SMARTCHAIR – Special chair for special people

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Abstract:

In old age, it is crucial to monitor the old people in our homes for their health issues. Due to weak joints and other health conditions they become vulnerable to falling down. Keeping an in depth tab of recent folks or folks on chair with bound health conditions for his or her health and safety is a very important task. With maturity, weak bones and weakness because of alternative health connected problems could lead to will increase risk of falling. Furthermore, old age also causes weak eyesight which makes it compulsory to monitor them all the time. A supervisor might not continually be on the market with them and if correct assistance is not provided at the correct time it should cause larger health considerations which will need extra resources for treatment. Our Literature Survey [1] of the Planet Health Organization's report states that pretty much 28-35% of people matured sixty five and over fall every year expanding to 32-42% for those more than seventy years getting on. The recurrence of falls and other accidents will increment with age and slightness level. Now it is important to know if an old age person has fallen or met with any accident so that he/she can be helped on time. Also people on wheelchair need to be checked for fall detection. For this purpose we propose our project the "Smart chair".

I. Introduction

The Smart Wheelchair is an intelligent machine equipped with all sorts of basic yet extremely useful features to prevent any harm to the sick person.

The system uses Accelerometer and Gyro sensor which are combined in MPU6050 module to detect person's 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 readings of acceleration and angular momentum. The system keeps monitoring for fall detection and abrupt movement changes in person. A sudden abrupt change with jerk in the system followed by no further movements 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 through Wi-Fi connection to alert the loved ones of the person about the situation INSTANTLY.

It also contains an object detection system on the other end for people with weak eyesight or no eyesight or if there is a blackout.

II. Components

Bread Board:

Breadboards are the basic building blocks in electronics projects. A Breadboard is a circuit board with multiple ports, making it feasible to connect multiple devices at once without soldering them completely. Breadboards are usually used in prototyping when the project is in testing stage. Breadboards come in different sizes and are widely used in IOT projects.

Jumper wires:

Jumper wires are simple wires used for connection. Jumper wires are usually multi colored. The colors are just for differentiation and have no other advantage. Jumper wires are mainly of two type male-male and female-female. The male-male jumper wires have connecting pins at both ends while the female-female jumper wires have ports for these ports at each end. There also exists a hybrid jumper wire which is male-female type.
These jumper wires will be used in our project for connecting peripherals on a breadboard without the requirement of soldering.

Micro USB cable:

Micro USB is somewhat similar to a USB as it contains a similar port. The micro usb cable is used to connect devices to laptops either for charging or for data transfer from laptop to your smart phone , digital cameras, hard drives etc. It will be used to connect microcontrollers to our laptop.

Arduino IDE:

The Arduino Integrated Development Environment is a multi-platform application for Windows, macOS, Linux. It

is used to write programs for Arduino boards and other compatible boards like nodemcu. As the popularity of IOT is increasing day by day, new boards are also being made compatible with arduino ide

Nodemcu:

The name "NodeMCU" combines "node" and "MCU" (micro-controller unit).
It is a special type of microcontroller board used in IOT applications. Unlike other commonly used boards Nodemcu is even more special because it contains an on chip wifi module to connect It to the internet.

MPU6050 Module:

MPU6050 sensor module is complete 6-axis Motion tracking device. It combines 3-axis Gyroscope, 3-axis Accelerometer and also a temperature sensor.

It has additional I2C bus to communicate with other sensor devices like 3-axis Magnetometer, Pressure sensor etc.

Power Bank:

A power bank is a portable charging device which has its own battery. It is charged before hand and can act as a secondary power source to charge phones, tablets, cameras, portable speakers, or even laptops.
It will be used to power the microcontrollers in our project.

Arduino Board:

The Arduino Board is a microcontroller board developed by Arduino.cc. The board contains sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. The board is programmable with the Arduino IDE (Integrated Development Environment) . It can be powered by a laptop through a USB cable or by an external 9-volt power source.

