A Real-Time Approach of Fall Detection and Rehabilitation in Elders Using Kinect Xbox 360 and Supervised Machine Learning Algorithm

V. Muralidharan and V. Vijayalakshmi

Abstract Nowadays, fall in elders is a major issue almost in all the countries. Sometimes, heavy fall in elders cause serious injuries which leads to major medical care. Fall may lead to disability and also cause mortality to the elderly people. Due to the development of science and technology, the life of the fallen elders is rescued, and the injuries are healed. The newly developed technologies bring happiness and makes the elders life comfortable. At present, fall detection and prevention draws the attention of researchers throughout the world. New technology like Kinect Xbox 360 brings a new way to develop new intelligent system, which could be used to monitor the elderly people in their daily activities. Kinect Xbox 360 is a low-cost device. It tracks the body movements. It is used by the elders doing rehabilitation exercises in the homely environment. Elders who are living alone face the risk of fall. Activity recognition system is a very important technology for elderly people to do their daily activities in their life. Physiotherapy is one of the branches of rehabilitation science which brings differences in the ability and makes the individual to lead a healthy life. In this paper, we are going to analyze various methods of human fall detection and techniques by noticing the daily activities of the elders. We are also going to see different types of machine learning algorithm used for fall detection.

Keywords Fall detection · Kinect · Supervised machine learning algorithm · Homely environment · Daily activities · Medical care

1 Introduction

Due to advancement of technology diagnosis and treatment of diseases, the span of life regarding elders is increasing day by day. It has been estimated by World Health

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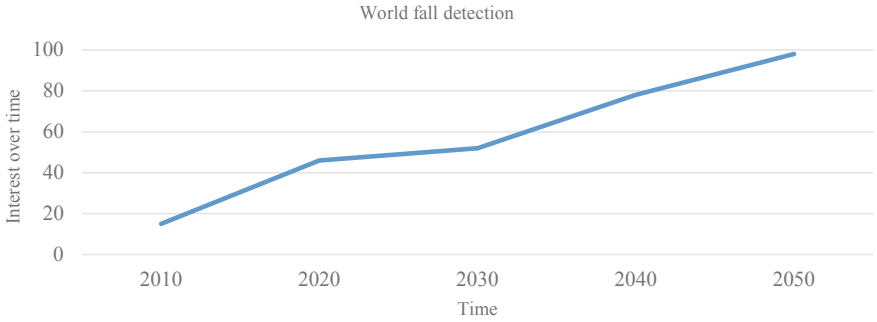
S. Smys et al. (eds.), *Inventive Computation and Information Technologies*, Lecture Notes in Networks and Systems 336, https://doi.org/10.1007/978-981-16-6723-7_10

Organization that in 2050, the number of persons over 65 years will be nearly 2.5 billion. The increasing of elderly population results in more number of falls. Due to the increase of age, the rate of fall and fall injuries raises gradually. Interest of fall detection overtime, from January 2010 to December 2050, is shown below in the given graph. The data are taken from the Google Search fall detection.



Fall in elders leads to major problem for the whole world [1]. After fall, individual medical care decreases the damages from fall injuries which results the increases of survival rate. The fall detection system functions very quickly and detect the fall [2]. Thus, it gained more importance. At present, researchers draw their attention toward fall detection and take remedial measures. The existing fall detection system is divided into three groups. They are ambience device, camera-based systems and wearable devices [3]. The devices of ambience are fixed in an area. It detects the fall. Some of the ambience devices are Doppler, microphone and accelerometer sensors. Computer vision uses camera which tracks the human movements. In this, fall can be detected when a person is inactive for a long duration. Wearable devices are attached to the body of the user to detect the fall [4]. Some of the wearable devices are accelerometer and gyroscope.

Elderly people who are suffering from injuries, disability or any other reason must practice rehabilitation exercises so that they may perform their daily activities without others help [5]. Physiotherapist in rehabilitation centers identify the problems of the elderly people, and they design suitable rehabilitation therapy to the individual concern. Some people do not adhere to the programs suggested by the physiotherapist, and they do the rehabilitation exercises in their own way. The patient must pay keen attention to both the body postures and the range of motions, repeating the exercises suggested by the therapist so that the patient can avoid unnecessary strain to the joints and muscles and may avoid further injuries.

Kinect is a low-cost sensor box which is used for playing Xbox games in the beginning [6]. Kinect consists of video camera, combined with depth sensor which could be able to measure the distance between an object and the Kinect box. Kinect detects 3D space about 4 m in depth and an angular field of view of 30 degrees to right and left. It is designed in the way that the camera of Kinect tracks human skeleton and joints. The Kinect sensor to some extent record human movements. This device can

be easily portable from place to place [7]. Kinect sensor was introduced in the year 2010. Kinect offers natural user interface and not only tracks the body movements but also records voice commands, interpret gestures and facial expression, speech recognition and environment recognition.

Machine learning has its significant development over the past few years. It is a branch of science which exhibits the ability of machine in classifying the data given to them. Some of the benefits of classification of data are as follows.

- It helps in data protection.
- It improves data security.
- It improves user productivity and decision making.
- It helps to eliminate unnecessary data.
- It also develops algorithm.

