Lifesaver: Android-based Application for Human Emergency Falling State Recognition

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Summary

Smart application is developed in this paper by using an android-based platform to automatically determine the human emergency state (Lifesaver) by using different technology sensors of the mobile. In practice, this Lifesaver has many applications, and it can be easily combined with other applications as well to determine the emergency of humans. For example, if an old human falls due to some medical reasons, then this application is automatically determining the human state and then calls a person from this emergency contact list. Moreover, if the car accidentally crashes due to an accident, then the Lifesaver application is also helping to call a person who is on the emergency contact list to save human life. Therefore, the main objective of this project is to develop an application that can save human life. As a result, the proposed Lifesaver application is utilized to assist the person to get immediate attention in case of absence of help in four different situations. To develop the Lifesaver system, the GPS is also integrated to get the exact location of a human in case of emergency. Moreover, the emergency list of friends and authorities is also maintained to develop this application. To test and evaluate the Lifesaver system, the 50 different human data are collected with different age groups in the range of (40-70) and the performance of the Lifesaver application is also evaluated and compared with other state-of-the-art applications. On average, the Lifesaver system is achieved 95.5% detection accuracy and the value of 91.5 based on emergency index metric, which is outperformed compared to other applications in this domain.

Key words: *Mobil application, Android application, Healthcare, Detection of fall down state, sensor, disable human, Machine learning, Artificial neural network*

1. Introduction

Lifesaver is the smart application used to detect and recognize a fall state of humans in case of emergency situations. This application can save humans in case of a dangerous accident and a lot of people get fall when they outside or alone at home, and sometimes they didn't survive. Following a fall, older individuals who live alone are at a higher risk of receiving delayed help. A low-cost, inconspicuous device capable of automatically detecting falls in the homes of elderly people might dramatically minimize the number of people who require assistance [1] later. This problem is common for the elderly in which there is one from every three persons in the United States exposed to fall (In 2010 there was 2.3-million-person exposure to fall 662,000 needed to anesthesia and cost the US Treasury approximately $ 30 billion) [2]and leads to causing concern for their families. The worst thing here is there are about 10,000 deaths every in the U.S. that occur due to fall accidents [3]. The Lifesaver application idea is too important not just for the elderly even for most disabled such as blind, deaf, and dumb. Because there are a huge number of smartphones users, interested in this topic focus on the development of new fall detection systems especially that smartphones already have communication facilities like SMS and GPS [4]. in this app we take the elderly, deaf, blind, and disables people as intended to help them when they alone and fall. A lot of people especially the elderly vulnerable to fall so we seek this application to save their life in the quickest way. A visual example of different emergency situations is illustrated in Fig.1.

The Lifesaver mobile application is developed in this paper to create an application for emergencies smartphones that might be exposed to humans, and the risk is described that the person making the request to call a friend or an ambulance to help the injured and he gets through this smart application to clear and the period will help the application to increase the speed save a person through the application and save time by selecting the location using GPS. For example, if a person falls down and there is a car accident. In this paper, a smart algorithm is developed to detect the emergency state of humans in case of a fall downstate or car accident. To develop the Lifesaver application, the perfect threshold is to determine the status of the fall person with high sensitivity and accuracy and use Oracle database GPS and accelerometer and orientation sensor data to detect fall down. To develop this Lifesaver application, the studio robot scout Tools API is mostly utilized.

The rest of the paper is organized as follows. Section 2 presents the background and some related work. The system design and data set collections are presented in Section 3 and system implementation in Section 4. In Section 5, the proposed system is evaluated and compared

Manuscript received August 5, 2021
Manuscript revised August 20, 2021
https://doi.org/10.22937/IJCSNS.2021.21.8.35