Ultrasonic Sensor:

An ultrasonic sensor is a special electronic device that has a basic function of measuring the distance of a target object. It does that by transmitting ultrasonic sound waves, and changes the waves that return after being reflected into an electrical signal. Ultrasonic waves can travel faster than the speed of sound that humans can hear. Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target) [7]

ESP 32 camera sensor and FTDI connector:

The ESP32-CAM is a very special mini camera module with the chip that is very inexpensive. It has OV2640

camera, and several GPIOs to connect peripheral devices, it also has a slot for a micro SD memory card that can be used to store pictures taken with the camera at any point of time. Instead of the commonly used usb connector, the ESP32-CAM comes with a FTDI connector to connect it to the laptop .

III. Proposed System

We are going to develop a Smart Chair with some basic safety features like fall detection, object detection and perform live stream of the objects present in front of the chair. So first we will initiate with the most useful segment of them all which is fall detection. To make a fall detection system we need a few things, bread board, jumper wires, nodemcu 8266 microcontroller, MPU 6050 module, a laptop with Arduino IDE installed on it, a micro usb cable and a power bank for power supply and assemble all these

parts which will forms a fall detection band like device which will keep record of all the movements of the chair (or the person in the chair if he is wearing the band). Next up we will develop the object detection system which will be on the right hand of the chair. This system will require an arduino board, an ultrasonic sensor, wires and breadboard, and obviously programming the board to work accordingly. Finally we will implement the live stream segment using the ESP32 camera and Blynk software. It can also click pictures while streaming. To understand the working of the Smart Chair let us take an example, Let`s say the person on the wheelchair accidently falls or the wheelchair falls , the system will immediately send an email and a message through blynk app to the caretaker`s phone and the victim will get help as soon as possible.

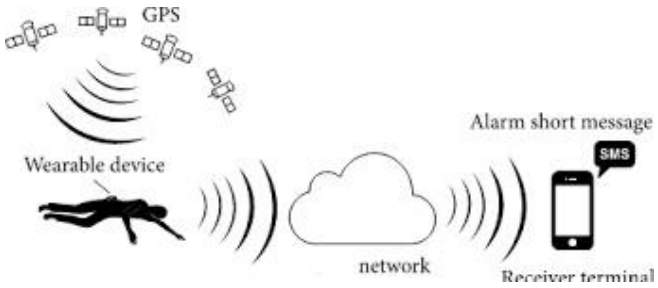

Fig.1 Diagram of Proposed System

IV. Experiment

The essential goal of this paper is to assess how the Smart Chair in the present or not so distant future can help the patients with one or multiple disabilities like abasia, guillain-barre syndrome, night blindness, complete blindness etc. Our project is highly cost efficient so it also helps people who cannot afford to keep a nurse with them all the time. At first, we expect that in any tragic event there exists a high chance of harm to both the patient and his family. Our project guarantees both accuracy and efficiency that too at such minimal level. Now let us get into how we actually brought this project into existence module by module.

Fig.2 Prototype of Smart Chair

Module 1. Fall Detection

To develop a fall detection system we require, a bread board, jumper wires, Nodemcu 8266 microcontroller, MPU 6050 module, a laptop with Arduino IDE installed on it, a micro usb cable and a power bank for power supply.

We shall initiate with the threshold detection system and check whether our parameters (accelerometer and gyroscope) are above a certain value within a certain time . In a situation of a fall, there must be a big change in acceleration value instantly and then the person lies for some time without any movement. These details help in the development of algorithm. In the first step, we shall collect data from the accelerometer section of the MPU module. The magnitude of acceleration gives us the data about how fast velocity changes while acceleration also gives us the change in velocity with time.

$$|a| = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

The above equation calculates net acceleration with all the three axes combined.

After getting the magnitude of acceleration, we want to know if the value crosses the first threshold. The first threshold is the minimum value in the range selected by the individual and the value slowly goes up to the second threshold. Then we need to calculate the time in which the threshold is crossed. If all the thresholds are crossed, then we will find out if there is a change in the position of the system in that particular time frame and it usually comes out to be true. After that, we see the duration of the change in position. If that is also true, then fall is detected. The algorithm also checks for false statements , if any condition is false it starts from the first threshold.