Machine learning algorithm helps the computer by converting complex patterns and develops intelligent [8]. In machine learning, data play an important role. It is used to gain knowledge from the data. The learning and prediction performance is affected by the quality of the dataset. Professor Husain-Tien Lin states in his book that machine learning is otherwise called as learning from data. Data occupies an important position in machine learning. Before entering into the study of machine learning, we must know first of all the notations of dataset. There are two types of datasets. First one is labeled dataset and next one is unlabeled dataset. We can group machine learning under three categories. They are supervised learning, unsupervised learning and reinforcement learning.

In supervised learning, the training set is labeled dataset. Supervised learning finds out the similarities between the feature set and the labeled set, that is, the knowledge and properties learn from labeled dataset. In unsupervised learning, the training sets are unlabeled dataset. It deals with clustering, probability density estimation, finding relationship among features and dimensional reduction. The results obtained from unsupervised learning could be used for supervised learning. Reinforcement learning is used to find out solution for salvation in decision making, for example, automatic vehicle driving.

Feature extraction plays a vital role in machine learning. The need for feature extraction are as follows. Extraction of technique of features are useful when there is large dataset. The need for number of resources are reduced. While doing so, there is no loss of relevant information. It helps in the reduction of the amount of redundant data from the dataset. Reduction of data helps to make the model with less effort of machine and the speed of learning is increased.

2 Daily Human Activity Recognition

Activity recognition means the task of recognizing the present physical action done by users in the set of definitive environments. In human activity recognition system, there occurs many challenges. The assistive technology helps the elderly people in fitness

tracking [9]. A fall may be an incident which brings rest to a person on the ground. It causes severe injuries and sometimes event to mortality. Internal and external factors are responsible for fall. Fall may occur, if a person loses his/her consciousness or slips all of a sudden while running or walking. Some of the internal causes are medical conditions like neurological, cardiac or other disabling conditions. Some other causes are medication of side effects, loss of balance, physical inability, especially among elderly peoples, poor movements and impaired vision and of hearing. Some of the external factors are overcrowded housing, poor footpaths etc. Tiredness, weakness in body condition and lack of concentration are other factors which lead to fall. Because of violent attack, fall occurs to some persons (Fig. 1).

Presently, due to the development of technology, human activity recognition reached its peak position. This technology is used to recognize the action of the user. It is also used to assist the task with the use of computing system. In this study, computer vision research as contributed a lot in this aspect. Human activity research indicates physical human activity [10]. In the beginning, research on human activity uses gestures. Gesture recognition is one of the main sub-topics of action recognition. At present, it gained more importance for its role in human machine interaction. In the past, devices like mouse, keyboard or touch screen were used. For elders and disabled peoples, it is difficult for them to use. So researchers are trying to find an alternative source. Table 1 gives approaches such as technology, merits and demerits of different techniques and some application of gesture recognition.

Human research activity is challenged by the traditional medical procedures. It gives great results in the areas of other fields like sports and industries. It also caters to the needs of human activities transportation, brushing teeth and medication etc. It is also used for gaming experience while using Kinect Xbox 360. We can use activity recognition for single person or a group. In order to identify single user, multiple user recognition can be performed, and thereby actions are tracked. This is used to

Fig. 1 Daily activities of elderly people

Table 1 Technology of gesture recognition

S. no.	Approach	Technology	Merits	Demerits	Applications
1	Vision based	Surveillance camera	High accuracy	Privacy issue	Gaming, smart screen interaction
2	Depth sensor	Kinect	Low price	Private issue	
3	Wearable sensors	Smart watch	High accuracy	Difficult to use	
4	Object tagged	Ultrasonic sensor	High accuracy	Device based	

monitor video camera. In the process of single user recognition, there are many ways to collect data.

3 Fall Detection System

An event that leads a person to lie or rest on the ground is described as fall. Fall in elders is a major problem globally. Fall occurs mostly to the elders due to age [11]. Fall causes major risk mainly to male, when comparing with that of female. There are five types of falls. They are

- Backward fall occurs when a person fall backward and rest on the ground.
- Forward fall occurs when a person fall forward and rest on the ground.
- Forward fall on the knees bragging the chair occurs when a subject fall forward remains on the ground and bragging the chair.
- Left side fall occurs when a subject fall on the left side and remains on the ground.
- Right side fall occurs when a person falls on the right side and remains on the ground.

There are different methods available to detect fall events. They can be divided into two kinds. They are

- Non computer vision-based methods and
- Computer vision-based methods.