with other state-of-the-art applications. Finally, this paper concluded in sect

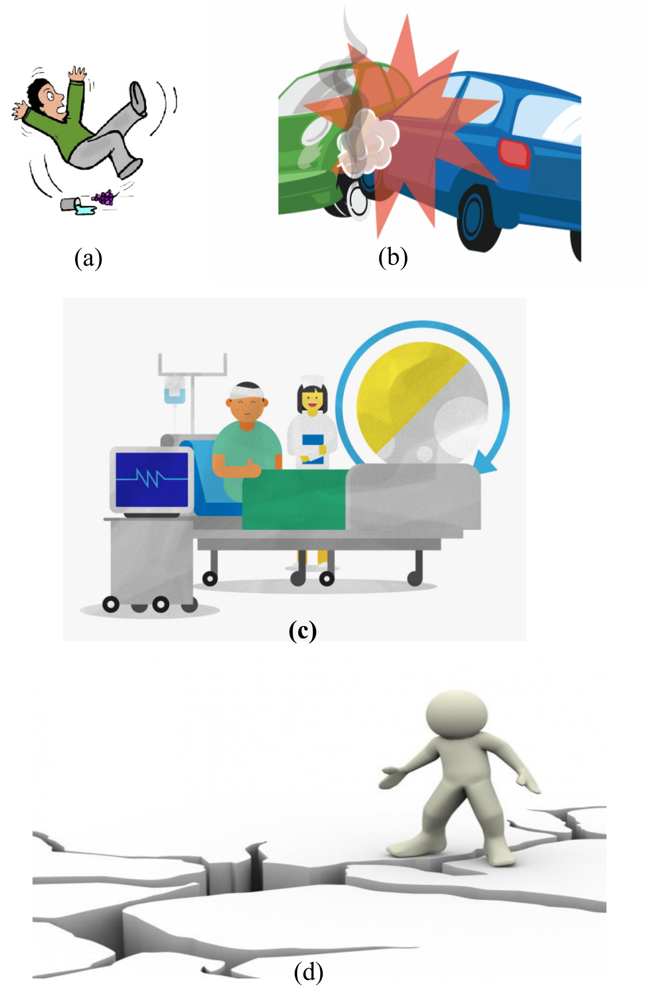

Fig.1. A visual example of different states of emergency situations, where figure (a) shows the fall down state, (b) represents the car accident, (c) indicate a person need medical assistant, and (d) shows the earthquake state.

2. Background and Literature Review

The human emergency status detection systems and applications are various like earthquake applications that give the users instructions when they exposure an earthquake and ICE application which has a number list to know who you should talk with and so on. But it has not developed as much as its importance. Fall detection is a very smart solution for the elderly and disabled people when they are exposed to falling especially when they are alone it may save their life or at least decrease the physical risk complications resultant from prolonged periods of lying on the floor following a fall. Algorithm and app development are the project sectors. Algorithms have a lengthy history, with the name dating back to the 9th century. Abdullah Muhammad bin Musa al-Khwarizmi, a Persian scholar, astronomer, and mathematician regarded as "The Father of Algebra," was indirectly responsible for the invention of the term "algorithm" during this period. One of his writings was translated into Latin in the 12th century, and his name was spelled Algorithm. However, algorithms were not invented at this time[5].

In general, the fall detection system consists of three main models, the first model is moving detection, the second model is tracking moving objects and the third is recognition of a person's behavior. [6]. In this project, the first model is the main purpose that we trying to develop its algorithm. Depending on different scenarios of falling " falls from walking or standing, falls from standing on supports, e.g., ladders, etc., falls from sleeping or lying in the bed and falls from sitting on a chair" [6] fall detection has many techniques. Fall detection techniques can be divided into three categories: wearable device-based, sensor-based, and digital camera-based solutions. The wearable device-based approaches depend on any wearable like watches and clothes with embedded sensors to detect the move and location of the object and it has different methods.

2.1 Digital cameras

Another works to detects fall by using monitoring camera, which takes sequence image of video and analyzes person shape deformation, they use Silhouette edge points extraction to analyze the changing of the person’s body shape, then match it by the video sequence to trace and determine the silhouette deformation. For shape analyzing they select two deformation measures and make comparing between them which are “the mean matching cost obtained from the shape context matching which has been used for shape recognition, and the full Procrustes distance which is a well-known tool for shape analysis, and which has been widely used to compare shapes in biology and medicine” [7]. To detect the event was fall or ADL they used the Gaussian mixture model depending on the shape deformation of the person’s body through the fall followed by a lack of significate movement after the fall. It has a high rate of fall detection with low errors, may it effective in a close environment like companies or at home, but when using one camera detect human fall will be from a specific point. Also, it requires a high cost if we want to cover more places because it is depending on more cameras. [7].