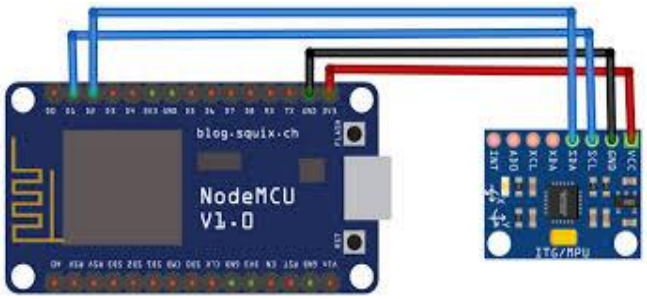

Fig.3: Node MCU

The Fall Detector Circuit

The circuit consists of two main components a Nodemcu 8266 microcontroller and an MPU6050 (accelerometer and gyroscope) module. For collecting data, we use the MPU6050 module which serves as input to the Nodemcu

microcontroller. The MPU6050 gives six values as output, three axes (x, y, z) values of an accelerometer, and three (x, y, z) values of a gyroscope. The MPU uses I2C protocol for communication with other peripherals. Such sensors are very popular . The MPU6050 also consists an on-chip temperature sensor.

The Nodemcu comes with an inbuilt wifi module that is why it is better to use over arduino. Next thing to perform will be making a blynk app for our fall detection system. It's a quite simple procedure which lets our smart phone interact with our nodemcu. The blynk app makes it easy for us to receive a message in the form of a notification and also an email, that too without the use of a GSM module. We can also improve this functioning by using a separate gsm module to receive a sms without using internet connection.

Algorithm Used For Fall Detection

1. First we collect data from the mpu module.
2. Take magnitude values of acceleration and angular acceleration (gyroscope).
3. See whether the value of magnitude breaks the first threshold. If false, return to Step 1.
4. Now see whether the magnitude crosses the second threshold . If false, return to Step 1.
5. Now check for change in position in that time duration . If false, return to Step 1.
6. If all of the above steps are resulted as true, turn the output pin as HIGH , the fall is detected .

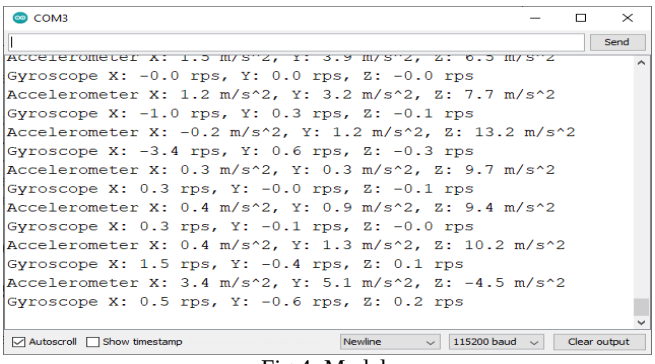

Fig.4 :Model

Fig.4 MPU readings on Serial Monitor

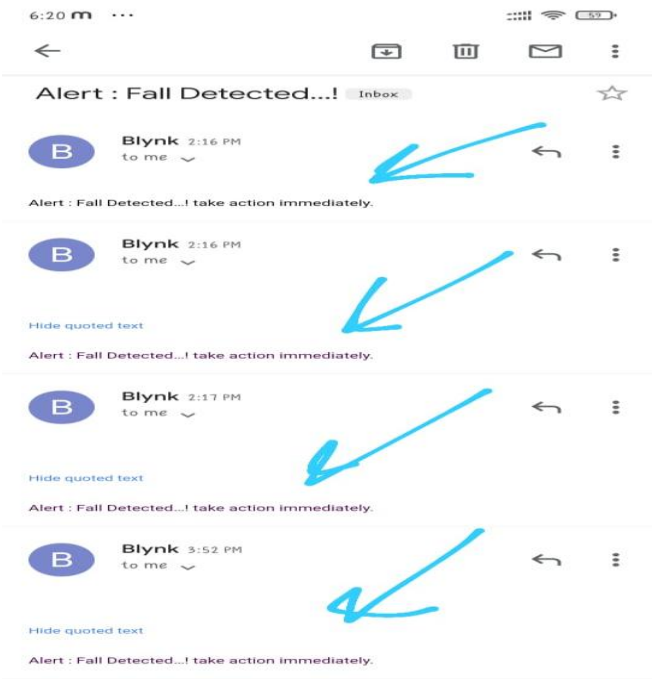

Fig.5 Message received when fall detected

Module 2: Object Detection System

For object detection we will require the following list of hardware :

- Arduino UNO
- USB cable
- Ultrasonic Sensor
- Breadboard
- Jumper wires.