3.1 Non-Computer Vision-Based Method [12]

In non-computer vision-based methods, different kinds of sensors such as acoustic, acceleration and floor vibration sensors are used to detect sound [13], vibration and data of human body movements [14]. The information is gathered is analyzed to detect the reason for fall. There are two ways by which non-computer vision-based methods are used. They are wearable sensor methods and ambient fusion-based

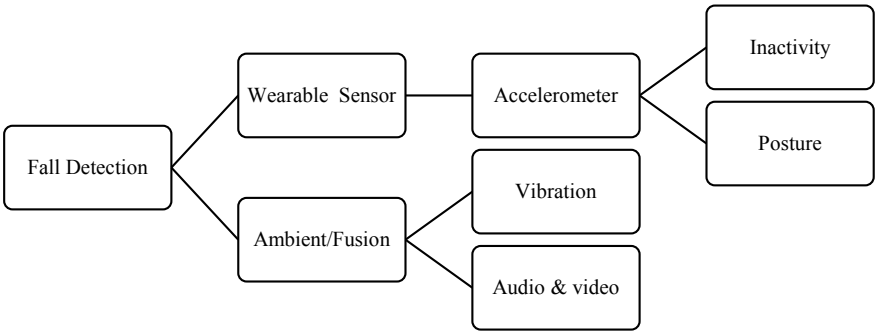


Fig. 2 Classification of non-computer vision-based method

methods. In wearable sensor method, we can use accelerometer, gyroscopes and tilt meter to detect the fall events. There are some disadvantages in this system. The elders always used to carry throughout the day wherever they go. Elders may sometime forget to wear and may forget to charge the battery. They may feel uncomfortable to wear it. Because of these, researchers pay their attention towards an alternative method. Ambient sensors consist of floor sensor, pressure sensor and an infrared sensor. We can fix floor and pressure sensors on the ground so that at time of fall, frequency of vibrations are recorded in the sensor. In addition to above-mentioned sensors, infrared sensor is also attached which records the motions in the surroundings environment. These systems are free from environment, and there may be difficulties in the installation of the above-mentioned sensors because the flooring is different from house to house, so we find difficulties in the installation (Fig. 2).

3.2 Computer Vision Based Method [12]

This system has foremost benefits when compared with that of non-computer vision system. There is no need to wear any device in this system. More cameras are used to track the human movements. There are three ways by which their performance is carried out.

- Using single RGB camera.
- Using 3D-based multiple cameras.
- Using 3D-based depth cameras.

3.2.1 Using Single RGB Camera

We can easily setup a single RGB camera for detecting human fall. It costs very low. In order to detect, fall need features which relates to shape and human motion analysis. Mirmahboub et al. use an ordinary simple method to produce a silhouette

of a person, and multiple features are then obtained from the silhouette area. A classification can be done with the help of silhouette of an individual.

3.2.2 Using 3D-Based Multiple Cameras

By using 3D-based multiple camera, we can also detect the human fall. This 3D multiple camera systems reconstruct the object and at the same time, we pay attention to time-consuming calibration process. Auvinet et al. uses multiple cameras for the reconstruction of 3D shape of the individual. By analyzing volume distribution, events of fall can also be detected. An alarm is setup to alert when event of fall occurs.

3.2.3 Using 3D-Based Depth Cameras

In the beginning, researchers used time-of-flight 3D camera for finding fall detection. It is very expensive. Due to the development of depth sensing technology, a new device called Microsoft Kinect Xbox 360 draws the attention of the researchers. It is with the help of depth camera, we can simply calculate the distance between top of the person and to the floor. This can be used to detect the features of the human fall.

By using normal video camera or by depth video camera, movements of the person are monitored in vision-based system. When a falling posture is detected, an alarm indicates help to prevent fall. A single setup of these system can be supervised more than a person at a time. So, these systems are very convenient to use and free from environment. They can be used in previous installed surveillance and security cameras. There are many improvements in using computer vision method such as detection and recognition of objects, classification of images and segmentation. Researchers made use of these concept in areas of various vision-based application.

According to Perry et al. fall can be grouped under three categories. They are

- Methods that measure acceleration.
- Methods that measure acceleration combined with other methods.
- Methods that do not measure acceleration.

All fall detection systems are similar. The main objective is discrimination between fall event and daily activity living (DAL). Certain activities of daily living are not an easy task like sitting down or going from standing position to lying down has strong similarities to falls. To test a fall detector, we are in need of data pertaining to fall and daily activities of living. Sensors recorded the data. It is recorded in the form of acceleration signal, images, pressure signals etc. They are processed and classified using detection techniques. They are expressed in the form of sensitivity and specificity. Fall is used for detecting sensitivity and daily activity living is used for detecting specificity.

4 Fall Rehabilitation

Rehabilitation belongs to a branch in medical science which deals with restoring the ability of an affected individual and make him to do his daily routine work. Patients suffering from injuries [15] or disability have negative effects often in their day-to-day activities. We have to give rehabilitation process to these types of people. In rehabilitation centers, the cost is very high. In order to support the patient, we have to make the patients to do the rehabilitation exercises in homely environment. The effect of the age differs in time from person to person, but there appears some in differences. E.g., slowness, balance disorders which results in physical limitations.

At the time of walking, elders move their hip largely when compared with that of younger generation. Youngers have very slow hip movements and the knee movements. Some of the falls are caused due to intrinsic factors. It is because of weakness in lower extremity muscles and limitation in lower limb joints mobility results in impaired gait pattern. They are called as significantly as risk factors. Death is considered to the sixth factor for elders who are above 65 years of old, and death is considered to the second factor for those who are in between 65 and 75 years old and for the people who are above 75 years of old, it is considered to the first factor. Recent study considers physical activities are very essential for maintaining good health and independence. Exercises pertaining to home games can be used successfully for preventing fall. Health games and therapy combined games contribute more care effectively (Fig. 3).