In [8], the authors use a Microsoft Kinect depth imaging sensor which uses two different kinds of cameras to detect falls. The raw values from the Kinect need to place on the shelf in the home without using Kinect SDK or skeletal tracking. By using these cameras there is the two-stage system, the first stage includes vertical state characterization that produces three features, the maximum height of the object, the height of the object's centroid and the number of elements of the discretized to find the value of the measure of a vertical state versus the vertical state. The first stage has the On-Ground Event Segmentation part which takes the vertical state for a tracked 3D object as a given all the time then identified the on-ground events through temporal segmentation of the vertical. The second stage describes the on-ground event features like MVV and MVA, then for each on-ground event with their features and an ensemble of decision trees fall confidence is computed, finally matching on-ground events to ground truth, a set of times, if they match then its fall. "The method proposed here does considerably better than the other algorithms using the segmentation and tracking system described in related work. It also performs better than the other algorithms using the OpenNI system, although performance is worse than expected at false alarm rates below 10 per month".

2.2 Wearable sensors

This work [9] was designed to fall detection system with a low-cost detector sensor for the elderly in Malesia, it android-based device and it can be worn on the waist or wrist, they developed an algorithm to measure the human position to determine the fall-down event then embedded it in the system which builds to send out an emergency SMS message to contact that stored. The sensor(hardware) is designed using Arduino UNO [10] and GPRS Shield [11], Arduino UNO is a microcontroller board that programmed and stack the GPRS Shield above it which "provides you a way to communicate using the GSM cell phone network. The shield allows you to achieve SMS, MMS, GPRS, and Audio via UART by sending AT commands" then develop the algorithm to detect fall in Arduino UNO environment. This system working as following, the elderly wearing the sensor when he falls down the sensor determine his body position and detect the fall-down event then triggers the alarm if didn't turn off after 15s the system will send an emergency SMS message to the contact stored in it. This system detects fall events when the threshold value is matched with its value set in the system, so there are issues with threshold values in the system. It only sent SMS messages and didn't provide GPS features to track the position and determine the person's fall down location.

Here is a study has been done to detect fall with wearable sensor and using machine learning techniques [12], they aim to get robustly and accurately detect falls that happen during people performing ADL by applying characteristic of the recorded signals around the point of peak acceleration instead of using the most method used in similar work which is simple rule-based algorithms that rely on thresholding the sensory output which is simplicity with short-time processing that may make confuse between fall event and ADL. For data acquisition, they used six MTw sensor units "The MTw Development Kit Lite is a solution for applications where orientation is required via a wireless connection. It is highly suitable for markets like training & simulation, pedestrian navigation, test & measurement and robotics" [13] each unit contain three tri-axial accelerometer, gyroscope, and magnetometer devices a person wore these six units on her\his head, chest, waist, right wrist, right thigh, and right ankle. Computing total acceleration of the waist accelerometer is a new characteristic added to the recorded signals around the point of peak acceleration, to recognize if it ADL or fall they apply six machine learning techniques which is

The k-NN, LSM, SVM, BDM, DTW, and ANNs and compare their results depending on these three criteria that measure the occurs Sensitivity, Specificity, and Accuracy, after experimenting and testing the highest rate of accuracy and sensitivity recorded by the k-NN classifier.

2.3 Devices sensors

This is an implemented system that combines smartwatch and smartphone to detect fall [14], by threshold-based and pattern recognition techniques in both the smartwatch and the smartphone regarding author's information this is the first system combine both these devices together to detect fall event, in this work they interest to observe the accuracy of a fall detection system based on an off-the-shelf smartwatch and smartphone through taking the advantages of motion sensor in both devices. The system implemented in the Android platform for both devices which the smartwatch powered by Android Wear and the smartphone powered by an Android version both devices support Bluetooth low energy radio, to communicate with each other and the smartwatch containing a 9-axis motion sensor combining a 3-axis gyroscope, 3-axis accelerometer, and 3-axis compass hence the smartphone has like 9-axis motion sensor. In both devices, they implement a threshold-based and a pattern recognition algorithm, usually, the threshold represents freefall and impact phases so threshold-based algorithm may use more than one formula." It is the simplest solution for detecting a fall and it can be used together with some form of pattern recognition to be more reliable.

