**HUMAN ACTIVITY RECOGNITION**

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***Abstract*: Human Activity Recognition is identifying the movement or the actions that are performed by the person based on sensor data. Movements are often typical activities that are performed indoors, outdoors and in vehicles. Recognition of activities is in research area of health. Performance is computed by using K-nearest neighbours, support vector machine, naïve Bayes, feed forward backward propagation and neural network. The appearance and motion features are extracted using the open pose library. Introduced a sigma based features for the better capture of activity thereby improve recognition accuracy and collected the accelerometer, magnetometer and gyroscope temperature of the user’s mobile phones. Activity performed on both indoor and outdoor location. And introduced a sigma based features for the better capture of activity thereby improve recognition accuracy and collected the accelerometer, magnetometer and gyroscope, temperature of the user’s mobile phones and arterial oxygen saturation sensor(spo2) data collected. There are four AI algorithms in those three different algorithms for Human Activity Recognition using motion sensor.** **Human Activity Recognition tells us about walking, standing, running and so on and one Acoustic Scene Classification to tell about whether persons are indoor, outdoor or anywhere you go based on environment captured by microphone [1].**

**Introduction**

FP-AI\_SENSING1 features complete firmware on BLE connectivity, IOT node, microphone, environment and motion sensing. There are four AI algorithms in those three different algorithms for Human Activity Recognition using motion sensor. Human Activity Recognition tells us about walking, standing, running and so on and one Acoustic Scene Classification to tell about whether persons are indoor, outdoor or anywhere you go based on environment captured by microphone. The neural networks provided have been trained on afflicted database and are for example purposes. The goal is to provide end to end example from sensor acquisition to sensor classification through smart phone application. All AI libraries in this pack generated using the X-CUBE-AI extension. This function pack is being designed for specifically ultra-low power application in virtual parallel micro controller STM32L4 it is compatible with ST BLE sensor smartphone app available for android and iOS the sensor is for sensor reading, audio/motion classification monitoring, FW upgrade over the air (FOTA) and always data logging and annotation for new AI datasets. The boards needed is the sensortile kit and nucleo-L476RG or we can also use nucleo-L476RG with other three X-NUCLEO-CCA02M1, X-NUCLEO-IDB05A1 and X-NUCLEO-IKS01A2 shell. We also need android smartphone and USB cable. Programming sensortile and the computers are connected. By

this we can come to know whether the human is in indoor, outdoor or on the vehicle. So the other person can come to know if the person is on vehicle the incoming calls can be drop downed. Generally recognized activity tracked by the image of human pattern. In videos, there are several approaches are available to analysing the motion sequences in order to identify the type of human activity. This motion sequence generally categorized as both appearance based method and motion based method. To classify the motion sequences that with various visual features extracted by video data the appearance based method generally useful. and motion based method is one such method which model the pattern sequence with temporal state space models. Performance by K-nearest neighbours, support vector machine, naive Bayes, feed forward backward propagation and neural network. In order to detect human physical activity along with indoor or outdoor information by using mobile phones and oxygen saturation sensors. Recognition of human physical activities is an important research area for health service and intelligence environment. We make use of smart phones and oximeter sensors were used to collect data and perform the physical activity recognition process. Initially selected simple physical activity namely walking running standing and sitting performed on both indoor and outdoor location. And introduced a sigma based features for the better capture of activity thereby improve recognition accuracy and collected the accelerometer, magnetometer and gyroscope, temperature of the user’s mobile phones and arterial oxygen saturation sensor(spo2) data.

**1.Machine Learning**

Machine learning is the application of artificial intelligence It provides a system to automatically learn and improve Its experience with ought being explicitly programmed. Machine learning is mainly focused on the development of a computer logical programs that it can access any data and use it to learn from themselves. The system that discover hidden patterns in data, and leverage pattern make prediction of future data.

When data exists data what are they don’t know perhaps especially when don’t know. We cannot pin down the functional relationship mathematically would just code up algorithm. High dimension data has a labelled training set.

**1.1Types of Machine Learning**

Machine Learning algorithms is classified into three main algorithms.:

1.Supervised Learning

2.Unsupervised Learning

3.Semi-supervised Learning

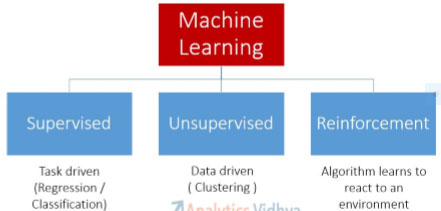


Fig 1: types of machine learning

1)**Supervised Learning**: supervised machine learning algorithms is a learning task that maps the input to the another output based on the input output pairs. In this learning method we teach or train the machine using the data which is already been labelled. There are two categories of algorithms are classified in supervised learning methods are classification and regression. Classification in which the data been categorized as labels according to the parameters given in the input and output. The data used for prediction is in the unordered form. classification being used in fraud detection, diagnostics, customer retention. The classification algorithms are support vector machine. The support vector machine is the learning model that analyses the data used in classification, Regression analysis. Naive Bayes is a technique is used for the construction of the classifier. K-nearest algorithm is an optimization problem that finds the point that is closest to the other points in a given set of points. Regression is nothing but the function in which we are distinguishing the data into a continuous real value not a discrete value. The regression model is used to predict the quantity. Regression is used in forecasting, prediction, process optimization. The algorithms used in regression are linear regression. Decision tree used to create the training model by learning the decision rules which is used to predict the values for the target variables. Whereas neural network model used to simulate the neuron to take a decision of the human brain.

2)**Unsupervised Learning**: In Unsupervised machine learning algorithms there no necessity of supervising the model. It contains unlabelled data whereas supervised learning model consist of labelled data. Here the patterns that are unknown in the data can be found. Clustering is a type of unsupervised models. Here we find the patterns of data from a given collection of uncategorized data. processing of data and the grouping of data is done by the clustering algorithms. The different types of clustering algorithms are partitioning, Agglomerative, probabilistic. In the case of partitioning in which the data is grouped such that data belongs to the one group only. In the case of Agglomerative where all the data are combined as a cluster and repeated union between the cluster to reduce the number of clusters. In the case of probabilistic where it uses a probability distribution for creating the clusters. The hierarchical clusters which creates a hierarchy of the clusters. Clustering will stop when the two cluster which are closer to each other and reside in the same cluster. K-means clustering in which we can find the value of highest iterations. The other types of clustering are Gaussian mixture, neural network, Hidden markov model

3)**Semi-supervised Learning**: It fall somewhere in between supervised and unsupervised learning. since they use both labelled and unlabelled data for training. -typically small amount of labelled data and a large amount of unlabelled data. The systems that use this method are able to considerably improve the learning accuracy. usually semi supervised learning algorithms is chosen when the acquired labelled data requires skilled and relevant resources in order to train it/learn from it. Otherwise, acquiring unlabelled data generally doesn’t require additional resources.

