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A NOVEL IOT BASED AUTOMATIC FALL DETECTION CAVITY FOR ELDERLY PEOPLE USING MEMS

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ABSTRACT: Falls are a major public health hazard for the elderly across the world. If a fall is not treated promptly, it can result in functional impairment and a considerable loss in an elder's mobility, freedom, and life satisfaction. The biggest effects are not connected to the fall, but rather to being unaided or being treated late. To enhance the quality of life for the elderly and others who require specialised assistance, a monitoring system that warns carers of any emergency assistance is required. In the last several years, technologies like the Internet of Things and mobile communications have been developed to gather information about people and the environment, which is subsequently utilised for a number of purposes. A unique IoT-based automated fall detecting cavity for senior persons is employed in this work, which employs MEMS (Micro Electro-Mechanical System). When an old person falls, a low-cost fall detection gadget is utilised to accurately identify the incident. To precisely identify a fall occurrence, the fall detection algorithm evaluates acceleration using lower and upper fall threshold values. To increase performance and accuracy, we now suggest using the post-fall recognition module, a combination of posture recognition and vertical velocity estimate. Our system will inform the user by voice in the event of a fall and display it on LCD. The data is then uploaded in the IOT server which is being monitored by the caretaker.

KEYWORDS: Falls detection, Elderly People, Internet of Things, Micro Electro-Mechanical System.

I. INTRODUCTION

Falls are one of the leading causes of health problems in the elderly. These falls frequently have fatal consequences. The incidence of falls has been growing in recent years, as has the number of senior persons.

The consequences of a fall are frequently negative, since they might include hospitalization, morbidity, and, in most situations, a lower quality of life. Elderly falls are a leading source of injuries and a significant barrier to seniors' independence. They are one of the top causes of injury-related hospitalizations in adults aged 65 and over. According to the World Health Organization, falls rank as the second leading cause of fatal accidental injuries, mostly among those over the age of 65. Falls are a primary cause of immobility, illness, and death among the elderly. With millions of bed days, falls cost health-care systems a lot of money [1].

An old person who has fallen and been hurt may be left on the ground for several hours or even days. Frequently, the patient may need immediate medical treatment and be unable to stand up without assistance or support. Also, fear of falling is formed or related with the fall occurrence. As a result, especially for elderly persons who have already had falls, there is a strong propensity to avoid engaging in everyday physical activity. If no one is present, it creates terrible sentiments of powerlessness in their brains. Continuous or consistent fall detection is necessary to avert the devastating effects of this accident [2].

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According to their cause, falls may be divided into three categories: unintentional, unexpected physiological, and predicted physiological. Accidental falls are unanticipated slips and falls brought on by outside factors that affect people who are not at risk of falling. Around 8% of all falls are caused by unpredictable physiological factors, which might include pathological fractures or seizures in people who are not at risk of falling. 80% of falls are predictable physiological falls, which have an effect on those who are susceptible to falling because of physiological changes. The Morse Falls Scale (MFS) is a tool that may be used on older people and patients to determine who is at danger of falling and how likely they are to do so [3].

Falls can be brought on by certain neuromuscular and sensory dysfunctions, as well as by exhaustion, rheumatoid arthritis, diabetes, dementia, nutrition deficit, anaemia, arrhythmia, disrupted body mass index (higher or lower), urinary problems, sleeplessness, cardiovascular disorders, etc. The three main processes of falling are defined as slipping, tripping, and staggering because of environmental factors such footwear, inadequate lighting, and slippery surfaces. The incidence of falls among persons over the age of 70 has also been connected to a number of medicines. Examples of such therapies include sedatives, hypnotics, antidepressants, diuretics, no blood pressure-lowering medicines or steroidal anti-inflammatory meds. The Morse Fall Scale (MFS) is frequently used by medical personnel to monitor risk factors and diagnose [6].