Threshold-based is the most used method for fall detection" [15] and it has been previously implemented and well described in other research articles targeting Android platforms. They selected three different threshold formulas, the pattern recognition algorithms take a sequence of the movement readings patterns and make a comparison with knowledge records from training sets. Patterns recognition must use to detect fall stages differentiate fall events from ADL. The system implementing strategy consisted of using three different approaches for detecting the fall PAT, PPR, and WTPR approach. The system detects events as fall-down with the current thresholds, when using PAT alone it detects 77,75% as fall. hence in their strategy, the PAT serves as a trigger for the other algorithms, whatever the system records a high rate of false positives.

2.4 Literature Review

A smartphone-based fall detection system to detect the fall and automatically send help massage. This system has a technique to decrease false alarms. It is an application that has a self-learning fall detecting algorithm. Depending on acceleration data collecting by a built-in accelerometer in the smartphone apply the fall detection algorithm. Then send the alarm to the friends when it detects the fall." The proposed algorithm is based on acceleration magnitude thresholds, timeouts and long-lie detection". Authors use three techniques such as Median filtering plus accelerometer magnitude, vertical velocity estimation, and accelerometer magnitude plus timeouts everyone has an advantage that distinguishes it from others. Those advantages are sensitivity, specificity, and accuracy which are very important things for fall detection systems. [16].

Another work [17] deals with the smartphone that contains an accelerator and orientation sensor, which detects a fall down event is depending on the changing of acceleration and orientation. An algorithm proposed to detect fall down events shows the method will detect the fall event effectively. They use the algorithm to compute thresholds. The method is working by analyzing the changing of acceleration and orientation when the fall event has happened. They suppose four categories of young people and make testing with different fall positions, their approach is record-high efficiency.

The FallAlarm [18] is a fall-down detection system for smartphones, it uses the accelerator in the phone and Wi-Fi module. This system aims to distinguish a fall event from ADL and determine the location of the fall event and sending an alarm message to the contact stored in it then the person who falls will get help. Since the system is on it compute the data of acceleration and distinguish if the movement is ADL or fall event, from the data if fall event is detected the system will take the RSSIs from Apps around the person who falls and get the location of the fall event by the position module, then the system will send a short message with the location to the number stored and the person gets help. On the sample testing, FallAlarm achieves 98.4% recognition accuracy, when the fall event on the region that didn't cover as the system can't get the location.

In [19] a demo of the mobile application to detect any emergency status by employing the embedded accelerator in the mobile monitors the user's physical activity and analyze the movement. When it detects a strange change in acceleration or unexpected movements such as a sudden fall or accident. Then the mobile phone can automatically make a call or send a message about the accident and the location. This demo has an issue which it may send false alarm since it doesn't distinguish the fall event or accident from ADL Fall down detection systems are in developing progress to get the high rate of accuracy and solve the common issues in these systems and keep pace with the development of the devices that make the life easier.

3. Methodology

Lifesaver application is based on android-platform and the methodology section of this paper is usually provided helps to the application developers and the authors to understand the internal architectures, interactions, and functions of the system. In this section, the design of Lifesaver application design is cleared by a systematic diagram. Therefore, this diagram is used to describe modular decomposition, system organization, system, and data architecture. In this paper, the Lifesaver application is started automatically to monitor the activities to calculate his phone's acceleration and gyroscope to detect the fall then make the call to his friends and send message to contain the fallen state and the user location. Either design part includes the algorithm that is followed in the implementation phase. The algorithm is described in the upcoming section and the steps are visually represented in Fig.2.