4) **Reinforcement learning**: It is a learning method that interacts with its environment by producing actions and discovers error or rewards. Trial and error search and delayed reward are the most relevant characteristics of reinforcement learning. This method allows machines and software agents to automatically determine the ideal behaviour within the specific context in order to maximize its performance. Simple reward feedback is required for the agents to learn which action is best this is known as Reinforcement signal. It is concerned with the how the software agents take actions in the environment in order to maximize the reward. Reinforcement learning is one of basic learning domain. Reinforcement learning is different from the supervised and unsupervised. Here we are not labelling the input and output pairs. Using of samples to obtain and optimize the performances and function approximation to deal with the large environment are the two factors which makes the reinforcement as powerful factors.

Machine learning analyse the massive quantity of data. while it generally delivers the faster, more accurate results in order to identify profitable opportunities or dangerous risks, it may also require additional time and resources to train it properly. Combining machine learning with Artificial intelligence can make it even more effective in processing large volumes of information.

**1.2 Algorithm:**

Here we describe the list of algorithm used in our project

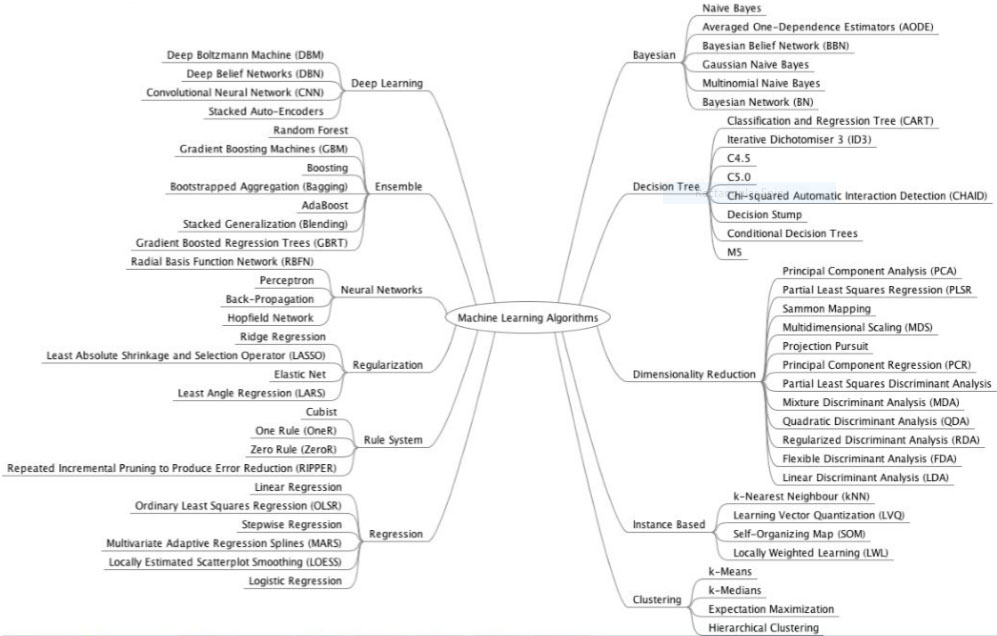


Fig 2: types of algorithm

**K-nearest neighbour Algorithm**:

K-nearest neighbour algorithm is a simple and easy to implement. supervised machine learning algorithm that can solve both classification and regression. In our project we use K-nearest algorithm compare to all the algorithm K-nearest neighbour yield a highest result with an accuracy of 100%. K-nearest neighbour algorithm best classifies the given action. K-nearest neighbour algorithm assumes that similar things exist in a close proximity. which means similar things are near to each other. K-nearest neighbour algorithm captures the idea of similarities with some mathematics. choosing the right value for K is an important factor. choosing the best value for K reduces the number of errors. The advantage of this algorithm is simple and easy to implement. There is no need of building the model. This algorithm can be used for classification, regression and search.

**Support Vector Machine Algorithm**:

The objective of support vector machine algorithm is to find a hyper plane in an N-dimensional space that distinctly classifies the data points. Hyper plane is the decision boundary that help to classify the data points. the data points falling on either side of the hyper plane can be attributed to different classes. Also the dimension of the hyper plane depends upon the number of features. If the number of input features is 2 then the hyper plane is just a line. if the number of inputs is 3 then it becomes two dimensional plane. support vectors are data points that are closer to the hyper plane and influence the position and orientation of the hyper plane. Using these support vectors. we maximize the margins of the classifier. deleting the support vectors will change the position of the hyper plane. In the SVM algorithms the loss function that helps to maximize the margin. We extract the required features and split the features into training and testing. Here the 90% of data is used for training and only 10% of data is used for testing. Here the learning rate and the regularization parameter is set to 1/epochs. Therefore, the regularization value reduces the number of epochs. The support vector machine models can be implemented by Scikit learn library and related functions.

**Naive Bayes Algorithm**:

Naive Bayes is a simple, effective and commonly used machine learning classifier. It is a probabilistic classifier makes a classification using the maximum posterior decision rule. It is represented using Bayesian network. Naive Bayes is commonly used in text classification and also used in spam detection. It is a classification technique based on Bayes theorem with an assumption of the independence among predictors. here the Naive means that every word in a sentence independent of other once. It has been successfully used for many purposes but it particularly works with the natural language processing(NLP) problems. Naive Bayes it is a family of probabilistic algorithms which means that they calculate the probability of each tag for a given texts and output the tag with highest one. Here the dataset is divided into 2 parts 1) feature matrix 2) response vector. where the feature matrix contains all the vectors of dataset in which the vector consists of the dependent features. The response vector contains the value of class variable. The naive Bayes assumption is that it makes independent and equal assumption. The Bayes theorem finds the probability of an event occurring given the probability of event that has already occurred.