A reliable fall detection system monitors the fall and warns carers, easing their stress and reducing the demand on resource-constrained healthcare systems. Fall detection systems come in two different varieties: approaches based on wearable devices and context-aware systems. Context-aware systems use networks of sensors placed throughout the environment to detect falls. They comprise vision-based devices as well as environmental sensors as infrared, floor, radar, microphone, and pressure sensors. Approaches based on wearable technology employ a variety of sensors that are woven into clothing worn by the user to track that person's position and movement. Fall detectors commonly employ wearable accelerometers and gyroscopes as sensors.

IoT describes a collection of devices used to build a network for a certain application. The Arduino/Raspberry Pi platform, wireless modules, and other components serve as the foundation for the Internet of Things. IoT offers customers a wide range of applications, including, to mention a few, energy production, device localization, Smart houses, smart agriculture, and fire, air pollution, and water pollution monitoring systems are all examples of intelligent technology [4].

Real time monitoring and fall detection in elderly is very crucial for immediate medical intervention. In order to give prompt medical treatments when necessary, a fall detection and management system must be developed [7]. Although several fall detection methods are discussed, it is crucial to accurately identify falls in order to give quick aid and prevent scenarios known as "long lies," which have been demonstrated to raise death rates. A tasteful fall discovery framework requires exactness and power, which the present approaches, have not been able to deliver. All things considered, the current fall detection system is struggling with three significant problems.

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Hence, an innovative IoT-based MEMS-based cavity for automatic fall detection in older individuals is presented in this study. Here is how the remaining work is organised: The Literature Survey is described in Section II. The third portion introduces an innovative MEMS-based automatic fall detection cavity for the elderly. The result analysis is described in Section IV. Section V provides the conclusion to this article.

II. LITERATURE SURVEY

The authors are Tianrun Wang, Dedi Zhang, Zhong Su, and Ning Liu et al. They discuss Pre-impact Fall Detection for the Elderly Using Fractional Domain, [5]. In this work, motion data are collected using inertial data sensors, and Before changing the data's time domain to fractional domain, axis synthesis, mean filtering, and the fractional-order Fourier transform are used as preprocessing. This algorithm framework is used to pre-alarm a fall. Based on the information above, a high-performance pre-impact fall detection system is produced, which includes a multilayer dichotomy classifier and a strategy for selecting each node's parameter. The experiment's findings suggest that this algorithm could be able to deliver more accurate classification and a stronger warning impact with fewer features.

DK Cahoolessur, B Rajkumarsingh et. al.,[8] the Fall Detection System utilising XGBoost and IoT is described. The Sisfall dataset is used to train the machine learning model and the XGBoost algorithm. A buzzer, a GPS module, a microcontroller, and an accelerometer are combined to form a waist-worn device. The machine learning model creates a forecast using the attributes that were created from the received acceleration data. In the event of a fall, the buzzer sounds, alerting the victim's emergency contacts through IoT and the Global System for Mobile Communications immediately (GSM). This lessens the negative effects of the fall by enabling the fall victim to receive treatment as soon as feasible.

Swapnil J. Vikhe,C. B. Kadu,S. M. Turkane, P. S. Vikhe et. al., [9] explains an older person's autonomous body fall detection system that employs an accelerometer and a vision-based method. In this study, we generally employ wearable sensors and vision-based methods to identify bodily falls as early as feasible. An instrument that monitors orientation and angular velocity is an accelerometer. An example of a vision-based method would be to start by getting instances or video configurations from the camera. The body shape is separated from the foundation by the division module. The GLCM technique is used to extract features. For classification, the SVM approach is utilized. With such approaches, one may definitely identify a human body fall and take preventive steps.

Jara Suárez de Puga, Diana Yacchirema, Manuel Esteve ,Carlos Palau, et. al., [10] explains a big data and IoT-based fall detection system for the elderly. An innovative IoT-based system that makes use of smart gadgets, big data, cloud computing, low-cost wireless sensor networks, and interior environments to detect elderly people's falls. This is done by utilising a wearable 6LowPAN device with a 3D-axis accelerometer that continuously records information on older people's movements. To provide great efficiency in fall detection, the sensor inputs are processed and analysed using a decision tree-based Big Data model operating on a smart IoT gateway. When a fall is detected, the technology reacts quickly by raising an alarm and notifying

the aged care organizations. The system ultimately provides cloud-based services.