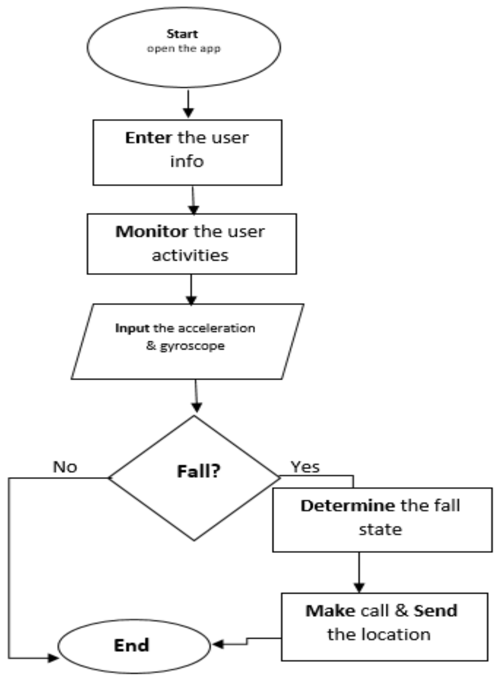

Fig.2. System architecture diagram to show in figure that represent all the components and sub-system collaborating in the system and its functionality.

3.1 Acquisition of Dataset

To test and develop the Lifesaver application, the 50-person including (60% males and 40% of females) and the age groups are in the range of (40 to 70 of years). All the participant involves in this study are performing different emergency activities that are highlight in the Table 1. This dataset is privately created and stored in the database for checking, comparisons and trained the application through deep-learning application.

Table 1. The private dataset consists of 50-persons including 60% males and 40% of females in the age group of (40 to 70 years).

No.	Title	Numbers	Age Group	Gender
1	Fall-down	20	40-44 years	Male
2	Medical Assistance	5	55-70 Years	Male
3	Medical Assistance	5	60-70 Years	Female
4	Room-Block	5	40-50 Years	Female
5	Car Accident	5	45-50 Years	Female
6	Car Accidents	5	40-50 Years	Male

3.2 Detection of Emergency State

Table 1 represents all important emergency states to detect human situations. These situations are used as training dataset by using artificial neural network with adjustment of hyperparameter. To get sensors data from mobile application, some parameters are required to fixed it such as acceleration is 8.9 m/Sec. This value parameter is fixed based on the downward direction depending on the orientation of the mobile phone. In addition, this parameter is defined by doing experiments against the gravitation force provided by the earth on different mobile phones with respect to various humans. By using the phytosaurs relation, the signal magnitude for the acceleration vector is measured to develop an algorithm for Lifesaver smartphone-based application. The device 3-dimentional (3D) model is followed in the design of mobile phone. For the fall location this essential calculation just uses the module ($Acceleration_k$) of the aggregate acceleration of the phone. This module can be processed as:

$$Acceleration_k = \sqrt{Acceleration_x + Acceleration_y + Acceleration_z}$$

(1)

Where ($Acceleration_k$) is the quickening readings in headings of x, y, and z-axis measured by the accelerometer that is installed in the smart phone. An emergency is detected if the measured module of the increasing speed surpasses a fixed threshold value. In this paper, the threshold (t>=12) is fixed after repeatedly doing experiments on different mobile phones. As a Result, the GPS location position is measured by getting quick coordinates by examine the emergency condition and ignore a point of fall happens.

Hence, this measurement is oriented towards the accurate classification of false positives. If the magnitude of acceleration reaches to the threshold, then it saves the orientation of the person and time to a GPS variable. This GPS variable was compared after 300ms for further confirmation of an emergency condition of human through the mobile phone. Accordingly, the average speed of a person in case of emergency condition is calculated by using the following equation.

$$AvgSpeed = \left\| \begin{matrix} Acceleration_x \sin\theta + Acceleration_y \sin\theta \\ +Acceleration_z \cos\theta \end{matrix} \right\|$$

(2)

Where θy and θz are the measured pitch and move values, which focus the smart phone. The gyroscope included with the cell phone detects these edges. Layer by layer, the computations were scrutinized. As a result, the computation examines two steps for both factors with the particular objective of surveying the occurrence of a fall. In order to resolve difficulties with the person's initial location, the device's linear acceleration is additionally validated in the detection window. This average speed parameter is measured by Eq. (2) and it is compared with the trained neural network (NN). If it is approximately closed by the output neural of NN then an emergency situation is detected by the algorithm. The utilized NN model is explained in the next paragraph.