4.1 General Concept for Fall Prevention in Elders

- We must take steps to improve the life style of the elderly people.
- Elders must be given independence by giving rehabilitation exercises.
- We must support the elders through telecommunication with their families.

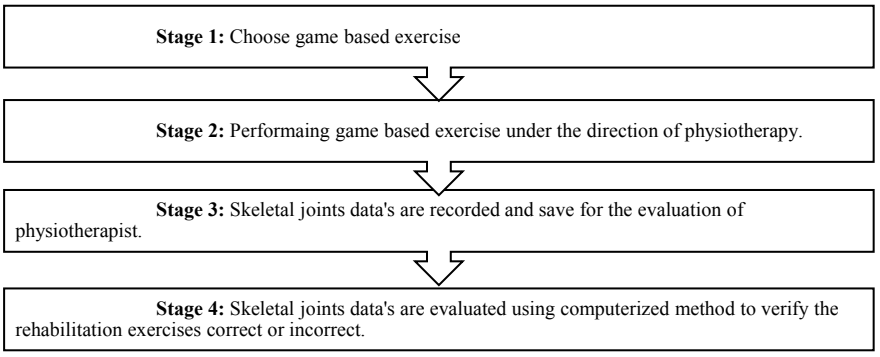


Fig. 3 Execution of game-based rehabilitation exercises

- We have to develop guidelines for elders regarding physical activities.
- We must offer pleasant opportunities for their physical activeness.
- Elders are to be educated how to live a safety life in their old age.
- We must ensure elders the good health care.
- Due weightage should be given to words of elderly people.
- Caretakers are educated how to take care of elderly people.

We can develop the health and quality of life of affordable actions. More than 50 trails are made to investigate the benefits of exercises. It is because of variation in the exercise types, intensity, frequency and time taken. The program of rehabilitation should be started on the day of operation or accident. By this way we can save time, money, individual suffering. Delay in this process leads to unnecessary mental and physical problems. The steps to be followed in this method are

- Evaluation.
- Physical medicine.
- Psychological supportive training.
- Vocational training.

The technique includes positive diagnosis and patient's rehabilitation potential. The team members who have attended the patient's recorded the collected information and data regarding the patient and evaluation is made. The team members made evaluation along with patient and members of the team make their individual contribution to rescue the patient. The part of the physiotherapist is vital because he has to explain briefly about the exercises pertaining to the patient. The physiotherapist helps in the rehabilitation planning by considering the nature and distribution of abnormal muscular activity.

5 Technology in Kinect

Kinect is used to track human body movements [16] and also used in homely environment for doing rehabilitation exercises [17]. It consists of a set of sensors, and it was developed as an input tool for Xbox 360 and Xbox one gaming console. There is an infrared projector, IR camera which is used for obtaining precise depth maps, a RGB color camera, a four microphone array and a motorized tilt [18]. In both, the camera images are produced at 30 frames per second (fps). The IR camera captures 3D video data with the help of structured light technology. The depth values portray to the imaginary image plane. An irregular pattern of dots is shouted by the IR projector with a wavelength comprising of 700 nm–1 mm. In addition to this, Kinect tracks human skeleton joints. The windows SDK for Kinect gives skeleton tracking, and it allows the users to identify people and track their actions. The depth sensor helps the Kinect to recognize six users standing from 2.6 to 13.1 feet. Moreover, two of the detected skeletons are tracked with the aspect of twenty joint positions. Each skeleton joint is calculated in a three dimensional such as X, Y and Z plane [19].

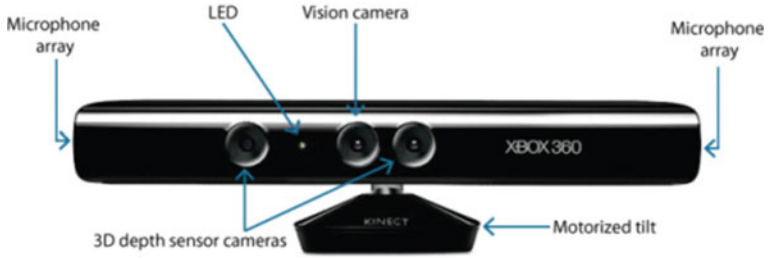


Fig. 4 Kinect Xbox 360

When the joints move from right to left, the X-axis varies. When the joints move up and down Y-axis differs. When the joints move back and forth in relation to Kinect sensor axis varies [20] (Fig. 4).

5.1 Use of Kinect in Fall Detection

The Kinect system detects the activities of the elderly people and track the events. The elderly people is perceptible. The sensor of the Kinect read, and the movements of the elders is restrained [21]. The method of fall detection is portrayed below designing of system (Fig. 5).