Chun-Long Tu, Xue-Song YeCong-Cong Zhou, Fei-Xiang Wang , Yun Gao, Hong-Wei Gong, Ping Lian, Chen He, et. al., [12] describes A low-power, wireless device that may be worn on the wrist that can detect falls and continuously monitor heart rate. This paper describes a novel wrist-worn, low-power gadget for wireless real-time heart rate (HR) monitoring and fall detection. This device is made up of sensors, signal condition circuits, a microprocessor, and a system communication module. To finish a low power task, algorithms and power management are used. The findings show that individuals have a threshold for recognising the occurrence of a fall that is considerably different from those for immobile, walking, and standing up from a seated position. An interrupt is promptly generated and forwarded to the microcontroller for processing when users of the gadget fall.

III. A NOVEL IOT BASED AUTOMATIC FALL DETECTION CAVITY FOR ELDERLY PEOPLE

This section introduces an innovative IoT-based automated fall detection cavity for senior folks that use MEMS. The primary goal is to design and create intelligent, dependable, and cost-effective fall detection and alarm system, as well as a fall detection system that is user-friendly and does not interfere with senior people's everyday activities. By providing a more broad and individualised form of care, the Internet of Things is a new paradigm that is assisting adults in improving their quality of life.

The main hardware modules included in this system are Arduino Uno, power supply, MEMS accelerometer sensor, Wi-fi module, Liquid Crystal Display (LCD) and Loud Speaker.

The ATmega328 powers a microcontroller board known as the Arduino Uno (datasheet). It has a set button, an ICSP header, a USB port, a ceramic resonator operating at 16 MHz, and six analogue inputs. 14 digital input/output pins are also included, six of which can be used as PWM outputs.

An electrical appliance called a power supply transmits electricity to a load. A power supply's main job is to convert electrical current from a source to the right voltage, current, and frequency so that the load may be powered.

Using a UART serial connection, the ESP8266 is a potent, reasonably priced Wi-Fi module that may be used to add adding Wi-Fi capabilities to an ongoing microcontroller project. It is possible to reconfigure the module to function as a separate Wi-Fi-connected device; all you need to do is connect electricity.

The ADXL335 capacitive accelerometer. It operates on the premise that when acceleration is given to the sensor, the capacitance within the sensor changes. This change in capacitance is then utilised to calculate the object's acceleration. A minimum full-scale range of 3 g is the least acceleration the instrument will detect. With tilt-sensing devices, both static gravity acceleration and dynamic acceleration generated by motion, shock, or vibration may be monitored.

The APR9600 is a flash analogue storage-equipped sound record/replay IC with good performance and low cost. Even when the module's power source is turned off, the recorded sound is preserved. The sound that is being repeated is of excellent quality and is quite quiet. The APR9600 gadget offers non-volatile storage, true single-chip voice recording, and a playing

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time of 40 to 60 seconds. The device enables access to both sequential and random messages. A speaker or speaker driver is a type of electro-acoustic transducer known as a loudspeaker, converts an electrical audio stream into sound. Liquid crystals are the main component of an LCD (Liquid Crystal Display), a type of flat panel display.

The block diagram of the suggested innovative IoT-based automated fall detection cavity system as demonstrated in Figure1.