Neural Network inspired by neurobiology and designed as electronic models based on brain neural structure. There are several kinds of interconnected models with various architectures, training, and implementations, but all are based on common concepts. It consists of simple processing units called nodes or neurons that can influence the behavior of each other via a network of excitatory or inhibitory weights. Every node calculates its inputs as a non-linear weighted sum and then sends the result to other nodes. The learning rule changes the strengths of the weights, as patterns are seen from the training set, so that the network can eventually learn to train [26]. The NN is an algorithm that trains on the large, labeled dataset to learn the label for each data. It consists of hyperparameters that change in each iteration to converge to the values that are produced as an output close to the correct label. The update of the hyperparameter will be using one of the optimization techniques such as gradient descent (GD) as following [27]:

$$E_m = \frac{1}{m} \sum_{s=1}^{m} C\left(\hat{Y}_s, Y_s\right) \quad (3)$$

$$\nabla\theta(t) = (\partial E_m / \partial\theta)(t) \quad (4)$$

$$\theta(t+1) = \theta(t) - \alpha(t)\nabla\theta(t) \quad (5)$$

Where, the $C\left(\hat{Y}_s, Y_s\right)$ represents the cost function between the correct label and label produced by the network. θ (t) is the hyperparameter in iteration t, m represents the batch size. The α parameter is the learning rate. ANN is able to solve even more complex recognition tasks but is not as excellent in terms of large vocabulary as the HMM. They can tackle low-quality, noisy data, and speaker independence instead of used in generic speech recognition applications [28].

4. Experimental Results

An android-based platform application is developed in this paper know as Lifesaver system to detect an emergency of human. To develop this application, a smart phone Samsung Galaxy S20 Ultra is utilized with Android 1.1 platform. This smart phone [23] contains 12 GB of RAM with 256 GB of storage capacity. This smart phone is also contained 4500 mAh lithium-ion battery. It is the device that contains an embedded accelerometer sensor.

To develop Lifesaver application, it decides to use Xcode development environment for MAC OS containing a suite of software development tools developed by Apple for developing software for MAC OS, iOS, watch OS and TV OS. Xcode has many features, but briefly describe and mention it’s major features which are it supports source code for the most use and well-known programming languages C, C++, ObjectiveC, ObjectiveC++, Java, AppleScript, Python, Ruby, ResEdit (Rez), and Swift that It works with several programming paradigms, including Cocoa, Carbon, and Java, among others. Support for GNU Pascal, Free Pascal, Ada, C#, Perl, and D has been added by third parties. Xcode contains the GUI tool Instruments, which is based on Sun Microsystems' DTrace dynamic tracing technology, which was published as part of OpenSolaris.

The Lifesaver prototype application is written in Java and uses the Android 1.7 SDK and Eclipse. Four main activities, one view, one service, and one resource are among the seven class files. The five main components are the user interface, monitoring daemon, data processing, alert notification, and system configuration. The monitoring daemon runs in the background as a Service on Android when the user starts the device, gathering and recording sensor readings. These measurements are analyzed and utilized to identify a fall using a power-aware method. For simplicity, all time frames in the data processing component are set to 4 seconds.

The alarm notification component is activated when an emergency condition is detected and classified into four categorize as describe in Table 1. This Lifesaver application used on the operation screen, bright, big virtual buttons; (b) a clear alert window (c) a straightforward, uncomplicated preference screen. functions to raise an alarm to alert a nearby attendant and contact emergency contacts. By using the preference screen, the user may also alter the setup options. This lifesaver application is compiled and build the system project in debug mode, produce and sign the .apk file, and then use the ADB tool to install it on the Samsung phone. The .apk program file is around 260KB in size. Finally, it is able to generate the .apk file in release mode, sign it with our release private key, and publish it on Android Market, making it accessible for download to Android users. A visual example of Lifesaver application is displayed in Figure 3. This Lifesaver's functioning is easy and intuitive, thanks to pleasant user interfaces. Monitoring, Setting, and Quit are the three buttons on the operating screen. The daemon may be reached by pressing the Monitoring button. When a fall is detected, a warning window will pop up. The siren goes off as well. The setting button takes you to the program's preferences screen.

