RED	I2C Data / Analog Input Sense
Terminal 4	UART TXD	ORANGE	UART Data Transmit of speed controller, connect to RXD of host
Terminal 5	UART RXD	YELLOW	UART Data Receive of speed controller, connect to TXD of host
Terminal 6	V+	GREEN	V+ should be connected to positive of supply or battery

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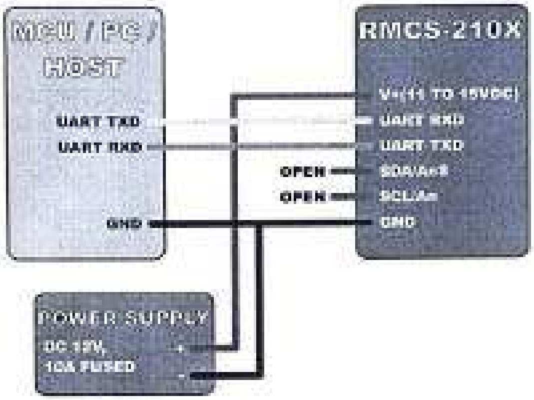
Motion Control Signal Connection UART

To control the speed of RMCS-210x via UART from a PC, MCU or Host device refer to the connection diagram below. In case of PC a RS232 level convertor must be used as UART works on TTL. The TXD line from the RMCS-210x must be connected to the RXD line from the Host device or controller and vice versa for the TXD line.



Motion Control using UART

The ideal way to use the UART interface of the RMCS-210x is with a terminal software like hyper-terminal, putty, etc. The UART interface works at a fixed baud rate of 9600bps. The UART signals must be TTL logic compatible.

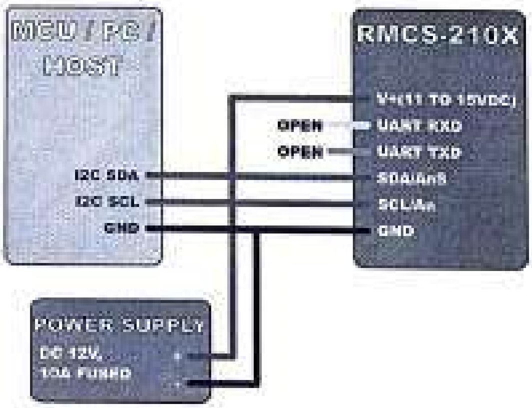
The UART interface on the RMCS-210x prompts the user for a command variable and decimal value string. To set a value of a variable the user must provide an integer decimal value following the command code. To read/display the value of a variable the user must give the command code and immediately follow it by line feed and carriage return. The UART command processor will return the value of the variable. The command list and value range are as follows.

Command	Description	Value Minimum	Value Maximum
'S'	Read/Write Motor Speed and Direction	-255	+255
'M'	Read/Write Motor Max Speed	0	255
'D'	Read/Write Speed Damping	0	255
'E'	Read/Write I2C address	0	127
'Y'	Load Default Values of Speed, Max and Damp	-	-

The motor rotation direction is specified by the '+' and '-' characters before the speed value. "-255" and "+255" are maximums in either direction while the motor will remain at stand still at '0'. The following snapshot depicts normal usage of UART commands to control the speed and motion of the motor. Here the 'S' speed command is first used to read the speed which is initially '0' at startup. Then the motor is commanded to move at a speed of '100' in the forward direction and then at the same speed but in the reverse direction by the value of '-100'. The usage of the 'M', 'D' and 'E' are similar.

Motion Control Signal Connection I2C

RMCS-210x is and I2C slave device with default slave device address of 0x10 (hex) or 16 is decimal. The I2C clock and data lines must be connected to the I2C master line on a host device or controller. The I2C master device must pull-up the I2C lines with 4.7kOhm resistors.



Motion Control using I2C

RMCS-210x is an I2C slave device with a default I2C address of 0x10 (hex), decimal '16'. I2C is the easiest communication technique if multiple RMCS-210x or i2C devices are to be controlled from the same I2Ccontrol master.

The I2C interface on the RMCS-210x will receive the command variable number followed by the value that should be written to it. Value format is a 2-byte signed integer representation and it follows little-Endian byte ordering. The value can be read out immediately after performing a write command using the repeated start command or by the next read command. During the I2C write command if exactly 2 bytes are not received after receiving the command variable the RMCS-210x I2C interface will not write that value to the variable. This is useful to read the value of a variable without having to update its value.

The command list and value range are as follows.

Command Byte	Description	Value Minimum	Value Maximum
0	Direction Read/Write Motor Max Speed	0	255
1	Read/Write Motor Speed and	-255	255
2	Read/Write Speed Damping	0	255

Here is an example usage of updating the speed variable on the RMCS-210x to forward 255. We will assume the default slave address of 16.

```
I2C_Start(0x10 + 0);       // send the slave address of the RMCS-201x and write bit 0
I2C_Write(1);              // send the command variable for speed
I2C_Write(255);            // send LSB of 255
I2C_Write(0);              // send MSB of 0 to and so Speed of forward 255
I2C_Stop();                // send I2C stop
```

Here is an example usage of updating the speed variable on the RMCS-210x to reverse 255 and reading it back. We will assume the default slave address of 16.