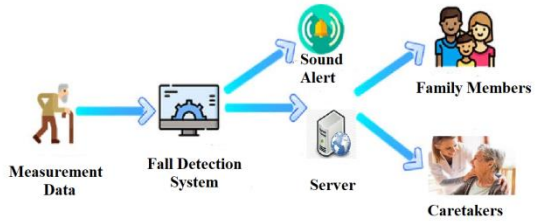

Fig. 1: Block diagram of presented novel IoT based Automatic fall detection cavity system

An MEMS Accelerometer is employed in this study to detect an old person's fall. The accelerometer can measure both the static and dynamic accelerations of gravity in sensing applications and during shock or vibration. The ADXL335 is a 3-axis accelerometer sensor with analogue output and a measuring range of 3g. It also includes predefined axis threshold settings. The system will identify the fall condition if the acceleration of the body condition reaches the threshold value. When a person falls, an alert message may be delivered via the wifi module integrated with the controller. If the old person falls, a message is instantly sent to the caretaker, whose mobile phone has previously been registered with the controller code. When the acceleration exceeds a certain threshold, the fall is recognised and an alert is triggered. The fall detection message appears on the LCD display, and a pre-recorded alert is broadcast over the loud speaker.

IV. RESULT ANALYSIS

This part implements an innovative IoT-based automated fall detection cavity for senior folks utilising MEMS. The results of the deployment of an unique IoT-based Automated fall detection cavity for senior persons utilising MEMS are detailed here. This system identifies four different sorts of falls: front falls, rear falls, right falls, and left falls. Figure 2 depicts a unique IoT-based automated fall detection cavity for senior folks utilising MEMS.

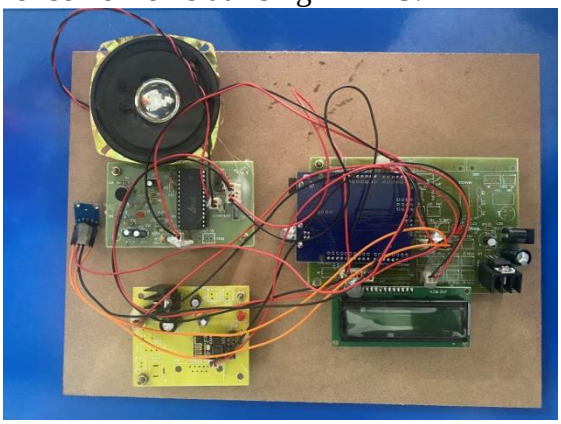

Fig. 2: Implemented novel IoT based Automatic fall detection cavity for elderly people using MEMS

The implemented novel IoT based Automatic Fall Detection system contains a Aurdino uno, Mems sensor, APR voice module, LCD display which are connected for the purpose of fall detection. As soon as the device is connected to a power supply there will be a message “Automatic Fall Detection” displayed on the LCD which is shown in Fig. 3.

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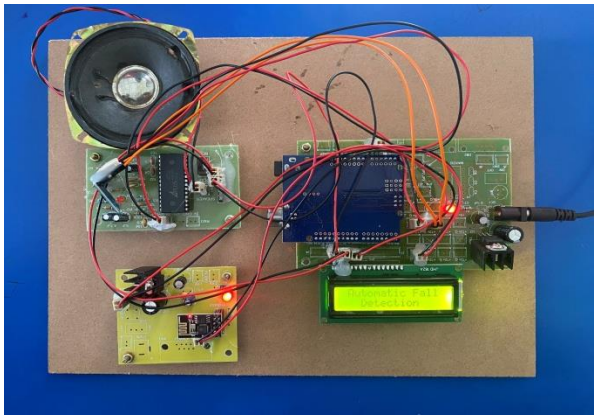

Fig. 3: Switching on the Power Supply

The Fig. 4 shows how this system is connected to internet.

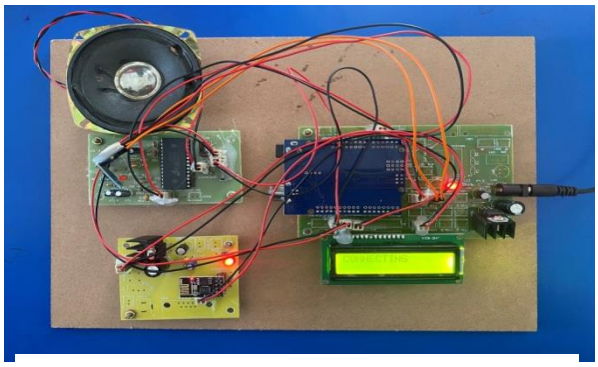

Fig. 4: Connecting to Wifi

As soon as the device is powered on it waits for the internet connection. If the wifi is connected it displays as Wifi ready which as demonstrated in Fig. 5.