**Feed forward neural network**:

A feed forward neural network is an artificial neural network model where connections between the nodes do not form a cycle. It is the simplest type of artificial neural network. Here the information moves only in one direction and forward from the input nodes through the hidden nodes to output nodes. There is no cycle or loop in a network. There are many types of neural network. The simplest kind of neural network is single layer perceptron network, which consist of single layer of output nodes. The inputs are added directly to the output via series of weights. The sum of the products weights and the input is calculated for each node and if the value above some threshold neuron fires and take the activated value (typically 1). Otherwise it takes deactivated value (typically -1). The perceptron can be created using the any values for the activated and deactivated states. perceptron can be trained by delta rule. It is capable of learning linear separable patterns. other one is multi-layer perceptron: It consist of multiple layers of computational units. Each neuron in one layer has directed connection with the subsequent layer. multilayer networks have variety of learning techniques the most popular is back propagation rule.

**Linear discriminant analysis algorithm**:

Linear discriminant analysis, normal discriminant analysis, are the generalization of fisher’s linear discriminant. It is used in statistics, pattern recognition and machine learning to find the linear combination features. LDA is closely related to analysis of variance and regression analysis. which is used to express one dependent variable as a linear combination of the other features. Linear discriminant analysis is also closely related to the principal component analysis and factor analysis. The discriminant analysis is completely different from factor analysis. LDA works when the measurements made on the independent variable for each observation. The linear discriminant analysis is designed for classification of the predictive modelling problems. is a simple model for application. It discovers how machine learning work including KNN, Decision trees, naive Bayes, support vector machine. logistic regression is a simple powerful linear classification algorithm. LDA model representation is straight forward and it consist of statistical properties of data.

**Ensemble bagged Tree Algorithm**:

Random forest is also one of the most power full algorithm. Bagging and boosting is also ensemble technique. Here the weak learners are combined with the strong learners to obtain the better performance. It combines several decision trees classifier to provide a better performance. Ensemble learning is helps to reduce the errors, noise etc. Bagging and boosting techniques are helps to reduce the variance and increase the robustness of the model. Bootstrapping it helps to understand the bias. It helps to understand the mean and standard deviation from the dataset. Bagging is also known as Bootstrap aggregation is a simple ensemble method. Bagging produce high variance of machine learning. Boosting means a group of algorithms utilizes the weighted averages to make the strong learner to the weak learners. Whereas in case of bagging where each model run independently and aggregate the output at the end of the models. compared to bagging and boosting bagging is the best option. Bagging avoids over fitting whereas boosting provides over fitting. Bagging is more effective then boosting. another name for bagging is also known as bootstrap aggregating. Machine learning algorithm improve the stability and accuracy. machine learning algorithms used in regression and classification. It reduces the variance and over fitting. Bagging leads to the improvements in the unstable procedure. Example include artificial neural network, classification and regression trees. The Random forest method designed for decision tree classifier. Where each trees are generated based on the bootstrap samples. The random vectors are generated from the probability distribution.

**2 Sensors used in Human activity recognition** **Accelerometer sensors**:



Fig 3. Accelerometer sensor

Accelerometer sensors used to measure the acceleration experienced by the object due to some of inertial force and converts the mechanical motion to the electrical forces. These sensors are used as anti-theft sensors. These are used in various areas like vibration measurements, automotive control and detection, aircraft aviation industries and so on. Some of the accelerometer sensors that are widely used both in industries and IOT projects. The accelerometer gives two types of data :1) static force that are applied on the sensors due to gravity.2) Force/acceleration that are exerted upon the sensors. Accelerometer have many applications in the industry and it is able to detect the motion of the human. Accelerometer it detects and monitor the changes in rotating machine.

**Oximeter Sensors**:

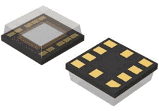


Fig 4. Oximeter Sensor

We can also detect human physical activity along with indoor or outdoor information by using mobile phones and oxygen saturation sensors [indoor and outdoor]. Recognition of human physical activities is an important research area for health service and intelligence environment. We make use of smart phones and oximeter sensors were used to collect data and perform the physical activity recognition process. Initially selected simple physical activity namely walking running standing and sitting performed on both indoor and outdoor location. And introduced a sigma based features for the better capture of activity thereby improve recognition accuracy and collected the accelerometer, magnetometer and gyroscope, temperature of the user’s mobile phones and arterial oxygen saturation sensor(spo2) data collected from 12 real subjects of different age groups and interpret the raw observation and decide whether a value is outlier or not. for this purpose, they have used sigma based feature for recognition.

**Gyroscope Sensors:**

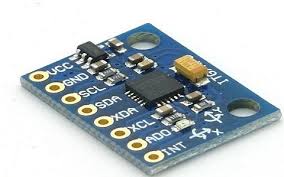
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Fig 5. Gyroscope sensor

Angular velocity and angular rates have been measured by these sensors. It measures the speed of rotation around the axis is known as angular velocity. Navigation and measurement of angular velocities is the primary use of these sensors. These sensors have been used in robotics control, drone and RC control helicopters and consumer electronics and many more. there are various kind of sensors some of them are selected based on their mechanism, output type, power sensing range .and environmental condition are rotary gyroscope, optical microscope, micro-electro-mechanical gyroscope. All these sensors are being combined with the accelerometer to provide feedback to the systems.

**Motion detection sensors:**

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Fig 6. Motion detection sensors

This is a kind of sensors which detects the motion in a given area and transform the motion into an electrical signal the motion can be of an object or the human being. There are various uses of this sensors such as smart camera, automatic door control, toll plaza, automatic parking systems, automated sinks and so on. Some of the mostly used motion detection sensors are infrared, ultrasonic or microwave. These sensors detect the moving objects and particularly movement of the peoples. In many cases it is used as transmitter for illuminations. It is also used in activating the automatic door openers in business and public buildings. motion sensors are widely used as a true occupancy sensor in activating lights in indoor or street. A motion detector sensor may be used as burglar alarm to alert the home owner when it detects a motion of the intruder. It may also trigger the camera to record the intrusion.