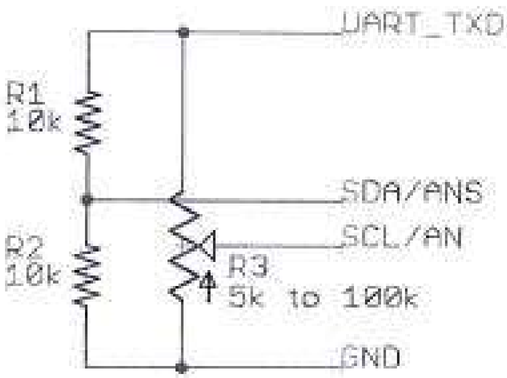
```
I2C_Start(0x10 + 0);       // send the slave address of the RMCS-201x and write bit 0
I2C_Write(1);              // send the command variable for speed
I2C_Write(1);              // send LSB of 1
I2C_Write(255);            // send MSB of 255 to and so Speed of backward 255
I2C_Rep_Start(0x10 + 1);          // send I2C address with rep start and 1 to read
speed = I2C_Read_Ack();           // read speed LSB byte and ack
speed = I2C_Read_Nak();           // read speed MSB byte and don't ack
I2C_Stop();                // send I2C stop
```

Speed Control Signal Connection for Analog Input

The speed of the RMCS-210x motor can be controlled using via an analog voltage from a supply, Digital to Analog Converter, a fixed resistor divider or a potentiometer.
To enable the analog signal input to the RMCS-210x the SDA/Ans analog input sense must be at 2.5V +/- 0.5V. This can be produced by connecting a resistor divider between UART TXD and GND.

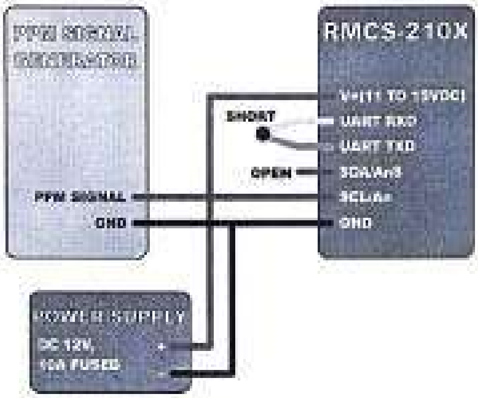
An analog signal for speed control can be produced by putting a potentiometer between UART TXD and GND and connecting the center terminal of the potentiometer to the SCL/An analog input line of the RMCS-210x.

The analog voltage range for speed control is from 0V to 5V DC. The motor speed will be zero at the center voltage of 2.5V.



Speed Control Signal Connection PPM Signal

RMCS-210x motor speed can be controlled using via a PPM signal from any PPM generator like a wireless PPM receiver, Servo controller or a micro-controller I/O pin.



To enable the PPM signal input to the RMCS-210x the UART TXD and UART RXD lines of the RMCS-210x must be shorted together. Remember to power - off and power - on RMCS-210x after shorting RXD and TXD.

The PPM signal pulse width must range from 600us to 2.4ms. The motor speed will be zero at PPM pulse width of 1.5ms.

Maxspeed and Damping

Maxspeed sets the maximum speed at which the motor will rotate in forward or reverse direction. The speed will drop off linearly to 0 from the max speed. For example a max speed setting of 100 and speed setting of 100 will return a true speed of 39.

Damping variable sets a limit on how quickly the true speed and change based on its current value. It allows for smooth ramp up and down for speeds and removes jerks and clicks in the system.

Please note that maxspeed and damping can only be modified via the I2C and UART interfaces. But, they will affect the motion in both the analog and PPM interfaces.

Speed range for different interfaces

Interface	Reverse Max Speed	Forward Max Speed	Motor Stand-Still	Input Units
UART	-255	255	0	Ascii Values
I2C	-255	255	0	Signed integer 2's-complent
PPM	0.6	2.4	1.5	ms
Analog	0	5	2.5	Volts

Guide to General Problems

Problem Symptom	Possible Reasons and Solutions
Motor is not rotating	Drive is not powered up
	Correct inputs are not being provided to update the motor speed
Erratic Motion on Motor or Drive Resets	Power supply voltage not stable or regulated
	Power supply not able to supply enough current to change the speed or direction
	Control input signals are not connected properly or not adequate
	Control signal interference due to power supply or environmental noise
Excessive Motor or Drive Heating	Load on the motor is excessive or irregular
	Drive is damaged
	Power supply voltage is too high
	Not enough cooling or ventilation for motor or drive

Power Supply Selection

A high-torque DC motor requires high current during startup and during high load or irregular load conditions. The general rule of thumb to make sure your power supply is adequate for a DC motor is to make sure it can supply the maximum current required by the motor during stall condition. For RMCS-210X this is 7 Amperes. This doesn't necessarily have to be its continuous current capability but it should be able to provide a pulse of 7 amperes during startup of the motor. It is also good practice to have sufficient low –ESR decoupling capacitors on the output of the supply before you connect it to a DC motor drive. This is to make sure that the motor driver does not reset or suffer from variations in speed due to an insufficient or unregulated supply.