There are two stages in operation of the proposed system. They are

1. Acquisition stage.
2. Recognition stage.

The first stage consists of Windows personal computer joined with Kinect sensor by both physiotherapist and patient. Computer is in charge running the machine learning program. A program is used by the physiotherapist, and exercises are recorded and patient should practice it. The patient performs the exercises before the sensor, and it is translated into a machine main program. The patient uses a system for his performance, and the progress is recorded in the database. By using the system, the performer could retrieve the exercise. Regarding skeletal feature

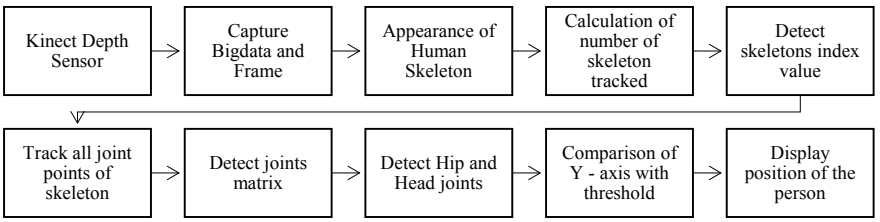


Fig. 5 Method of fall detection

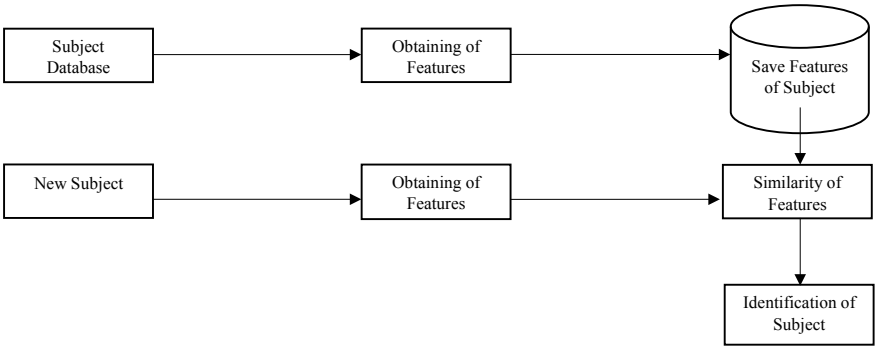


Fig. 6 Operation of acquisition and identification stage

recognition, the Kinect sensor capture RGB video and depth information and extract skeletal data. A skeletal image provides information about the human body as depth maps. The sequence of skeleton provides information about shape, structure, position and angles (Fig. 6).

The second stage is recognition stage. After selecting the exemplar, the user must follow the real time feedback pointing out the body joints. On the basis of comparison, analyze the skeleton points in correspondence with the save image and the target image. Motion instructions are given by the system for correcting in accurate joint. Apart from this, the system plays back the learning exemplar while the user fails to follow the movements. In this, the skeleton detection of the user before the device is obtained from the depth image. At the end of the process, the result is exhibited and is recorded in database.

5.2 Rehabilitation and Kinect

It is with the help of games; the customized real-time system is developed with the help of Kinect. It allows the elderly people to perform physical rehabilitation exercises by using Kinect [22]. This type consists of serious games which stimulates body mobility by means of immersive experience. These technology helps the rehabilitants to do their exercises in the homely environment. The different types of exercises uploaded in the platform help to do several aspects like strength and aerobic capacities. This system does not need the presence of physiotherapist while the rehabilitants do their exercises. In this system, the rehabilitants are monitored and an audio visual feedback is given during these session so that the user may know if he is performing the exercises correctly which are designed by the physiotherapist to them. There are different kinds of games designed for elders. Some of them are Wii, PlayStation, Wii balance, Xbox. Kinect is chosen because it can be used very easily by the elders. Using Kinect is a natural interaction; hence, it is less intrusive.

The flow chart mentioned below gives information about Kinect-based user activity (Fig. 7).

There are two different types of games included in this platform.

1. Games related with aerobic capabilities [23].
2. Improving strength skills [23].

The first type of game is designed to develop aerobic capabilities. A patient is asked to walk in front of the Kinect with different landscapes [24]. The patients are advised by the system when they should increase their speed and when they stop. At the time of game, they are asked to pick up colorful balls which are scattered on the ground. Four different kinds of activities are developed in aerobic games. They are training of upper limb and lower limb, training both limbs at the same time and training of any one of the limbs.

Strength skills are developed in the second type; the patients are taken to the scenic places to have beautiful view and relaxing sounds which might encourage them. The system observes the number of repeated exercises and series the performance of the patient. In this game, the patient is asked to practice some games in the gym. The patients are instructed what kinds of exercises they can perform. The movements of the patients are detected to verify whether the performer performs correct movements. If the patient is not able to perform the exercises within a stipulated time, the system identifies it. It instructs the doer to switch over to the next exercises. Time taken by the patient while doing different exercises are recorded, and it will be brought to the notice of the physiotherapist.

6 Machine Learning

Machine learning algorithm is a science, which brings out the machine's ability in clear understanding of the data given to them. Algorithm development is included in it. Machine learning algorithm makes the computer to have the clear view of the complex patterns and brings out intelligence at the time of machine learns. It includes numerous processing. If there is any challenge for the machine, it changes its structure, and their buy programs are developed. Alp Aydin et al. defined machine learning as optimizing a criterion of a performance by using example data and previous experience. In the process of machine learning, data plays vital role. The learning algorithm learns knowledge from the data. The quality as well as quantity of the dataset affects the learning and performance prediction. The other name for machine learning is deep learning. The benefits of deep learning are

- Maximum use of unstructured data.
- Removal of need for feature engineering.
- Ability to produce quality results.
- Unnecessary costs may be eliminated.
- Elimination of the use of data labeling.

