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A Fall Detection System Based on a NODEMCU and a Literature Review

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***Abstract*— This paper presents recent research about a system uses to detect person's movement and development of a system which uses an Accelerometer & Gyro sensor to detect person's movement. When it comes to old age, it becomes necessary to monitor old ones and people on wheelchair for their health and safety. They have a great risk of falling down. Now it is important to know it this type of person has fallen so that he/she can be helped on time. This device can mount on person's hand or wheelchair for detection. The system keeps monitoring for fall detection and abrupt movement changes in person. If fall is happen the alert is trigger.**

***Index Terms*—fall detection, MPU6050, NODEMCU,**

I. INTRODUCTION

In 2015, world population of 7.2 billion is projected to increase over 1 billion within 12 years and reach 9.6 billion in 2050 [1]. The World Health Organization (WHO) [2] predicted that next 30 years the population of the elderly will increase to 11.1% - 18.6%. Falls are a major health hazard for the elderly and a major obstacle to independent living [3]. Therefore, many research topics are currently to develop surveillance system and care for the elderly.

According to the Home Safety Council, around 6,000 people die due to fall-down at home each year [4]. Annually at least thirty percent of senior people experience fall-down and get injured [5]. Many of these falls are fatal if medical care is not given in time. Some seniors may become unconscious after falling down thus not able to call emergency by themselves for help [3].

Nowadays, as sensor devices and communication technology grows, automatic fall-down detectors have been explored to improve the healthcare of seniors due the fall-down. The latest developments in terms of micro electromechanical sensors and wireless communication technologies have enabled the creation of low cost and wearable monitoring devices. The main advantage of these systems is that they don't restrict the patients' mobility and don't hinder them from performing their usual activities of daily living [6].

In this work, a fall-down detector using a set of micro sensors, which is composed of an accelerometer and a gyroscope has been explored and developed for monitoring the fall-down of senior people. The alarm is ring if fall is detected.

II. BACK GROUND WORK

Here, the different methods used to make the fall detection devices are presented.

A. System Based on WSN. [7]

In this system, a noninvasive fall detection system for older people, based on the use of a wireless sensor network (WSN) is proposed. It uses the acoustic signal sensed by a node of the WSN, as well as signal processing and pattern recognition techniques to detect a fall.

The model uses a signal-processing algorithm based on the use of cross correlation to measure the similarity between the sampled signal and a reference template signal, which represents a fall event. A WSN is a set as motes at fixed place that contains one or more sensors the motes of a WSN are wirelessly connected to each other, and to a special node called the sink. When a node detects an event of interest, it sends the sensed information to the sink, through the intermediate motes using multi-hop communication.

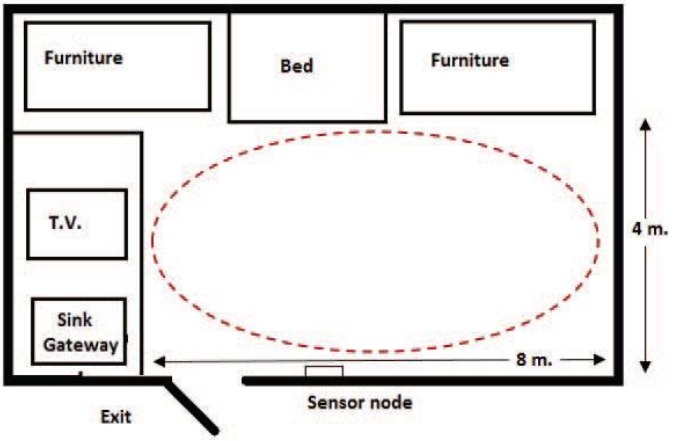

Fig: 1 Deployment of the Mote

If the two signals are similar, then the Mel-frequency cepstral coefficients (MFCC) of the fall sound are extracted. Afterwards, the dynamic time warping (DTW) method is used for pattern recognition. The detection rate is not appreciable compare to accelerometer. The node of the WSN is placed at fixed location so it is not portable can used only at fixed location

B. System Based on Multi sensor. [8]

This paper presents an elderly-falling detection system using ultrasonic sensors. The ultrasonic technology-based multi sensors are couple of receiver and transmitter together, which are connected to Arduino microcontroller in order to send the elderly person's fall related signal using Wi-Fi to the processing unit. The sensors are positioned as an array on the roof and wall in the room.