Service and Support

Service and support for this product are available from the Rhino Motion Controls Web site (http://www.rhinomc.com) and our customer service email: info@rhinomc.com

Six-Month Warranty

Rhino Motion Controls (rhinomc.com) warrants its products against defects in materials and workmanship for a period of 6 months from shipment delivery. During the warranty period, Rhino Motion Controls will either, at its option, repair or replace products which proved to be defective.

Exclusions

The above warranty does not extend to any product damaged by reasons of improper or inadequate handlings by customer, improper or inadequate customer wirings, unauthorized modification or misuse, or operation beyond the electrical specifications of the product and/or operation beyond environmental specifications for the product.

Obtaining Warranty Service

To obtain warranty service, please contact our customer service department at info@rhinomc.com before returning product for service. Please make sure that you have gone through this entire installation manual and datasheet before deciding that your product is liable for replacement or repair under this 6-month warranty Customer shall prepay shipping charges for products returned to Rhino Motion Controls for warranty service, and Rhino Motion Controls shall pay for return of products to customer.

Warranty Limitations

Rhino Motion Controls makes no other warranty, either expressed or implied, with respect to the product. Rhino Motion Controls specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Some jurisdictions do not allow limitations on how long and implied warranty lasts, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the 6-month duration of this written warranty.

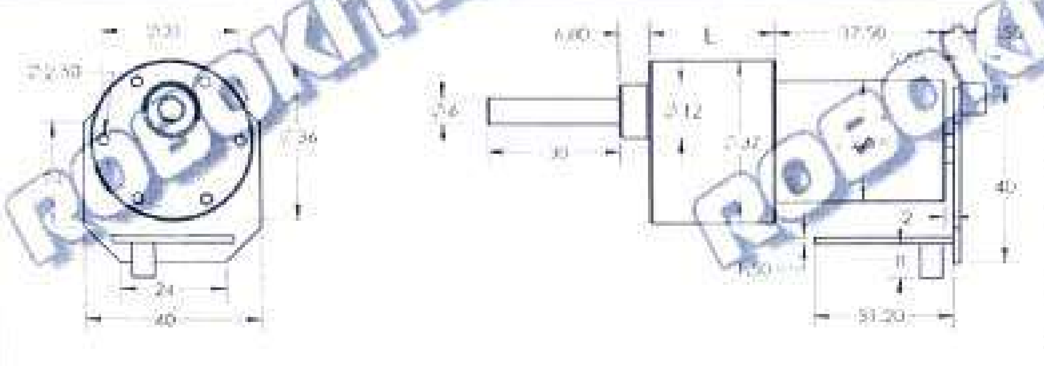
Disclaimer

This product and its documentation are supplied on an as-is basis and no warranty as to their suitability for any particular purpose is either made or implied.

This document provides preliminary information that may be subject to change without notice.

Model Number RMCS-2108	High Torque DC Geared Motor 30RPM with Driver

Mechanical Drawing (Dimensions are in mm)



10RPM	L=28.5mm
30RPM	L=28.5mm
60RPM	L=26.5mm
100RPM	L=26.5mm
200RPM	L=25mm
300RPM	L=25mm
600RPM	L=22mm
900RPM	L=22mm

Technical specifications of Motor

Motor Type	High Torque DC Geared Motor
Operating voltage	12V DC
Motor Speed at Output Shaft (RPM)	30RPM
Stall Torque(Kgcm)	32Kgcm(Gearbox Breaking Torque is 30Kgcm)
Rated Torque(Kgcm)	21Kgcm
Gear Ratio	1:540
Weight	180gm

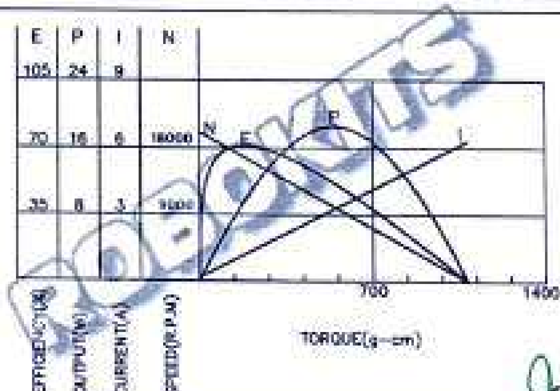
Driver Pinouts

Support	UART / I2C / PPM / Analog Signal
GND	Black
SCL / PPM / Analog	Brown
SDA / Analog Sense	Red
UART TXD	Orange
UART RXD	Yellow
V+	Green