**Temperature sensor:**



Fig 7. Temperature Sensor

Temperature sensors is kind of sensors which is used to measure the temperature of the environment. by detecting the temperature of the environment it is able to detect whether the person is performing the activity in indoor or outdoor. Wide use of these sensors are found in refrigerator, A/C controllers. This kind of sensors used to measure the amount of heat energy which allows you to detect physical change in temperature for a particular source. It is used to detect the temperature of the solid, liquid, gases. The some of the categories of temperature sensors are Thermocouples, RTD, Thermistors, Thermostat, semiconductors and infrared sensors. The thermostat is a type of electro mechanical temperature sensor or switch.

**Proximity Sensors:**



Fig 8. Proximity sensor

Proximity sensors it is a kind of sensors which detects the presence or absence of nearby object to it and then it is been converted into the signals which can be easily read by the users. These sensors are commonly used in vehicles when we take reversing in car to detect any obstacle present if so then the alarm will be turned on. There are some of sub-categories of proximity sensors are inductive sensors, capacitor sensors, photo electric sensors, ultrasonic sensors.

**Pressure Sensors:**



Fig 9. Pressure Sensor

Pressure sensor is a kind of device which senses the pressure based on the pressure levels. And convert into the electric signal. It is helps in detecting the drops in pressure. One of the advantage of this pressure sensor is it consumes less power and have higher burst pressure. Disadvantageous is that it has higher cost due to its manufacturing volumes.

**Barometer sensors:**



Fig 10. Barometer Sensor

These sensors which performs the same work as that of pressure sensors. It measures the relative and absolute altitude by the continuous analysis of atmospheric pressures. These sensors are commonly used in sport and fitness or location based applications. The barometer sensors is one of the latest sensors present on smart phones it measures the atmospheric pressure of the environment. In human activity recognition we have used this sensor to indicate the changes in the user position.

**3.There are several approaches for activity recognition but only some approaches are described below:**

**a) Vision based Activity Recognition**

It uses visual sensing facilities such as camera based surveillance system to monitor the behaviour of actors and the changes in its environment. It contains four steps such as human detection, activity recognition, behaviour tracking and high level activity evaluation. different methods use a different research approaches such as single camera or stereo and infrared to capture the context of activity. In case of image based approaches it uses single or multiple cameras to reconstruct the 3D human poses and detect the coordinates of the joints and extract the limbs of the body. The image analysis used to isolate the human body from the backgrounds. This can be achieved by using the background subtraction algorithm.

**b) Sensors based Activity Recognition**:

Sensor based activity recognition uses sensor based network technologies to monitor the behaviour of actor within its environment. In this case many sensors are attached to human body. Data from thee sensors are collected and analysed using the data mining and machine learning algorithms to build the activity models to recognize the activity. Here the recognized activities include walking, running, sitting up and down etc. The most of the wearable sensors are not used for real time applications because of their size or the life of battery. In the case of sensor based approach uses wearable sensors or object attached sensors. The most commonly used machine learning model is the hidden markov model. another model is the CRF model which is a uni directed graphical model which allow the dependencies between the observation.

**c) Human sensing Taxonomy**:

In this case initially it extracts the information regarding the people environment which can be indoor or outdoor. It also describes the spatiotemporal properties. This also consist of low level components regarding the position and history of people in the environment.

1. Presence: by the use of motion sensors and proximity sensors. detects the presence of people .in the indoor or outdoor.
2. Count: Detects the no of people present in an environment by counting the people entry or exit to the room.
3. Location: Detects the location of each person. Localization it can be achieved by using the GPS or cameras. In addition, a presence sensors are used to locate the people. The localization can be considered as a higher resolution generalization of presence detection.
4. Track: It determines the where the person is before? of each person in a scene. Tracking used to recover a person’s relative identity. For example, initially person is labelled with a temporary ID then track the sampling of the scene The temporary ID is typically lost when the person leaves the scene and returns on the next day. At that point the person will be given with a new ID when he was re-detected. This leads to the loss of person relative id are often called as ambiguous.
5. Identity: Detects who is each person? By usage of spatiotemporal properties. Here the identification nothing more than the natural extension of tracking the presence of each person assigned with the same globally unique Ids. Therefore, identity detection extends the tracking so it is possible to recover a person’s spatial temporal history across sensing gaps

**4 Problem statement:**

The most of the old age people are prefer to live alone on their house. This is a challenge for care taker to give the quality of services. The human activity recognition helps in monitoring the old age people living alone by identifying the unusual activity of those people. The sensors in the video and hidden markov model are constructed to identify the six unusual activities of old age people such as forward falling, backward falling, fainting, vomition and headaches experience or pain in the chest measures a physical cardiogram and using GPS helps to find a person who has filled in the outdoor environment [2]. And also The most of the old age people in western countries are increasing day by day and most of them prefer to live independently. To address this problem, we develop a machine learning framework for human activity recognition. The algorithms used here are artificial neural network, K-nearest neighbours, quadratic support vector machine(QSVM), and ensample bagged true(EBT). Here performance of these algorithms are tested by classifying the human activities, the result reveals that the accuracy of fall detection reaches 100% for both QSVM and EBT algorithm with ought any false alarms. This approach is very cost effective and no new equipment are required. To evaluate the performance, we need records of actual falls but it is very difficult to collect real world fall data of older people hence we need to monitor the people for several weeks to obtain the records of actual falls. The gyroscope and accelerometer that measures the acceleration and the angular velocity. Human activity recognition place an important role in the field of video surveillance, navigation of the robot and It uses the skeleton data to obtain the skeleton information directly from the camera [3]. Human activity recognition is an important technology in mobile computing era. The smart phones are equipped with the sensors such as accelerometer, gyroscope, microphones, GPS and camera. These sensors are used to recognize the human activity and gesture recognition. another problem is that A mobile device has limited memory capacity so there is a chance that some data are missing [4]. some algorithm is used t to test and handle the missing data they are Bayesian network, multilayer perceptron (MLP), K-Nearest neighbour(KNN). compare to all the algorithm KNN gives best result with an overall accuracy of 100%.