The signal is analyzed to recognize human by sensing distance, and detect the action such as standing, sitting, and falling by pattern matching with the standard templates of top and side signal. The ultrasonic sensors often use the approximately frequencies as 40 kHz with an 8 pulses signal waveform. The sensor radiates a pulse signal, Tx, to the object and then receives the reflected signal, Rx, back to the sensor. The distance is measured by calculating the time used between the reflector targets and the sensor.

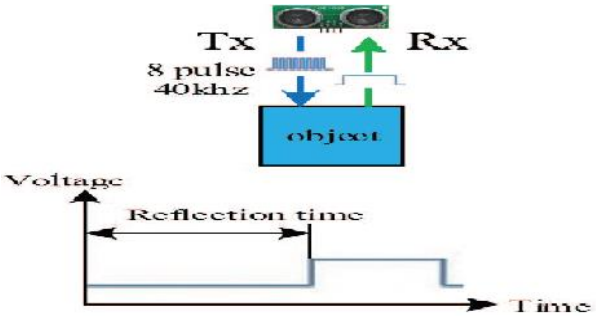

Fig: 2 Distance measurement using ultrasonic sensor

The proposed system is divided into two main sections. The first section is the hardware which is used for storing and processing the information given by the sensors. The other section is the software section which is used to decide the state of falling and monitoring. The data is transmitted to computer thorough Wi-Fi module, the data is processed their and send to monitoring place.

Two arrays of the ultrasonic sensors are at the top and the side of the room model. The different gestures and positions are detected by the changed distances which are measured by the information received from the ultrasonic sensors. The experimental result is that the accuracy of the proposed system is 93%. Here using only the ultrasonic sensor provides not enough information. As the sensor fixed in room so this device can used only in one room.

C. System Based on Doppler Radar and Motion Sensor network. [9]

Here a fall detection system with Doppler radar sensor and implemented ceiling radar in real senior apartments. However, the detection accuracy on real world data is affected by false alarms inherent in the real living environment, such as motions from visitors.

To solve this issue, this system proposes an improved framework by fusing the Doppler radar sensor result with a motion sensor network. They have deployed ceiling radars in six different apartments in Tiger Place.

There is seven motion sensor and one Doppler radar facing down to the floor placed above the ceiling at the center of the living room and dining room. The detection range of the radar is about 6 and the height of the room is about 3m.The data logger for each sensor is synchronized with the same data server in Tiger Place.

For detect the fall use equation like,

If, t_{dist}> = delta, fall

t_{dist} < delta, false alarm

D. System Based on GSM Communication and GPS

Localization. *[10]*

This system presents a fall detection system based on a tri-axial accelerometer, which also provides GPS (Global Positioning System) localization and GSM (Global System for Mobile Communications) wireless communication. The system consists of a mobile station and a base station. The mobile station uses a 2-axis accelerometer sensor for acceleration measurement and a 2.4 GHz wireless radio chip for data transmission.

Fall detection algorithm implemented in Java. The mobile phone must have an integrated tri-axial accelerometer in order to be used for fall detection. For wireless communication and remote data transmission, the proposed system uses a GSM module. One disadvantage of GSM modules is that they have higher energy consumption

The GPS module can also be turned on only when a fall is detected and geographical coordinates have to be calculated, in order to conserve system power. If fall is detected the buzzer is on, the message send to the doctor or caregivers and the GPS used to get information about the location of the Pearson. For this system they only implement the algorithm.