RHINO

Base Motor Specifications

Nominal voltage(V)	12V
No-Load Speed (RPM)	18000
Rated Torque (gcm)	151
No-load current (A)	0.8A
Load current(A)	up to 7.5 A(Max)



Base Motor Characteristic Graph

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Providing Knee movement Assistance using Android and IOT

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Abstract— Aging in living beings is a natural process and with aging one encounters challenges with walking or standing for long hours. Obsolete solutions like walking sticks do not provide satisfactory and effective solutions permanently neither can they be integrated with smart features to help in physical ailments. Our project aims to provide a knee brace made up of aluminium along with the device built using lead screw mechanism attached to the legs for the movement of the legs. This is made possible using 12V High Torque DC Geared Motor with 30 RPM and 21 Kg /Cm Rated torque. Lead Screw Mechanism uses the power generated by the motor to facilitate movement. Arduino Uno with the microchip ATmega328P controls the motor. The Bluetooth module (HC-05) helps in connecting the microcontroller to the Walk-Easy mobile app created. The Walk-Easy app allows the user to sit or stand using either buttons provided or through voice command. The Mobile App is integrated for user convenience, through which the movement is assisted as desired by the user.

Keywords— Knee brace, Lead screw mechanism, Bluetooth module, DC motor.

I. INTRODUCTION

The Knee is one of the most complex joints in the human body. Its importance in stabilizing the body is evident in a range of activities, from everyday activities such as standing, walking etc. On aging our elderly encounter challenges in walking, standing and sitting activities. Through extensive research and survey it is found that around 25% of people around the world, who are above 50 years of age have serious problems related to knee joints. In India 15% of people are already taking treatments for knee pain, which is about 18 crore people roughly. But a lot of people in India go for domestic medicine, Ayurveda etc. hence the above number at minimum and on a rough estimation will be double i.e. 30% or about 36 crore people. In addition, it is an important fact that women undergo these pains a lot more frequently than men, about 10-20% more [1].

An orthosis is defined as a device designed to align, correct or prevent neuromuscular or musculoskeletal dysfunction, disease, injury or deformity. There are various devices that were/are under development and already present for the complications mentioned. Some of the devices are, passive gravity balancing passive leg orthosis [2], Powered Leg Orthosis [3], Hybrid Assistive Limb (HAL) [4], Rewalk [5] and Ankle Foot Orthosis [6] etc. But these devices are complex, not portable. The devices are bigger in size, consume more power, and are more expensive, hence not affordable. Moreover, a person is always required to set up the device.

The most efficient way to deal with this problem is by overcoming the previous drawbacks and to inculcate new features to design a wearable knee brace comprising of outer exoskeleton, Motor which is the driving force, Microcontroller to actuate the device, Bluetooth module as well as Wi-Fi module to act as interface between the android app and wearable device.The body of the exoskeleton used is primarily made of aluminium 7075 alloy as it is lighter in weight and has high strength, toughness, good resistance to fatigue and has significantly better corrosion resistance. Other heavy metals are conventionally used, galvanised iron makes up the base to strengthen the material steel is also employed on the movable part to provide robustness.

The proposed system is a compact rotary series elastic actuator for knee joint assistive system. CRSEA is a system with torsion spring in a chain of spur gears and worm gears which controls the generated torque. A DC motor is used which contributes to maximum speed and torque of 8200rpm and 0,181Nm. CRSEA system torques up to 10.87Nm.The basic principle used in the system is that the reduced speed reduction ratio obtained by worm gear and worm wheel maximizes the torque. While considering the requirements such as precise and large torque generation, back drivability, low output impedance, the system gives good performance. But, since the torque amplification ratio of the worm gear is sensitive to the friction coefficient, it introduces variability to the system model and reduces the overall efficiency [34].

The knee-ankle orthotic device incorporates a low transmission ratio which produces a higher torque output. An AC servo is used to provide a peak torque of 7.2Nm and speed of 80 rpm. Since the device weighs around 4.88kg, we can infer that the overall design is not compact. Besides, the system's response time is too high due to low speed and the feedback mechanism in servo motor trying to correct any drift from the desired position, results in poor stability of the system [35].A powered prosthetic leg designed, embodies high density actuators which serves several benefits like free swinging in knee motion and compliance with ground. The motor used is ILM85X26 motor kit with peak torque rating of 8.3Nm and velocity up to 1500 rpm .Additionally it is driven with motor driver which has a rated current of 17.6A. Active knee rehabilitation orthotic device is majorly created to serve as a gait rehabilitation device for patients past stroke. It involves several techniques to prevent hypertension amongst individuals. On comparing the motors in [34]-[35], Gear bearing drive is a novel mechanism used in the system. GBD is a compact system which integrates a brushless DC and gear bearing. GBD is not a heavy system and its volume is ¼ th of the volume when compared with actuators in[34]-[35].The torque rating of GBD is 3.42Nm with rpm rating of 266.Thus ,due to its compactness we can infer that GBD proves to be a novel technology that can be utilized in robotic orthosis devices.