It is recorded as falls in various directions (forward, lateral, and backward), at various speeds (rapid and slow), and in various environments (living room, bedroom, kitchen and outdoor garden). Walking, jogging, standing, and sitting are among the activities of daily living (ADL) that is track. All of the obtained data is divided into two sets: one for training and one for testing. A functional fall detection system must be accurate enough to be effective and relieve careers of their duties. Three indices have been developed based on the four probable scenarios described in Table 2 to determine the system's quality.

Table 2: Evaluation metrics for determine human emergency state

	An emergency Occur	An emergency does not occur
An emergency is detected	True Positive (TP)	False Positive (FP)
An emergency is not detected	False Negative (FN)	True Negative (TN)

- The sensitivity (SE) statistical metric is used to detect a human emergency state. It is given by the ratio between the number of detected emergency states and the total emergency states that followed:

$$Sensitivity\ (SE) = \frac{TP}{TP + FN}$$

- The specificity (SP) is the statistical metric utilized in this paper to avoid false positives. By using this SP metric, it is only used to detect an emergency condition if it occurs by the humans and calculated by the following equation.

$$Specificity\ (SP) = \frac{TN}{TN + FP}$$

- Whereas the accuracy (AC) is another statistical metric used in the past to detect the ability for making distinguish and detect both emergency (TP) and non-emergency states movement (TN):

$$Accuracy\ (AC) = \frac{TP + TN}{N + P}$$

- Where P and N are, respectively, the number of emergency states performed, and the number of non-emergency states performed.

The SE, SP and AC statistical metrics are calculated by the above-mentioned equations. It allows a better understanding of some of a system's boundaries, whereas accuracy is a global measure. An emergency state has a lot of acceleration and angular velocity, which isn't typically possible during the normal use of mobile phone. When, it is utilized a predetermined low threshold to identify a fall, the sensitivity is 100%, but the specificity is low since emergency state like other actions such as sitting fast in a chair, bed, or sofa may entail accelerations over that threshold. To access and compare with other applications, the emergency state index metric is used to calculate by using the following Eq. (6).

$$\text{Emergency}_{\text{Index}} = \sqrt{\sum_{k-15}^{k} (Accerlation_k - Accerlation_{k-1})^2} \quad (6)$$

Because the emergency index (EI) necessitates a high sample frequency and rapid acceleration changes, it will miss slow falls. As a result, this measure is only utilized if researchers seek to compare their system's performance to that of prior studies that have used it.

According to what has been stated so far in the literature and background section, several other alternative methods to solving the problem of emergency state detection have been developed. However, those systems only detect fall state using accelerometers sensor. However, in this paper, this Lifesaver application is used to detect four different emergency states. In other applications, the authors used the most simple and straightforward method utilizes a threshold to determine whether someone falls, which is prone to many false positives. Since, the Lifesaver application is used ANN model to recognize 4 states of humans and it has many applications in practice compared to other applications.

Several researchers have attempted to implement computationally difficult types of intensive algorithms, but the objective has always been to achieve a balance between system accuracy and cost.

A. E. Stone and M. Skubic (2015) [8] analyzed the acceleration provided by two sensors implanted in different regions of the body using a two-level neural network method. The algorithm receives these accelerations and converts them into spatial coordinates. The final product of the whereas if the probability is medium or high, the system generates an alarm unless the person presses a button.
B. A. Tang et al. [9] created a system that included a CPU, a wireless transmitter, and a series of accelerometers. The measured acceleration is constantly compared to some reference values. The processor transmits an alert signal to a distant receiver if a fall occurs.
C. Barshan et al [12] use a sensor module and an algorithm to detect posture, activity, and fall in a similar way. There are intermediary nodes that function as repeaters for long-range communication with the base station. 93.2 percent of the population was sensitive.
D. Vilarinho et al [14] measured velocity and acceleration using an acoustic device attached to the back of the ear.
E. The Abbate et al [16] was developed an inescapable smart human fall detection system that employed a sensor with an accelerometer and a smartphone as a base station. The sensor's usefulness and battery life were both increased by moving the processing to the smartphone. They were able to attain 100% sensitivity without reducing specificity. Other approaches rely on body position and employ many sensors. Human actions have been classified into two categories by some researchers: static position and dynamic transition. They utilized two sensors, one with an accelerometer and the other with a gyroscope, in tandem.