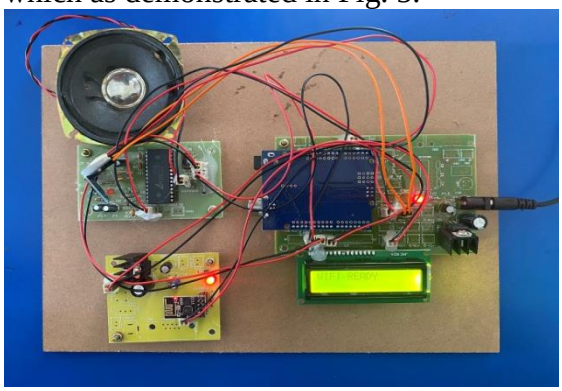

Fig. 5: System Connected with Wifi

Device is connected to wifi when we on the hotspot on our mobile phone and a message "Wifi Ready" will be displayed on the LCD. When the device is stable it displays as MEMS stable and is shown in Fig. 6.

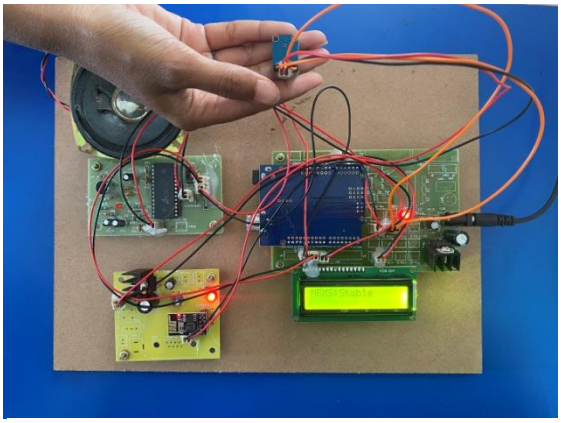

Fig. 6: Device in Stable Condition

When there is no movement the sensor will be in stable condition. When a person falls forward then the sensor detects front fall and is displayed as shown in Fig.7.

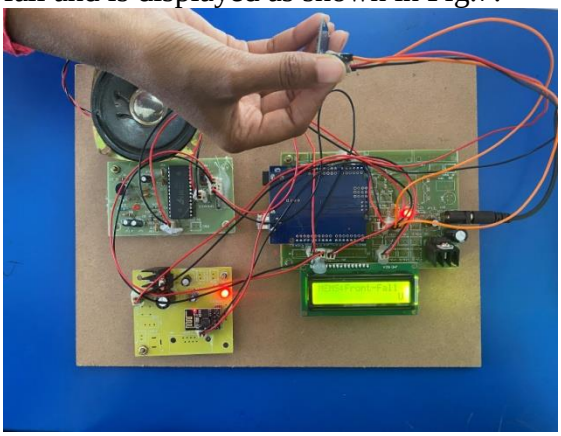

Fig. 7: Front Fall Detection

When a person falls backward then the sensor detects back fall and is displayed as shown in Fig.8.

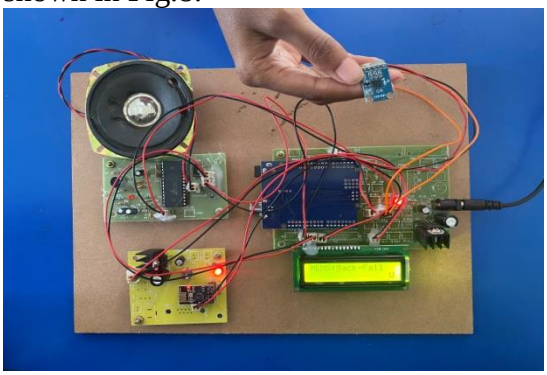

Fig. 8: Back Fall Detection

When a person falls towards Left then the sensor detects Left fall which is shown in Fig. 9.