Human Activity Recognition is an identification of different activities that are performed by the humans. Inertial sensors are used in HAR like accelerometers [5] and gyroscopes to find acceleration and angular velocity that are produced from the body. Sensor based techniques are superior as compare to other methods like vision based in this method camera and microphones are used to identify the activities performed by the human. But its disadvantage is it is less sensitive to the environment, in power consumption and cheap. Methods are classified based on the kinetic signals. But the process should be worked based on the application and the human activities. Human activity recognition it doesn’t observe on the difficult task but it will match the pattern of the activities that are already stored on data. Convolution Neural Network can detect the activity by the signals and it groups the activity by looking into the data and produces a result. inertial sensors by this activity can be classified to the different classes. Human Activity is classified by using Convolution Neural Network. The combination of inertial sensors produce a data is used in this model. Set of sensors and activities signals are produced into the different network architecture. In this it also compares different task performed by the group sensor, check the signal potential and sensor system. In this CNN work on the HAR there are 16 activities in a set from Otego program. CNN’s are trained by signals that are coming from the sensors so that it can compare with the given set of data and detect the activities. Use of single sensor is having same potential like multiple sensors, but it is better to use multiple sensors for the detection.

**5 Challenges of human activity recognition using sensors.**

According to the research human activity recognition is beneficial due to the sensors, unobtrusiveness, flexibility, and many other advances, it is also having challenges that have brought with them. There exists major common challenge for the human activity recognition using mobile sensor. Corresponding solution also present to solve these challenges.

Challenges that are phased by the human activity recognition system are as follows. First one is the recognition of the parallel activities that is nothing but identifying more than one activity at the same time for example watching TV and talking to a friend is a quite challenging. Second one is recognizing overlapped activities. for example, while person is cooking in the kitchen and phone rings at that time and she or he stops cooking for a while until he or she finishes call is also challenging. Interpreting the similar activities in different ways for example opening the refrigerator door may have considered as cooking or cleaning operations is challenging task. Multiple occupants that is the place occupied by more than a single person is also challenging.

Developing the human activity techniques still consists of the many issues and challenges which will improve the accuracy under more realistic conditions. Human activity recognition challenges are discussed as shown below. A number of these challenges are:

a) The human behaviour: The recognition task become difficult when human is performing more than one activity or performing multiple task at the same time.

b) The definition of physical activities: For the activity recognition system develop appropriate definition for the activities by investigation and their specific activity.

c) Intra class variability: Which is defined as the same activity may be performed in a different way by the different individuals.

d) Intra class similarity: The classes of the data that are fundamentally different, but they are showing similar characteristics in the sensor data.

e) Selection of attributes and sensors: The sensors are used to measure the attributes that is selected. And this plays an important role in activity recognition performance.

f) Sensor inaccuracy: The data obtained from the sensors should be accurate. Thus obtained sensor data play impacts the activity recognition results.

g) Sensor placement: If the sensors are placed in a wrong way and this orientation of the sensors which cause the effect on the recognition performance.

h) Resource constraints: The sensor nodes and the size of the battery is mainly affected by the power consumption (if using inertial sensor).

g) Usability: The recognition system that is developed should provide best usability. That is, it should easier to learn and more efficient to use.

h) Privacy: The sensitive user information from the system should not be attacked.

i) Subject sensitivity: The subjects or the data that is participated in the training and testing stages are heavily effected due to the accuracy of the activity.

j) Obtrusiveness: In this human activity recognition system the user who involved in the activity no need to wear many sensors and also no need to interact too often with the application.

k) Data collection: The training data is collected based on the realistic conditions.

l) Flexibility: The human activity recognition system should be flexible to support to the new users without re-training the system.

m) Processing: This human activity recognition should identify where the activity recognition task should be performed, whether in the server or in the integration device.

n) Trade-offs in HAR: The trade-off between accuracy, system latency, and processing power.

o) Multiple residents: This human activity recognition system should have more than one resident but the activity can be present in the same environment. And off course there is another challenges corresponding to the application domain itself, but we present the common and the most popular.

**6 Experiment:**

To evaluate the performance of human activity recognition we need records of actual falls but it is very difficult to collect real world fall data of older people hence we need to monitor the people for several weeks to obtain the records of actual falls. [6]. A total of 30 participant of different gender, ages and weights contributed to this experiments. They perform the activities such as walking upstairs, walking downstairs, sitting, smartphone is attached to the waist of each participant to collect acceleration and angular velocity of data. The participants are young and healthy adults who perform planned falls and only acceleration and angular velocity signals are provided as input to the feature extraction block .and output of feature extraction block is used by the classification algorithm to recognize the human activities. The classification algorithm is fails to recognize different types of activities. then the classification accuracy will be very poor. The feature extraction reduces the dimensionality problem. feature extraction helps to determine the type of activity performed by the users. classification algorithm recognize the user activity based on acceleration and the gyroscope data. initially algorithm is exposed with a large set of labelled data based on that data the classification algorithm it reduces the misclassification rate. after the training phase the classification accuracy of the algorithm can be accessed using test data. data are organized in buffers. each of these buffers are labelled with activity identity(ID) determine which class the data belong. The Ids are numbered from 1 to 7 corresponds to walking, walking upstairs, downstairs, sitting standing, and lying. if the data buffer has activity id equal to 4 then this implies that the participant is sitting. In this paper he conducted experiment on the chalearn dataset containing of 20 classes. And data set contain 940 video sequences where the videos are performed by the single persons [7]. For the given input deep belief network predict the emission probability.at the end chalearn protocol is used to evaluate the performance. The two challenging dataset are used to determine the activity first dataset is cad-120 and the second dataset is accompanying where the data is collected from homecare environment. The cad-120 dataset contains 120 RGB-D videos with the 4 subjects performing daily activities such as drinking, eating, pouring, moving etc. Initially start and end frames are labelled. we apply graph based approach to parse the video into segments. specially we use nodes to represent skeletal joint at each frame and measure the speed of joints between 2 frame then detect the changes in skeleton joints [8].