The microcontroller employed to actuate the motor is Arduino Uno equipped with a high level programming facility needed for deciding the degree and time for motor operation. Receiving signals is a Bluetooth module or a Wi-Fi module independent of one another so as to provide convenience to the user which is a unique attempt made and is absent in other knee braces.

Out of the numerous ways to create an App. An app can be created using android studio to control the RPM and directions of the motor and also to control the motor through voice [27-32]. MIT app inventor is easy to use in comparison with android studio. Since it has a graphical interface, conventional coding is not required to create an app, instead we can drag and drop the interface to be performed. This can be used to interface the microcontroller with the motor and control the RPM and directions through the Bluetooth module [26] & [33].

II. DESIGN

A. Design Overview

An aluminium 7075 alloy is moulded in the shape of a typical knee brace providing a 12 inch circumference for the arrangement so as to comfortably accommodate the knee. An adjustable Velcro is also tied and can be loosened if the user feels uncomfortable. The thickness of the material will be around 5mm so as to optimise and keep a balance between strength of material without adding unnecessary weight. A microcontroller and driver IC will be placed on the side of the mould so as to give signal to the motor. The high torque motor is placed at the sides of the aluminium mould to facilitate expansion and contraction of knee joints.

BLOCK DIAGRAM

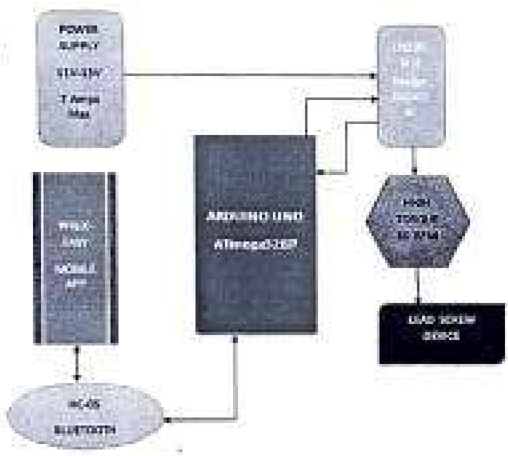


Fig.1

The jaws of the knee braces can only support movement of the knee up to 90 degrees and not beyond that, higher degrees of freedom can be obtained by using open design knee brace. A device built using Lead screw mechanism is placed between the upper part and lower part of the leg, which provides the necessary angle required for the movement of the leg. This device is controlled using a mobile app. The Mobile app is designed with two features for leg movement, the first feature is the buttons and the second feature is voice command. Through these features user can acquire his/her expected movement. The Bluetooth module is used for the communication of mobile apps with that of the motor.

B. DETAILS OF COMPONENTS:

Body Material

Aluminium 7075 is an alloy, with zinc as the primary alloying element. It is used in the framework to provide a strong exoskeleton and also provide a suitable structure to help in sharing of weight with the knee joint. Additionally strips of GI are provided as base foundation and support on top of the aluminium alloy this also facilitates movement. The variable length part outer body is made of 0.75 inch breadth and inner steel body also made of steel is 0.5 inch breadth, the inner steel body is welded to the lead screw.

Gear Bearing Drive System

GBD is a fusion of brushless DC motors and gearbox. It generates high torque to assist and support in any kind of movement desired by the user like standing, sitting and any other activities involving knee joint by providing a good degree of freedom. Our actuator could produce the required torque while remaining as light as possible. We have chosen a motor with 30 RPM 12V DC motor with metal gearbox,18000 RPM base motor ,6mm diameter shaft with M3 thread hole Gearbox diameter of 37mm ,Motor diameter of 28.5mm with Shaft length of 30 mm,180g weight,32Kg/cm holding torque,800mA no load current and load current max up to 7.5A.

Current controlled Drive:

This motor comes with a current controlled drive for Industrial grade high torque dc motor with various types of input signals. High-Current DC Constant-Torque motor drive is integrated with the motor. Motor speed control interface via UART, I2C, PPM signal and analog input, Speed control is possible in both directions down to almost 1% of max. Speed, Small package and integration allows for easy installation and operation, Speed can be controlled using a terminal or MCU via simple UART commands, I2C master device can control multiple RMCS-210x via simple I2C command structures. An RC receiver or any PPM source can directly control the speed of the motor. An analog signal or fixed analog voltage from a potentiometer can directly control the speed of the motor.