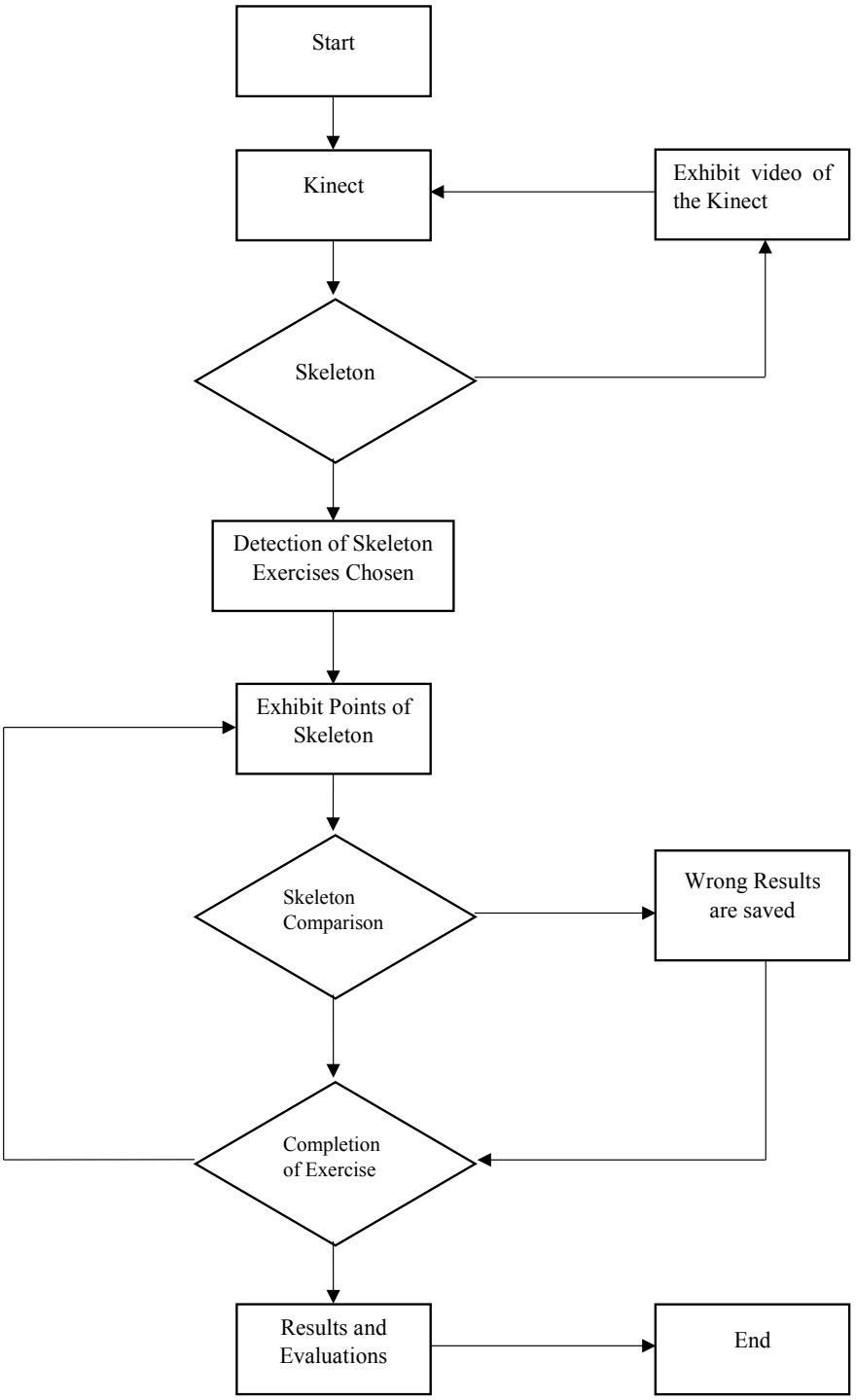


Fig. 7 Kinect-based user activity

Datasets are of two types. They are

- Labeled dataset and
- Unlabeled dataset.

Labeled dataset is a piece of data which is tagged with one or more labels. It identifies certain properties or contained objects. Labels make the data, which has been used for certain machine learning commonly known as supervised machine learning setups. It needs experts to annotate. It is very expensive, very hard and time-consuming to get and store. It is used for complex predicting tasks.

Unlabeled datasets consist of pieces of data. It has not been tagged with labels that identifies characters, properties or classification. Unlabeled data has no labels. It predicts features to represent them. Basically, it is raw data. It is used in unsupervised machine learning. It is obtained by observing and collecting. It is very easy to get and store. It is used as a preprocessing dataset.

An unknown universal dataset assumed to be exit in the machine learning. It contains almost all possible data and the probability distribution appearance in the real world. But in reality, what we see is only a subset of the universal dataset. This is because of memory loss or some other reasons. The other name for acquired dataset is training data. It learns all the properties of the universal dataset. In no free lunch rule, the learned properties can explain the training set, so machine learning is infeasible. The techniques involved in machine learning are statistics and computer science. Statistics is explained as learning the statistical properties from given data. Computer science involves optimization of efficient algorithms, model representation and evaluation of performance.