Before the start of smartphone, the human activity recognition is done by using wearable sensors or cameras. After the smartphone era was started the wearable sensors are embedded with the smartphone to make it easier to use. Activity recognition used in a field such as fitness tracking, health monitoring, fall detection, context aware behaviour, home and work automation, self-managing system. A mobile device has limited memory capacity but machine learning algorithm holds the large no of dataset so there is chance of missing of data. If the raw data is missing, then it affects the performance of human activity recognition. The short sleeves present T-shirts, wrist band, socks, and with ought sleeve T-shirt are the preferred garments for STS. In order to synchronize the sensor, we move the data collected from the oximeter sensors present in smart phone through Bluetooth and all the sensors are set to the same time as the computer time to which the data is transferred. Data collection protocol contains 4 activities such as walking, running, sitting and standing and some activities are performed at both indoor environment and outdoor environment [9]. Each entity has to follow this protocol. Initially prepared the instruction for them. These instructions determine the how many minutes will an entity walk, and run, sit, stand and determine the indoor or outdoor environment. recorded dataset contains 4 different type of physical activities at 2 different type of location and selected 12 male and female subjects for performing these activities at different intervals from morning to evening. All collected records different age group. Each subjects performs all physical activities and we label these records within 1 Ms. for this reason they have developed the mobile application for an android device. The mobile application records the sensor data and stored in a .csv file. They have used between 0.75 and 1.75 millisecond as the range of the walking speed. The rate greater than 1.75 as running speed. Sigma based feature representation: In the machine learning algorithm the input data is very important and if there is changes in trainings data will results in misleading the training process of machine algorithm hence outlier has to be cleaned from the sensor data. To cope up with this problem at the end we calculated sigma and determine the variation between each data point relative to the mean and if the data points are far from the mean will results in higher deviation

Human Activity Recognition is to identify the human activity, behaviour its application on healthcare, smart home and nursing [10]. Human activity recognition is based on vision and sensor cameras are used to view performance, angle and location. Sensors are placed on the other hand to reflect the human activity it is more used to recognize the activity. Activities are categorized by their duration basic activity and transitional activity is the two types. Basic activities are mostly used as compare to transitional activities as it can recognize in a short duration of time recognition of the transition are not useful as the multiple tasks are performed in short time. Transitional activities are useful for example if the older people met an accident or if fall it can be easily recognized by the various posture that sensed by sensor. So the different human activity should store in the data and the observed data that are obtained by the camera and sensor which will distinguish basic activities and transitional activities. Here K Means is used to classify the recognized data and checks whether it matches to same activity in a short time. In this various activities are recognized by the transitional activities [18] it is well recognized as compare to the basic activities in a short period of time. The future task is to recognize state of art method, more data set will be experimented.

**7 Application of human activity recognition using sensors.**

In most of the cases human activity recognition which identifies the activity by making use of the sensors. The most commonly used sensors are as follows they are accelerometer, gyroscope, barometer, etc. But now a day most of the smart phones are equipped with different and rich set of sensors, which will act as an alternative for the human activity recognition. Human activity recognition requires running classification algorithms, originating form statistical machine learning techniques. But most commonly supervised or semi supervised learning techniques are utilized and such techniques depends on the labeled data, i.e., associated with a specific class of activity. In most of the situation the user only need to label the activity which in turn increases the burden on user. Therefore, user independent training and activity recognition are required to promote the growth of the use of the human activity recognition system. where the system can use the training data from the user in classifying the activity of a new subject.

**7.1. Subject sensitivity**

The accuracy of the human activity recognition depends on the accelerometer data and highly effected by the subjects involved in the training and testing stages. The reason for this is due to the different people involved in the activity is having different motion patterns. Even though for the same motion the people may have different patterns at different time. The comparative experiments show that training and testing on same subject of motion achieves the highest accuracy. Training and testing on the same group of multiple subjects has the second highest accuracy. The accuracy decreases when the test data are collected from same subject, but on different days. The Human Activity Recognition using Sensor is having Applications and Challenges in a Smart Environment. A recognition model trained to work on the on the different dataset. And which is more reliable when it is tested on data from new individuals. Deng et al. proposed a cross-person activity recognition model to eliminate the effect of user sensitivity. There exists two parts in the model training stage: first stage is the initial model is trained off-line and through the online adaptive model is updated. In order to generate the new training data, set the algorithm selects those high confident recognition results for new users in the online phase. The algorithm will update the recognition model to make easier the subject sensitivity. based on this new training data set.

**7.2 Location sensitivity**

In both wearable sensors and smart phones because of the property of accelerometer, this raw reading is actually depending on the sensors’ orientation and subjects body positions. For example, the user is walking along with holding mobile phones, the moving reading data is different if user holding the mobile phone in his/her pocket when compared with user is not holding the mobile phones. by using another sensor magnetometer in order to address the orientation sensitivity. The magnetic vector along with the three axes of the device’s coordinate system in the orthogonal directions is provided by the magnetic field sensor. Later the accelerometer reading is converted to the earth coordinating axes reading.

**7.3. Activity Complexity**

Often the complex human activity imposes a challenges on the recognition model. For example, between two activities the motion during the transition period is difficult for the proposed classification algorithm to recognize the type of activity. When the user or people performing multiple task in the same way it might confuse the classifier, which is trained under one activity-per-segment assumption. There is difficulty in applying the activity recognition models globally due to the additional, culture and individual difference which might result in the variation in the way that people perform tasks.

**7.4. Energy and Resource Constrains**

The continuous sensing and online updating of the classification model is essential in case of the human activity recognition and both of which requires the energy consuming. The significant computing resource is also required for the online is updating memories. The sampling frequency is different for the different activities, the A3R usually takes the choices on both the sampling frequency and classification features. Hence it reduces both the energy and computing resource cost.

**7.5. Insufficient Training Set**

As described in the subject sensitivity the challenging task is to collect highly desirable training which must contain the varieties of the all possible subjects. And coordinate the people with different ages and body structures in order to collect data under a controlled lab environment is not easy to. To solve this issue Semi- supervised learning is introduced. In learning accuracy is achieved when the unlabelled data is in conjunction with a small amount of labelled data during the many of the classification tasks and which is also having the essential amount of improvement. The collection of unlabelled data for the human activity recognition, is easy and which requires less effort. The human labelling cost is reduced by combining semi- supervised learning algorithm along with virtual evidence boosting (EVB) method, and this method also improves efficiency for feature selection. Along with the traditional semi-supervised learning method, the scale- invariant classifier SIC-R is designed in such a way that in order to identify the multiple events of human activities. Then introduced feature descriptor allows the feature from one training set to describe events which may take place over varying time scales.