Fig.6: Object Detection System

The USB cable is used to connect the arduino uno to the computer and power it. Initially we connect the arduino to the laptop to program it and use power from the laptop. In the final model we will power the system using a power bank. Both arduino and the ultra sonic sensor operate on the same voltage capacity that is 5V. For connecting the arduino and the ultrasonic sensor we use jumper wires on a

breadboard (temporarily). In the final model we will probably solder the connections.

Connections are as in the image:

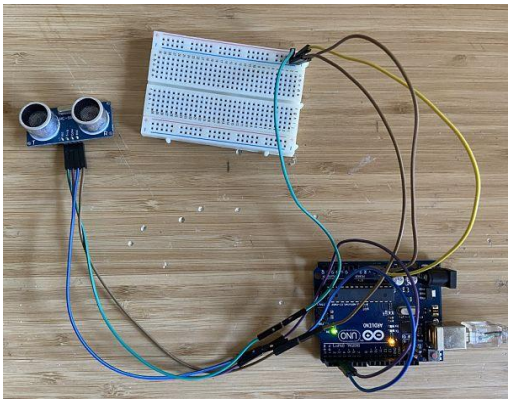

Fig.7 Object Detection System Connections

The basic idea of the system is to detect all objects in front of the chair which can be of any shape or size.

First we have to define the detection range of the ultrasonic sensor. Next, we have to define how which position on the chair is best of the sensor for maximum efficiency.The ultrasonic sensor`s ability to detect objects is not affected by characteristics like color, reflectivity etc. It can also detect objects coming from any direction not just front. In the final steps we setup the code by continuously calibrating the ultrasonic sensor. The ultrasonic sensor is not a very precise sensor but it does the job as per the requirements in our project.As for our project we have taken the range in a few centimeters so that it can function properly as a prototype. The user can consider any distance according to his needs and can update the same in the code.The sensor will continuously take the readings which will work as inputs to the arduino. As soon as the threshold of the ultrasonic sensor breaks , the microcontroller informs the sensor to switch on the alarm. This beep sound indicates the patient to be aware of the obstacles in front of the chair.

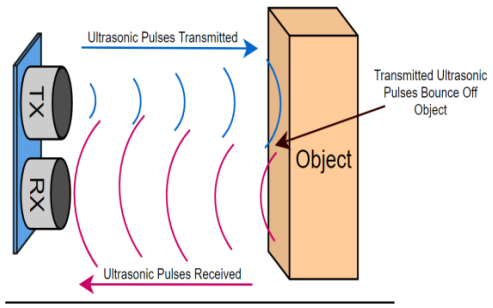

Fig.8 Working of Ultrasonic Sensor

Module3: Surveillance System

The surveillance system is an extremely useful function for a Smart Chair. This system fills the patient with confidence that someone is constantly with them and also ensures their privacy which will not be the case if we put a separate camera in their room . Also with a live streaming system constantly on , the patient can go anywhere freely and enjoy his own time.Usually such systems require expensive cameras but that is not the case with our project. The module we have used for this is ESP32 camera module which comes in just a fraction of the price of an expensive camera. The ESP32 Cam is an economic and compact option to the expensive cameras that are usually used for surveillance. With the ESP32 camera you can watch live stream and even click images in real time.

Working Of The Surveillance System

- We have used the following components:
- ESP32 camera module
- FT232RL adapter (USB to TTL)
- Female-female jumper cable

Connection and Cabling of the ESP32 Cam via Serial USB Port

In contrast to the NodeMCU Development Board, the ESP32 module with a camera does not have a USB port and must therefore be connected to the computer via an adapter. We use the FT232 USB-TTL serial adapter for this. Make sure the jumper is set to 5V. Here you can see the whole thing again as a schematic structure:

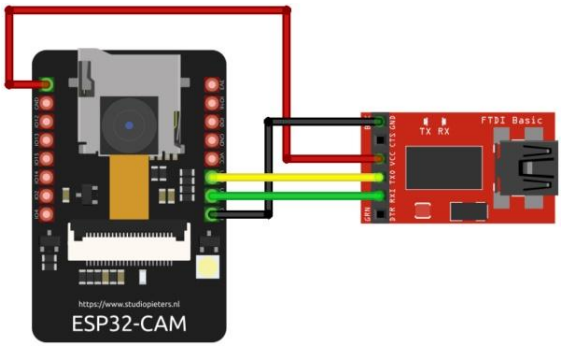

Fig. 9: Connection and Cabling of the ESP32 Cam

Now you can connect the FT232 adapter to your computer. A new device should have been recognized immediately. As soon as the connection is successful, open the serial monitor (under Tools) in Arduino IDE. If nothing is visible here, you can restart the ESP with the reset button (RST) on the back. You will then see the screen of the serial monitor :

The internal IP address is visible at the end (192.168.1.12 in our case). We enter this IP in the browser of another device that is in the same network.

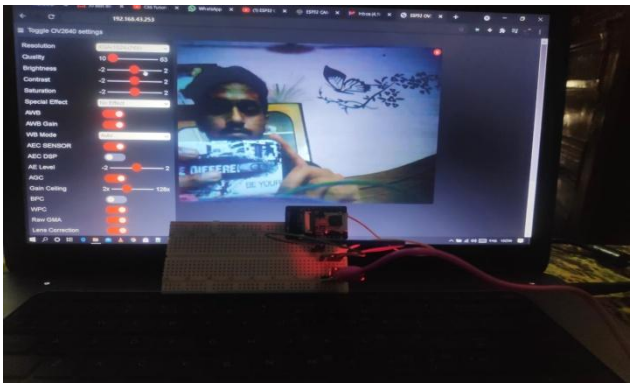

Fig.10 Live streaming using the setup

Many options are now visible on the left. For example, we can adjust the resolution (a higher resolution leads to a lower frame rate). Of course, brightness, contrast, saturation and many other options can be set. This is still possible while the stream is already running. Now click on "Start Stream", after which you will see a live preview of the camera on the right as in Fig 9. After setting up the camera ,we also tried connecting it with a blynk app so that it will be as handy as possible for the user. By the use of blynk app, we can click pictures for records in our smart phone directly.

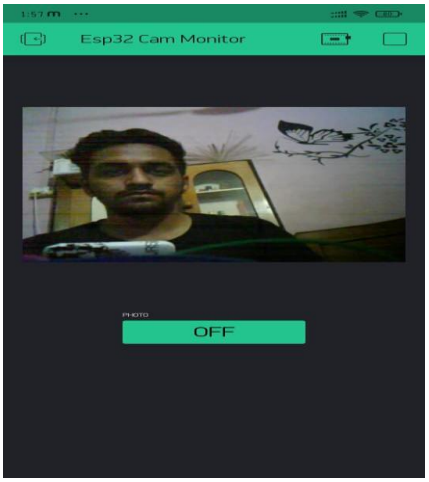

Fig.11 Clicking picture in Blynk app

Use of Smart Chair

- Real time surveillance .
- Informing about the sudden fall.
- Informs the person in charge to check.
- Detects whatever is in the way.

Advantage and warnings:

- Live Streaming and monitoring.
- Safety of the patient.
- Reduces risk of bumping into things.
- Ensures privacy of the patient.
- Does not require a person to be present all the time.

We should use the Smart Chair safely and mindfully, to prevent any harm or damage being caused to any individual, or property. No matter how safe a machine is it can still cause damage in one or other way. Make sure that it should not be in reach of children.

Risks associated with the use of Smart Chair :

1. Discharge of the power supply.
2. Damage caused by weather conditions.
3. Hitting in an obstacle (tree, building, high-voltage line).

These dangers can be anticipated.

V. Conclusion

This paper developed a Smart Chair with a fall detection system based on a tri-axial MPU sensor and an object detection system using the ultrasonic sensor. One can either mount each of these systems on the chair itself or on the patient`s body. The system consumes very less power unlike the advanced versions. It is also highly efficient due to the high sensitivity of the sensors used.Due to the high sensitivity of the system the normal day to day activities can also trigger the alarms so one must keep that in mind.

Other than this the project also contains a monitoring system. Continuous updation of the hardware and software is required so one must keep in check of that.

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