6.1 Classification of Machine Learning

We can classify the machine learning into three categories. They are (Fig. 8)

1. Supervised learning.
2. Unsupervised learning.
3. Reinforcement learning.

6.1.1 Supervised Learning

The supervised machine learning algorithms consist of dependent variables which are predicted from independent variable. By using the variables, we run a function that creates input from desired outputs. There is continuity in the training process until we achieve accuracy on the training data. In supervised machine learning algorithm, labeled dataset plays as an orientation for data training and testing exercises. Some of the popular supervised machine learning algorithms are linear regression, decision tree, random forest, k-nearest neighbor and logistic regression.

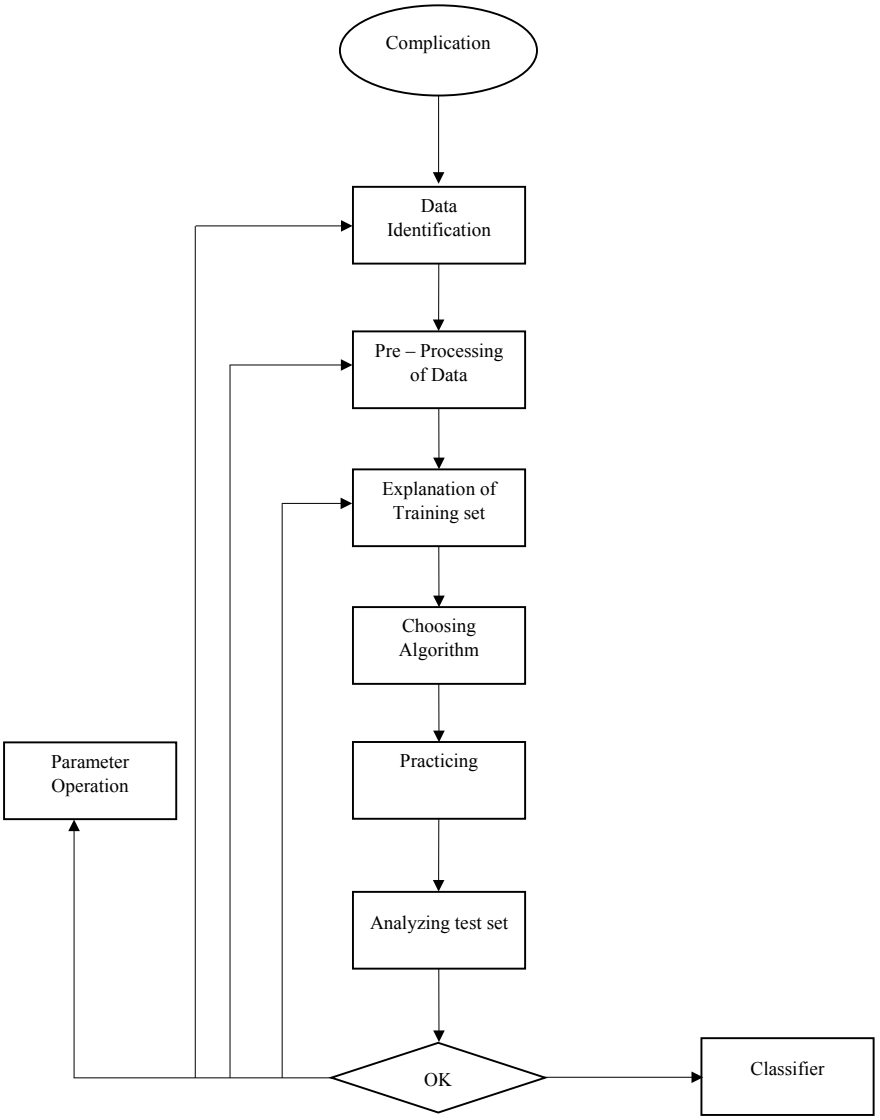


Fig. 8 Process of machine learning

Linear Regression

It is used to estimate real values. We establish relationship between independent and dependent variables by a fitting a best line. The classifiers of these algorithms are

$$\text{Precision} = \frac{\text{FP}}{\text{TP} + \text{FP}} * 100 \tag{1}$$

$$\text{Recall} = \frac{\text{FN}}{\text{TN} + \text{FN}} * 100 \tag{2}$$

$$F1 = \frac{\text{Precision}}{\text{Recall}} * 100 \tag{3}$$

Decision Tree

Apart from other supervised machine learning algorithms, decision tree algorithm solves regression and classification problems. The main of this algorithm is to create a training model that predicts the value of the target variables by simple decision rules. The classifiers of these algorithms are

$$\text{Particularity} = \frac{\text{TN}}{\text{FP} + \text{TN}} * 100 \tag{4}$$

$$\text{Susceptibility} = \frac{\text{TP}}{\text{TP} + \text{FN}} * 100 \tag{5}$$

$$F1 = \sqrt{\text{Particularity*Susceptibility}} \tag{6}$$

Random Forest

Random forest is a trademark term for an ensemble of decision trees. Random forest consists of collection of decision trees. In order to classify the new object based on attributes, each tree gives a classification, and we say the tree "votes" for the class. The classifiers are

$$F1 = \frac{\text{TP} + \text{TN}}{\text{FP} + \text{FN}} * 100 \tag{7}$$

K-Nearest Neighbor

KNN algorithm stores all available cases and classifies new cases on the basis of similar measures. It is used in statistical estimation and pattern recognition. KNN is also used for classification as well as regression predictive problems. KNN is otherwise called as lazy learning algorithm or non-parametric learning algorithm because it is not having specialized training phase, and it uses all the data for training while classification. The classifiers included in this algorithm are