The human activity recognition is essential during many applications. Based on the targeted beneficial subjects then the applications of mobile activity

recognition can be classified. They are described below.

1) This is applicable in the many of the end user end users such as fitness tracking system, health monitoring system, fall detection system, behaviour-based context- awareness system, home and work automation system, and self-managing system.

2) the targeted advertising system, research platforms for the data collection, corporate management, and accounting are used as the third party application.

3) The social networking systems are the example for the Applications which is for the crowds and groups and activity-based also based on the crowdsourcing. And review on some representative of some application is made.

**7.6. Daily Life Monitoring**

The some of the daily monitoring applications for the human activity tracking usually provides the information or assisting about exercise and healthy life styles. And these application device is provided with the embedded sensors such as, gyroscope, accelerometer, GPS. And they are generally used to track human activities such as stairs or steps climbed, amount of calorie burned during the activities, hours slept, distance travelled, etc. And also online report is provided to the user in order to get their activities report which monitors the health. When compared with smart phone sensors, the mentioned devices sensors are more modern or sophisticated, because these sensors designed only for the activity detection and monitor. The main disadvantage of these sensors are they are more expensive. The now a day the smartphone applications are with activity recognition techniques having the wide range of applications. And these applications are having similar role as mentioned in the above specialized devices. And these devices generally track users’ such as jogging route, steps taken, and sleeping time. By obtaining logged data, they may provide the user a summary on his/her lifestyle and report the sleeping quality.

**7.7. Personal Biometric Signature**

Any subjects motion pattern is usually exclusive and unique that means motion of some different subjects evolve different subject patterns. For example, when two or more peoples are raising their hands, and however it is almost impossible for two or more people’s hands to share the exact same motion patterns. And if two or more people are performing same motion even the successful imitation of another one can also possible, because of the presence of the difference in the motion of the related bones and muscles on human bodies, the differences is still existing. However, the sensors such as accelerometer is applicable for capturing the such differences. But the human activity recognition techniques are useful technique which provides a possible solution for taking human biometric signature along with the motion patterns. The pattern recognition method is an approach which are used to obtain the unique motion patterns I these applications. And these approaches are in turn saved in the database. Because of spread through out of mobile devices it is convenient and feasible. Another threat is that motion signature and motion patterns can be used in a harmful way. For example, people could use the learned patterns to crack users’ behaviours, such as smart phone keyboard typing, or other spying activities.

**7.8. Elderly and Youth Care**

Now days there is a growing need for elderly and youth care in terms of physical and mental perspective. But the current research made on the human activity recognition is to develop an application for the elderly care. These type of application are really helpful for the aged people which prevent form harmful situation. For example, these applications are helpful to detect older people’s dangerous situations. A certain architecture on the smart phone is developed with the purpose of users’ fall detection. These human activity recognition application equipped with activity recognition and monitor sensors which could help elders in a proactive way, such as life routine reminder for example taking the medicine, living activity monitoring for a remote robotic assists. The another benefits from the human activity recognition is youth. This youth care application helpful to monitoring infants and helpful identify babies sleeping status and also includes predicting their demands for food or other stuff. Activity recognition techniques are also used in children’s (ASD) detection.

**7.9. Localization**

The human activity recognition can also be achieved using the mobile phone with context-awareness and hence it can be applied in localization. Since the GPS signal is usually very weak inside the buildings and underground hence the mobile sensors are used rather than that of GPS for localization. Another benefit of the activity recognition using the mobile phone sensors is that it could assist in locating the position. This GPS localization is nothing but a 2-D based positioning which provides no information about the user altitude. A similar system is provided for infrastructure-free floor localization. The GPS accuracy decreases inside the cities with the tall buildings surrounded is another reason to use a mobile sensor. This GPS-based localization is confusing, so this type of mistakes can be eliminated by the activity recognition applications. Which is achieved by augmenting the positions with people’s current activity type.

**7.10. Industry Manufacturing, Assisting**

This human activity recognition provides service to the workers in daily work. This type of activity recognition work makes use of the wearable sensors in to work wearable computing which is like an extension of the body that allows and helps the worker to perform various task. The human activity recognition is having wide range of applications one such application is make use of the smart camera which is helpful to understand the peoples position during the shooting time, robot assistance, in car production.

**8 Techniques that is used to achieve human activity recognition**

**8.1 human activity recognition using digital image processing**

The digital image is the numeric representation, normally binary, of a two dimensional image. digital images are manipulated for various different purposes using the digital image processing technique. Using the computer vision technique, the certain products are applied by adding digital image processing. This approach is used or implemented in various different fields. Nowadays, image technology is best utilized for various products. For example, fingerprint machine, object detection from digital cameras, face recognition, motion detection and others are some of the implementing technologies that is used for computer vision or in the digital image processing. The various devices are available to capture digital images. Now a day’s scanners, digital camera, webcams, security camera and others are the many devices that are available to produce digital images. The challenging task in designing such systems are to identify the objects. The segmentation, algorithm and feature extraction are the proposed approaches or methods in order to recognize the object. The few human poses are identified using the certain feature extraction technique. This technique is achieved by taking and capturing the object and identifying the width and height of the object that is achieved by making use of the pixel ratio values of the captured images. By measuring the height and weight of the segmented human objet the results were generated. The obtained data consists of three variable both height and width. The best suitable algorithm is used in order to identify the types of activity from the result of the feature extraction. In case of the human activity recognition using digital image processing makes use of the Nearest Neighbour algorithm in order to recognize human poses based on training data.The best nearest neighbour algorithm used is using k value which is required to design the human activity recognition system. This Nearest neighbour algorithm actually works on the numeric data appropriately. By using the feature extraction in the form of ratio this numeric data is generated. After that by using Cross Validation and k-Fold Cross Validation methods the data testing was constructed.

The highest accuracy is to identify the poses is reached by the Nearest Neighbour with k=3. Thus the final 90% recognition accuracy is due to the Cross Validation methods and 60% recognition accuracy of the due to the k-Fold Cross Validation methods. Thus finally proposed that the Nearest Neighbour with k=3 configuration reaches the highest accuracy in order to identify the human activity. Hence the Nearest Neighbour algorithm produces the best accuracy for the configuration. Thus finally this result will be used to design a human activity detection system.