Mobile Application Design

MIT app inventor is used to create an Android app which will be used by the user to provide instructions to the Arduino through Bluetooth to carry out the desired motor functions.

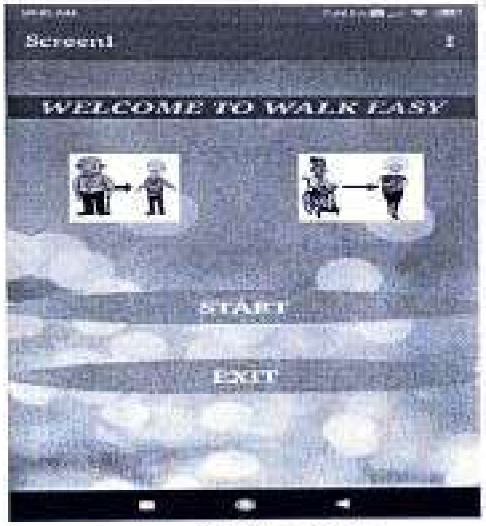


Fig 2.App Design

METHODOLOGY

A wearable brace is fabricated or moulded in the shape so as to cover the upper and lower regions of the knee joint so as to facilitate free movement but also provide support when required. A Velcro or adjustable belt is provided to facilitate any knee size. The major component facilitating the movement of knee and movement assistance are the small yet high torque motors, these motors when rotated in clockwise direction helps in sitting down or actions involving bending the knee, when turned counter clockwise it assists in standing up or actions involving stretching of knee joint. The controlling of the motor is done using a user friendly android app which has standard commands to actuate the motor. IOT acts as an interface between the hardware component and the software aspect of android, to efficiently control and manage the entire system. The device is connected to the motor through Bluetooth as per the convenience of the user. The nodal centre or the operation is initiated by the user when he/she selects the desired operation on their android mobile, the signal is received by the Bluetooth module this in turn sends a signal to the microcontroller device installed. The microcontroller then sends a signal to the motor through wires to rotate in the appropriate direction. The rotation of the motor is directly related to movement of the carbon reinforced aluminium joint attached to the knee brace through a mechanism called "Lead screw mechanism". Additionally the app also provides emergency contact to medical staff and family members in case of any mishap.

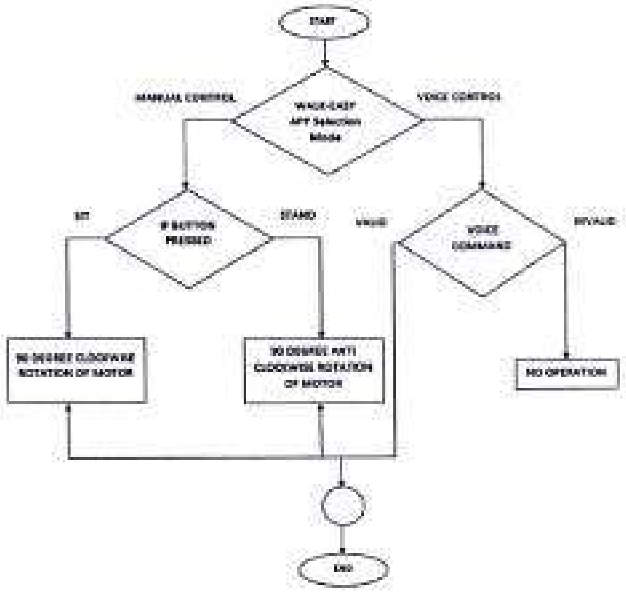
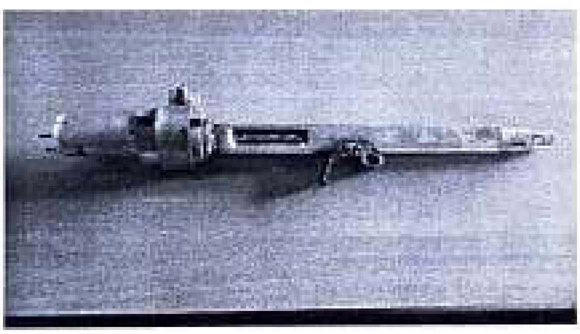


Fig 3.Flowchart

Lead Screw Mechanism:

This is a simple machine that can generate very large forces. The screw can be thought of as a wedge or ramp that has been wrapped around a shaft. Holding a nut and rotating the shaft will allow the nut to slide either up or down the shaft via the key. In this way, a relatively small moment on the shaft can exert very large forces on the nut. Lead screws are commonly used in linear actuators, machine slides such as machine tools, vices, presses, and jacks. Lead Screws are made in the same way as other thread forms. They can be rolled, cut or sanded. A lead screw uses the helix angle of the thread to convert rotary motion into linear motion, combining a screw and nut with the screw thread in direct contact with the nut thread.