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} * 100 \tag{8}$$

$$\text{Recall} = \frac{\text{TN}}{\text{TN} + \text{FN}} * 100 \tag{9}$$

$$F1 = 2 * \frac{\text{Precision*Recall}}{\text{Precision} + \text{Recall}} \tag{10}$$

Logistic Regression

Logistic regression is a classification not a regression algorithm. It is used for estimating discrete values (yes or no) based on given set of independent variables. It predicts output values lies between 0 and 1. The classifiers of these algorithms are

$$\text{Precision} = \frac{\text{TP}}{\text{TN} + \text{FP}} * 100 \tag{11}$$

$$\text{Sensitivity} = \frac{\text{TP}}{\text{TP} + \text{FP}} * 100 \tag{12}$$

$$F1 \text{ score} = 2 * \frac{\text{Precision*Sensitivity}}{\text{Precision} + \text{Sensitivity}} \tag{13}$$

6.1.2 Unsupervised Learning

In unsupervised machine learning, everything is in order. The main aim is to make the computer learns something which we cannot teach it and the computer is not instructed the process of doing. Unsupervised machine learning has two approaches. In the first approach, the agent is taught to use rewards system to denote success. The second approach of unsupervised machine learning algorithm is clustering. This approach finds similarities in the training data. Data is driven in this approach. In the view of Ghahramani, unsupervised algorithm is designed to receive structures from the data samples. Some of the unsupervised machine learning algorithms are

Apriori Algorithm

The Apriori algorithm uses frequent item sets. It produces association rules, and it is made to work on the databases which contain transaction. It is with the cooperation of association rule, it determines the strength or weakness of two connected objects. This algorithm uses breadth-first search and hash tree for calculation of item set association efficiently. It is an iterative process for finding the frequent item sets from the large dataset. The main use of this algorithm is market basket analysis. It helps to find products which can be bought together. It is also used in the field of healthcare. The different steps used in this algorithm are

Step 1: Determining the support of item sets in the transactional database.
Step 2: All higher support value or lower support values are taken into account.
Step 3: Determine the rule of these subsets that have higher values than threshold or lower confidence.
Step 4: Sort out the rules in decreasing order of lift.

K-Means

K-means clustering belongs to unsupervised machine learning algorithm. It is used to clear the problem relating to clustering in machine learning. It forms the unlabeled dataset into different groups. It is a centroid-based algorithm. The clusters related with centroids. Its main aim is to reduce the distance between the data point and their corresponding clusters. It takes the unlabeled dataset as input and separates the dataset into *k*-number of clusters. The process is repeated till the best clusters are identified. *K*-Values is predetermined here. There are two main tasks that this algorithm performed.

- Determining best value for the k center points.
- Each data points are given nearest to k-center. The points nearer to the k-center forms clusters.
- **Step 1:** *K* is selected to decide total number of clusters.
- **Step 2:** Choose random *K* points.
- **Step 3:** Each center points is assigned near to centroids, which performs earlier *K* clusters.
- **Step 4:** The variance is determined and fix a new centroid of every cluster.
- **Step 5:** The third step is continued.
- **Step 6:** If there is any reassignment appears, go to 4th step to complete.

6.1.3 Reinforcement Learning

In this algorithm, the machine takes specific decisions. It works by exposing itself to an environment by training itself by using trial and error method. The machine knows from past experience and get more information and thereby accurate decision is taken by the machine. Reinforcement learning differs from supervised machine learning algorithm. In supervised learning, the training data has the key answer. In reinforcement learning, no answer is found whereas the reinforcement agent determines what to do next. Reinforcement learning divided into two types. They are positive and negative. We can explain positive reinforcement learning as when an event occurs because of particular behavior which increases the strength of the behavior. Negative reinforcement learning strengthens the behavior because the condition of the negative is avoided. We can use reinforcement learning in the field of robotics and for industrial automation, machine learning and data processing. It is also used to create training system which gives custom instruction and material distribution according to the student's strength.

7 Conclusion

Presently, elderly population faces the problem of falling all over the world. They have to be saved. It is because of new technological development elders are rescued from their risk of falling. Rehabilitation is one of the processes by which elder's disability, injuries are healed. Physiotherapist plays a vital role in this aspect. Kinect is a low-cost device helps the elderly people to do rehabilitation exercises suggested by the physiotherapist in the homely environment. It tracks the human movement of the skeleton joints. There are many causes for elders to fall. Rehabilitation makes their elders to get from the bed and do their daily activities independently. Some of the techniques used in machine learning are statistics and computer science. Supervised machine learning algorithms are useful in many ways to detect the fall of the elders.

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