**8.2 human activity recognition using machine learning.**

The human activity recognition system aims at wide range of applications. But recognizing the complicated human activities is quite challenging and it is an active research area. The human activity recognition using machine learning is uses feature selection approaches for human activity recognition. Normally human activities are recognized by means of the sensors attached to the human body. After by making use of the daily activity records the capability, common activity and functional performance level of the human can be determined. In many of the health care organization the many of the diseases can be detected by monitoring the human activity and suggest people to be physically active by exercise opportunities. Thus the physiotherapy techniques also monitor an exercise is correctly accomplished and also monitors possible disorders. Thus the human activity recognition also introduced in case of entertainment, Security and many fields which are effected by tracking of human behaviour through mobile phone data. For users to get physical activity recommendations on a daily basis the mobile phone application is introduced. The Motion capture video systems have become an important research topic in the monitor human activity.

**9.different ways in which human activity recognition can be achieved:**

**9.1 The human activity recognition using smartphone sensors by novel ensemble ELM algorithm**

Now a day the health care services and smart buildings makes use of the human activity recognition applications. In order to identify the type of human activities, the mobile phone or the smartphone sensors are most commonly used. Because the signal of the smart phone sensors is quite noisy, the discriminant representations are easily extracted. But in order to recognize the different human activities several different algorithms are utilized. One such algorithm used in extreme learning machine(ELM) algorithm which is of the extremely fast in classification task with the very fast learning speed. But here smart phone sensors to recognize the human activities by making use of ensemble ELM algorithm. The input weights are initialized by the Gaussian random projection(GRP) approach [11].

**9.2** **The human activity recognition framework through matrix and tensor completion.**

The human activity recognition by sensor based approach is applicable in health care centers and also it is applicable in the bio medical research. The machine learning algorithm helps us to extract the data from the activity. The accurate estimation of missing multimodal inertial data is one of the problem is discussed in this paper, and also classification of framework is discussed. And in this paper they introduced concept of forming two dimensional(2-D) and 3-D Hankel structures from the available data streams. Data redundancy is exploited using suitable technique namely matrix and tensor completion. According to different data structures the system is evaluated. Then the data is available for the construction. The multiple sensing parameters, and body location is analyzed [12].

**9.3 The daily human life activity recognition with wearable sensors by weakly supervised recognition technique.**

describes about the scalable and attentive human activity recognition by using body sensing. And also described about the common methods for human activity recognition that will make use of the training data. but quite challenging task is obtaining accurate proper annotation for activities recognition. And also learning schemes for activity recognition that are introduced. There are actually two learning schemes are introduced, that the experimental results on the dataset is fully close to the supervised technique [13].

**9.4 human action learning through global and local appearances.**

described about problems and troubles in human activity recognition, which occur due to combining of global and local visual appearances features. Hence global temporal dimension is actually used, the linear dynamic systems (LDS) are utilized that propose to model the motion dynamics. The shift invariant subspace angles based distance is used, in order to measure the similarity between linear dynamic systems(LDS), but in this case the local visual dimension of sampled feature points is used to construct curved Spatio-temporal cuboids. Then later the distance between the motion sequence is completed. Finally combine global dynamic distance and local visual distances. After that by making use of global dynamic distance and local visual distance the classification is performed using the maximum distance learning method [14].

**9.5 The human activity recognition based on single wearable accelerometer through QPSO-KLEM classifier and kernel discriminant analysis.**

now a day’s human activity recognition has great demand for many applications which makes use of the sensor based approach. Here more concentration is given to the efficient HAR approach using single tri axial accelerometer instead of the sensor network based recognition system for HAR. The human activity recognition approach is actually based on the kernel discriminant analysis (KDA)and then the quantum behaved particle swarm optimization based on kernel extreme learning machine is provided since to improve the recognition of the accuracy of the system. in order to enhance the discrimination between different activities the KDA is utilized that extract more meaningful features. Three features are like original features, linear discriminant analysis feature, and the KDA features is also utilized to evaluate the effectiveness of KDA. The QPSO-KELM is composed with two classifications methods such as support vector machine and extreme machine algorithm which is used for activity recognition. Then final outcome will tell the superiority of the given approach [15].

**4.6 The human activity recognition using 3-D posture data.**

the human activities are actually recognized using the information data sensed by RGB-D camera, name of that camera is Microsoft Kinect. In this some of the essential joints of human body is identified by means of the RGB-D camera. In order to achieve these three different machine learning techniques are used actually based on K-means of clustering, support vector machine and hidden Markov models. Later these models are combined to identify the human body positions that is involved in the activity, and these methods also used to classify them, and to model each activity. After experiments were performed on the dataset then the result is obtained [16].

**Conclusion**

CNN works on the HAR problem it focused on collection of activities that [17] obtained from the common activities which are already stored on the data. The common points are detected by the sensors and they are classified into individual and group units [18]. The result of this experiment represents that convolution models is used to recognize the activities from given data set. Most recognition of activities by combining the two, three sensors which will give better result than the single inertial units. Smart phone detects the activity that are performed by human that are detected through the sensor. Using AI algorithm, the activity can be recognized. Activities like walking, running and standing these are recognized by HAR algorithm and Acoustic Scene Classification which recognizes whether the [19] person is in indoor, outdoor or the vehicle. The goal is to provide end to end example from sensor acquisition to sensor classification through smart phone application. All AI libraries in this pack generated using the X-CUBE-AI extension. This function pack is being designed for specifically ultra-low power application in virtual parallel micro controller STM32L4 it is compatible with ST BLE sensor smartphone app available for android and iOS the sensor is for sensor reading, audio/motion classification monitoring, FW upgrade over the air (FOTA) and always data logging and annotation for new AI datasets. The boards needed is the sensortile kit and nucleo-L476RG or we can also use nucleo-L476RG with other three X-NUCLEO-CCA02M1, X-NUCLEO-IDB05A1 and X-NUCLEO-IKS01A2 shell. We also need android smartphone and USB cable [20]. Programming sensortile and the computers are connected .by this we can recognize the data and it can be reflected in sensor app whether the person is in indoor, outdoor or in vehicle.

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