The above demonstrated lead screw mechanism is used to obtain the required force to overcome the weight of the person, the arrangement is connected in a linear fashion, diagonally from the upper thigh to the lower thigh, when the motor rotates the length of the lead screw either increases or decreases based on the direction of rotation, the increasing length facilitates the stretching of the leg or in this case the person transiting from sitting posture to standing posture, on the other hand the rotary motion on the opposite direction results in the decrease in length of lead screw which in turn signifies the transit between standing to sitting posture as length between the upper and lower thigh is less in sitting posture.

III. RESULT

Our wearable smart device assists in sitting and standing using the Lead Screw mechanism. This is achieved by receiving input from the user through an Android app, which has been developed. The app instructs the microcontroller to actuate the motor in desired direction and speed to help in movement.

The force that the knee experiences is 1.5 times the body weight. Theoretically our device assists up to 45% of the total force on the knee, which equals up to 40.5 N for a person with body weight of 60Kg .Practically our device can assist up to 35N of force.

Tabular column:

Theoretical value of force on knee (1.5*body weight in kg)in N	Assisted Value computed (45% of total)in N	Practical force obtained in N
90	40.5	35

Fig4. Mobile app

Fig5.Sitting position

Fig 6. Standing position

IV. CONCLUSION:

Impediments caused in Movement and other normal actions involving the knee joints have been a conventional problem since the beginning of mankind, especially in aged individuals. Former rehabilitation devices were massive in size, consumed a large amount of power, and were static. People with knee pain opted for orthodox solutions like walking sticks which had many consequences and side effects like pain in the shoulder region and these solutions were obsolete. Aged people with severe knee pain had to rely on others for day to day activities. This project has provided a better, smart, effective and permanent solution to this age old problem. Old people as well as people with severe knee injuries will now be able to stand, walk and live normally without the help of caretakers.