F. Ketabdar et al [19] utilized a sensor with two accelerometers, one of which was inserted under the armpit and was orthogonal to the other. Because of the slope of the chest and its velocity, the fall is recognized. If the patient hits a button on time, the alert is not activated, preventing false alarms. An experimental assessment revealed that the sensitivity and specificity were both 81%.

All above-mentioned applications are compared with Lifesaver application and results are described in the Table 3 in terms of SE, SP, AC and emergency index (EI). It noticed that Lifesaver application is achieved outperformed compared to other systems developed in the past. In fact, the researchers utilized a system with three separate sensors for body position detection, vibration detection, and vertical acceleration measurement in a similar investigation. The base station was in charge of data processing. The sensitivity and specificity in this case were both 85%. Other researchers created a real-time system that recognizes physical activities and their intensities automatically. They utilized five accelerometers, which were attached to the wrist, ankle, upper arm, upper thigh, and hip. They also utilized a heart rate monitor that was worn on the chest. Twenty-one persons were tested in 30 various physical activities, including laying down, standing, walking, cycling, jogging, and stair climbing. The Naive Bayes classifier was used to classify data in both the temporal and frequency domains. The accuracy of a person utilizing his or her own training set was 94.6 percent, whereas the accuracy of all other people's training sets was 56.3 percent. Another study used an accelerometer worn around the waist watch.

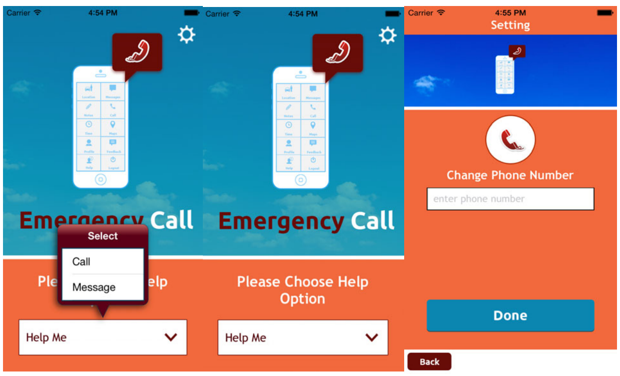

Fig.3. A visual example of the design of Lifesaver android-based application

In comparison to other, more efficient applications, our method employs a feedback mechanism to ensure threshold-based fall detection by monitoring the body's posture. As shown in Table 2, our method has almost met the expectations of previous devices, with nearly 100% recall activity for continuous monitoring. It decreased false detections by 90% and increased detection effectiveness by approximately 95%. With a specificity of 90%, this algorithm also categorized the falls as a back fall, front fall, or side fall, which needed to be further investigated. This program was created primarily to test and build an algorithm that could be used in any embedded system.

Table 3. State-of-the-art comparisons to the Lifesaver application based on Android platform and detect only fall state of humans

Methods	SE	SP	AC	EI
1. E. Stone[8]	78%	81%	79%	70.5
2. A. Tang [9]	75%	78%	76%	72.2
3. Barshan [12]	68%	72%	70%	69.5
4.Vilarinho [14]	78%	81%	79%	70.5
5. Abbate [16]	81%	83%	82.4%	82.5
6. Ketabdar [19]	77%	80%	78%	72.5
7. Lifesaver	94.5%	96.5%	95.5%	91.5

5. Conclusions

An emergency state is detected in this paper by Lifesaver android application, which is used to differentiate between four various situations such as fall, medical assistance, car accidents and room block. The recognition of an emergency state is classified using ANN model in this paper by using accelerometer and GPS sensors. Furthermore, because the graphical data is immediately available, this application may be utilized for further study of fall detection algorithms, reducing the time and effort required for testing and improving the logics. The above-mentioned program considers the 3-axis accelerometer's vector magnitude, absolute vector magnitude, and sensor orientation. This application is primarily intended to decrease false detection in the event of freely hanging detection devices or components of equipment that must move. Smartphones, on the other hand, are widely used for apps; nevertheless, these devices may be limited to usability.

Acknowledgments

The author would like to express their cordial thanks to the deanship of scientific research at Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia.

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