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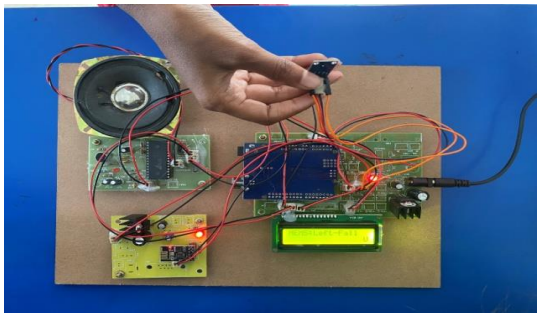

Fig. 9: Left Fall Detection

When a person falls towards Right then the sensor detects right fall which is shown in Fig. 10.

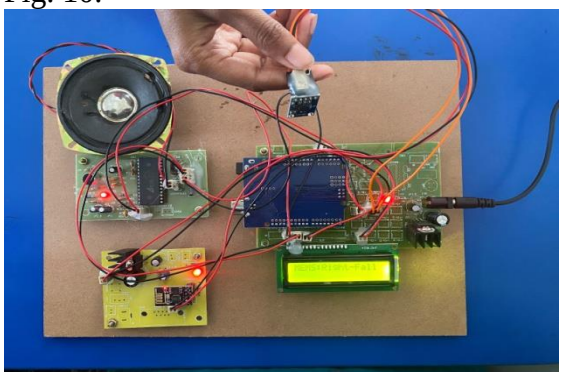

Fig. 10: Right Fall Detection

The Fig. 11 shows the server login page. User (Care Taker) should enter username and password to monitor the persons movements.

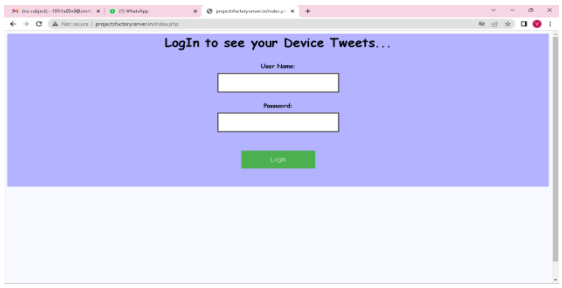

Fig. 11: Server Log-in Page

The user needs to enter his/her name and password to monitor the movements of elder people. The person movements are saved on IoT server Page which is shown in Fig. 12.

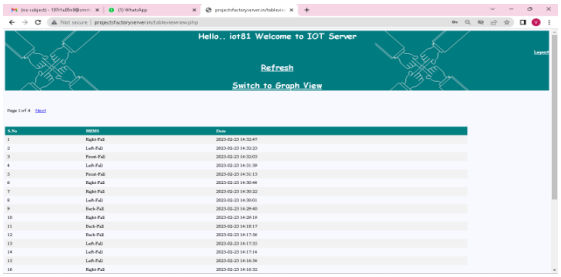

Fig. 12: IoT Server Page

Hence this system will be a better real time solution for fall detection of elder people.

V. CONCLUSION

This paper presents an innovative IoT-based Automated fall detection cavity for senior folks that uses MEMS. Although fall detection is seen as a serious difficulty in sectors such as health care, particularly in the case of the elderly, an IOT-based fall detection system based on MEMS sensors has been created. This system is capable of continuous monitoring of human body movement, and these types of detection methods employ a threshold value established by the controller to identify a fall. The prototype is put through real-world testing before being turned into a product for seniors and patients. When the acceleration exceeds a certain threshold, the fall is recognised and an alert is triggered. The system uses less energy and is more efficient. It also monitors various biological factors such as heart rate, temperature, and so on. This system is appropriate for both indoor and outdoor fall detection since it includes both software and hardware.

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