III. PROPOSED SYSTEM DESIGN

A. System Requirements

As shown in literature survey most of the fall detection system used WSN, Doppler Radar, Sensors, GSM and GPS, so this type of device can used only at fixed place they cannot attached with person's body. When designing a system for fall detection, one has to take into consideration several practical requirements the system has to meet. Practical requirements include low size, low cost, ease of use, low power consumption

In this paper the fall detection system based on MPU6050, NodeMCU. The MPU-6050 parts are the world's first Motion Tracking devices designed for the low power, low cost, and high-performance requirements of smart phones, tablets and sensors.MPU-6050 sensor contains an accelerometer and a gyro in a single chip. It is very accurate, as it contain 16-bits analog to digital Conversion hardware for each channel [11]. The triple-axis MEMS gyroscope in the MPU-6050 includes a wide range of features like Integrated 16-bit ADCs enable simultaneous sampling of gyros. Enhanced bias and sensitivity temperature stability reduces the need for user calibration. Improved low-frequency noise performance. Digitally-programmable low-pass filter. The triple-axis MEMS accelerometer in MPU-6050 also includes a wide range of features like multiplexer Accelerometer normal operating current 500μA, 40Hz Orientation detection and signaling. Tap detection. User-programmable interrupts [12]. Acceleration detection was a vital part in generating accurate analysis [10].

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266.

B. Block Diagram

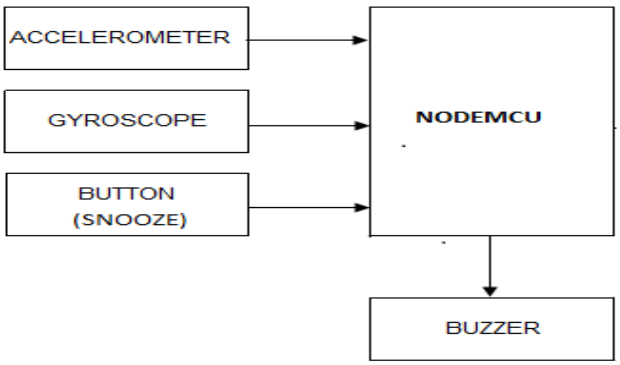

Figure: 3 Fall Detection System Block Diagram

The system uses accelerometer and gyro sensor to detect person movements, it can be mounted on persons hand or wheelchair for detection. The sensor is connected to a microcontroller in order to constantly transmit the acceleration data. A sudden abrupt change with jerk in the system is treated as a fall. Now in case the person did not fall and alarm was false, the system allows to snooze the alert if person presses snooze button in 5 seconds. If person does not press the snooze, system detects person has fallen and automatically triggers alert.

IV. EXPERIMENTAL SETUP

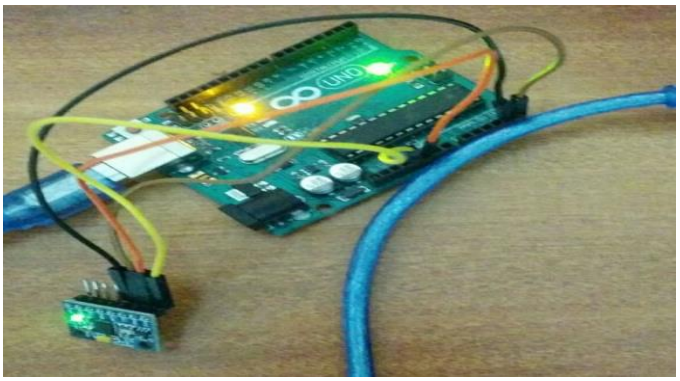

Figure: 4 Device setup for test purpose

The figure represents the setup for testing of the device, the all instrument work properly or not.

V. RESULT

This system able to catch up the situation if the person is falling down, through the aid of accelerometer and gyroscope. If any interested event happens, the alert is triggered. If the fall is false person accord approval to snooze the alert by pressing snooze button with in 5 second. .

VI. FUTURE WORK

The future work involves to embody Wi-Fi chip with the device so that we can apprise the caregivers about the fall by mail and also make the device self-configurable so that the device can used with in the area of any Wi-Fi network. To change the device configuration only mobile is require no need to make change in the firmware.

VII. CONCLUSION

A fall-down detection system using micro sensors is introduced in this paper. The set of the inertial sensors composed of a tri-axial accelerometer and a tri-axial gyroscope is used characterized the patterns of fall-down. The signals obtained from the motions were processed and analyzed by a microcontroller. The fall-down system developed in this work has successfully detected the fall-down.

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