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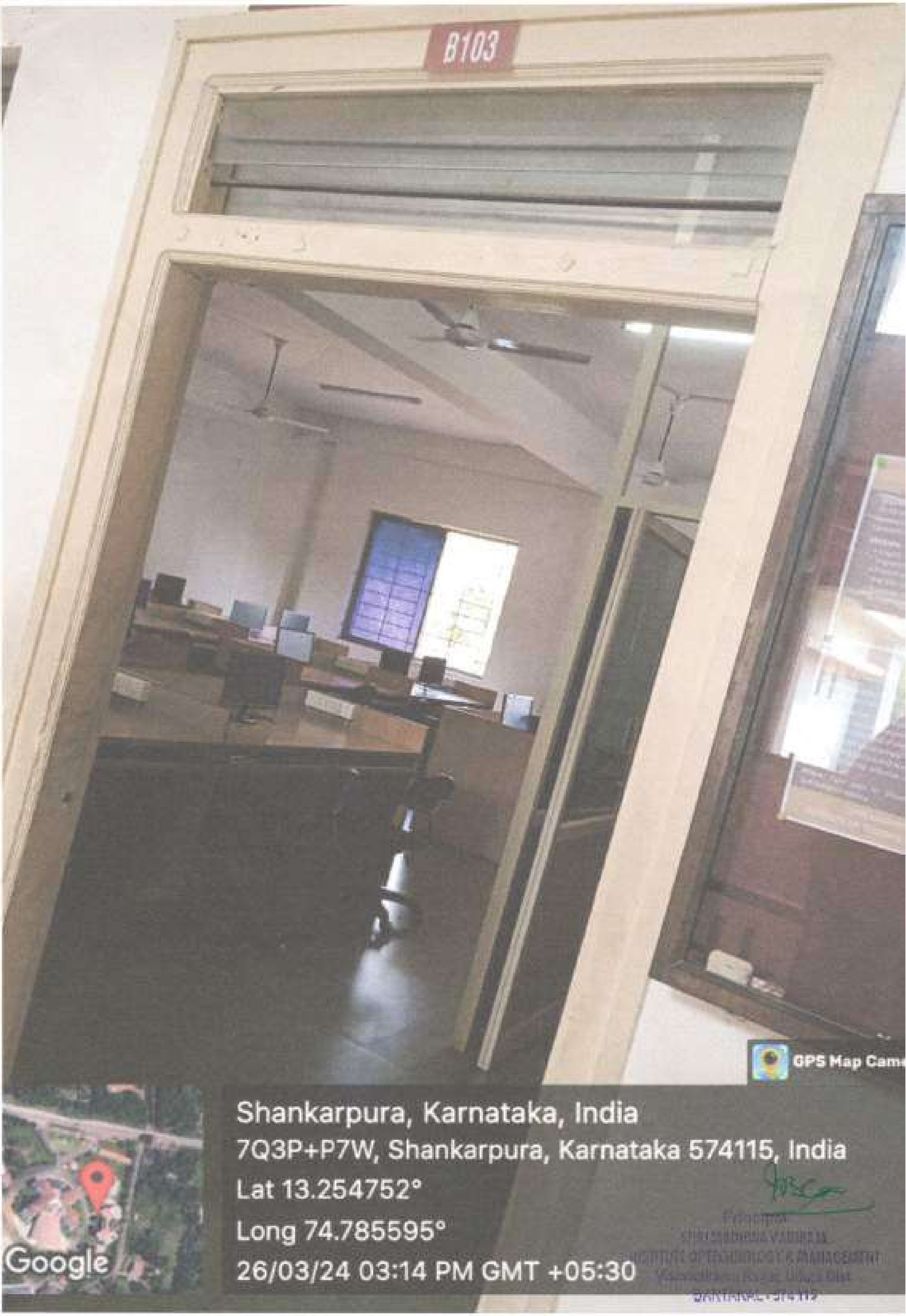
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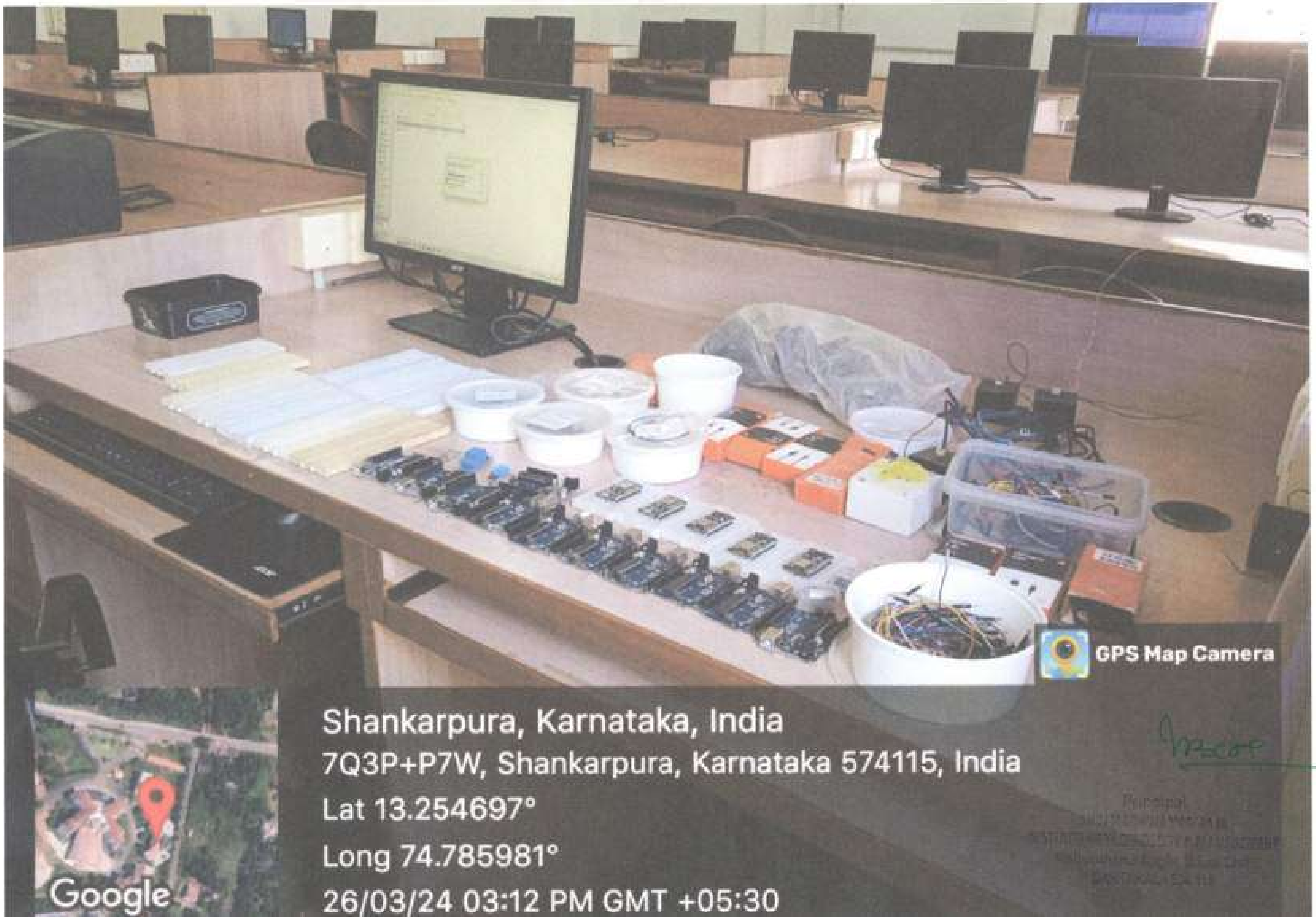
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7Q3P+P7W, Shankarpura, Karnataka 574115, India
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GPS Map Camera
Shankarpura, Karnataka, India
7Q3P+P7W, Shankarpura, Karnataka 574115, India
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