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AUTOMATED ASSISTANCE FOR PARALYTIC PATIENTS

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Abstract— The refined aim behind this project is to detect and measure the wrist movements of paralytic patients with an accelerometer, which is used to convey messages to the caretaker during regular or dire circumstances. Paralysis is the loss of strength in and control over a muscle or group of muscles in a part of the body, which many people in today's world suffer from. To cater to this problem of the paralytic patients, the wrist movements of the hands play a cardinal role in this proposed system. Our proposed system works by measuring the tilt angle detected by the device which is placed on the opisthenar area (dorsal) which is the corresponding area on the posterior part of the hand. Different tilt angles convey different messages and at the time of exigency with the help of Wi-Fi module and Blynk application, emergency notification will be sent to the concerned caretaker facilitating effective and efficient communication, ensuring full time attention to the patient's needs in all the circumstances.

Keywords— Wrist movements, tilt angles, Wi-Fi, Emergency Notification, Sensors.

I. INTRODUCTION

Paralysis is the impairment of voluntary muscular power. Paralysis can be a result of either diseases involving alteration in the makeup of nervous, muscular tissues or result of any metabolic disturbances that meddle with the functions of nerves or muscles. Other substantial causes are stroke, head injury, spinal cord injury, cerebral palsy, peripheral neuropathy, ALS (Lou Gehrig's disease), Parkinson's disease and trauma with nerve injury. Depending upon the region affected, paralysis can be of many types and degree, like partial, complete, permanent,

temporary, flaccid and spastic. Alternatively, generalized paralysis can also be categorized based on how much of the body is paralyzed, namely monoplegia, hemiplegia, diplegia, paraplegia and quadriplegia. In addition to these, some patients may be speech impaired making it challenging for them to communicate with his or her caregiver to express his or her needs at all points of time. Therefore, the key motive of the proposed system is to cater to these problems by providing a pragmatic solution.

To correlate with the above problem statement, our device is mounted on the posterior part of the hand (opisthenar or dorsal area) which still has motion abilities. Whenever the patient tilts his or her hand in a particular angle, a three-axis accelerometer is used to detect and measure these different tilt angles where every tilt angle is programmed to display certain messages with the help of microcontroller, which are then displayed on the LED screen in addition to a buzzer to alert the caregiver nearby. At emergency situations when the caretaker is not in the proximity, he or she is not only cautioned by the buzzer system, but also alerted with an emergency notification sent via Blynk application with the help of in-built Wi-Fi module present in the microcontroller. In this way, our device, Automated Paralysis Patient Care System truly automates the care taking ability of the patient which ensures timely attention to the patient thereby conveying vital messages to the caretaker.

II. SYSTEM DESIGN

A. Proposed Methodology –

The "Automated assistance for Paralytic Patient" accomplishes the task of providing seamless assistance to paralytic patients in both normal and emergency cases. This device is applicable for patients with either leg paralysis (paraplegia) or paralysis of one

single limb or an arm (monoplegia) or patients with speech disorders.

The device can be worn on any mobile part of a patient. Here, the unit is worn on the patient's wrist. The patient side consists of a system containing an analog accelerometer, a microcontroller with WiFi module (NodeMCU here), a LED display, an analog multiplexer and a buzzer. Since the NodeMCU has only one analog input A0, an analog multiplexer is used to interface the accelerometer with it. Here a triple axis accelerometer is used, which calculates the variation along X, Y and Z axes when triggered by motion. It is highly sensitive and any small movement can cause variation. Hence, the directions of wrist movement and the corresponding messages to be displayed are predetermined.

The block diagram in figure 1 shows the flow of the device. The inputs from the accelerometer are given to the analog multiplexer. One by one, the X, Y and Z coordinates are given to the microcontroller. Whenever the coordinates fall in the predetermined range, the corresponding message is displayed on the LED screen along with buzzer sound. Whenever a patient moves their wrist to the right, to the left and front, the messages "Need Water", "Need Food" and "Washroom" are displayed on the LED screen respectively. This way, a caretaker nearby will hear the buzzer, read the message on the screen and respond accordingly.

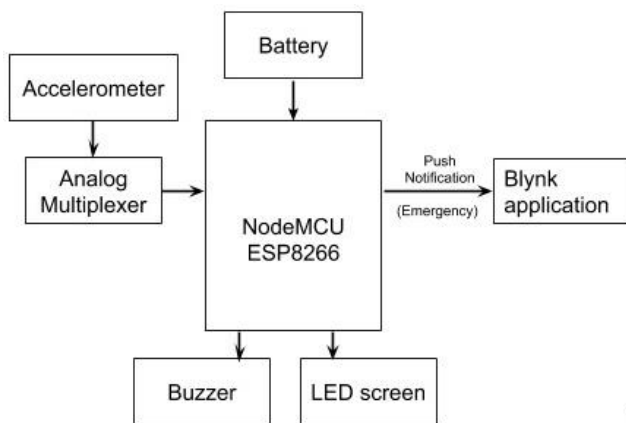


Fig. 1. Block diagram of the proposed model.

In cases of emergency, the patient moves their wrist backward and a different buzzer sound is played, and the message "Emergency" is displayed. At the same time, a push notification is sent to the Blynk application on the caretaker's phone. This ensures that even when the caretaker is far away, the notification on their phone alerts the caretaker and they can be at service to the patient as soon as possible.

III. SYSTEM IMPLEMENTATION

A. Hardware Implementation –

1. Node MCU ESP8266

NodeMCU ESP8266 is an open-source Lua based firmware and development board specifically used for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The Tensilica Xtensa 32-bit LX106 RISC microprocessor in the NodeMCU ESP-12E module supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.



Fig. 2. Node MCU ESP8266.

We use the Node MCU in our project as an IOT based microcontroller to process the data received from the accelerometer that is interfaced to Node MCU through the analog MUX and make decision of whether to display a message in the LED screen interfaced to it or send an emergency message to the user's caretaker's phone through the WiFi module to the Blynk application.

2. Interfacing Accelerometer to Node MCU

In the proposed system to device used to measure the tilt angle of the patient's hand is ADXL 335 as shown in the figure 3(a).

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. It is used to measure acceleration with a minimum full-scale range of ± 3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

In this application it is used to measure the static acceleration of gravity in tilt-sensing of the patient's hand. It is interfaced to the Node MCU as shown in figure 3(b).

Since it is an analog accelerometer and Node MCU has only one analog pin, it is essential to use an analog multiplexer to interface the ADXL 335 to the Node MCU. The 3-axis output of the accelerometer is connected to 3 inputs of the analog MUX and each pin is selected one after the other and sent to the Node MCU analog pin by Arduino IDE programming.

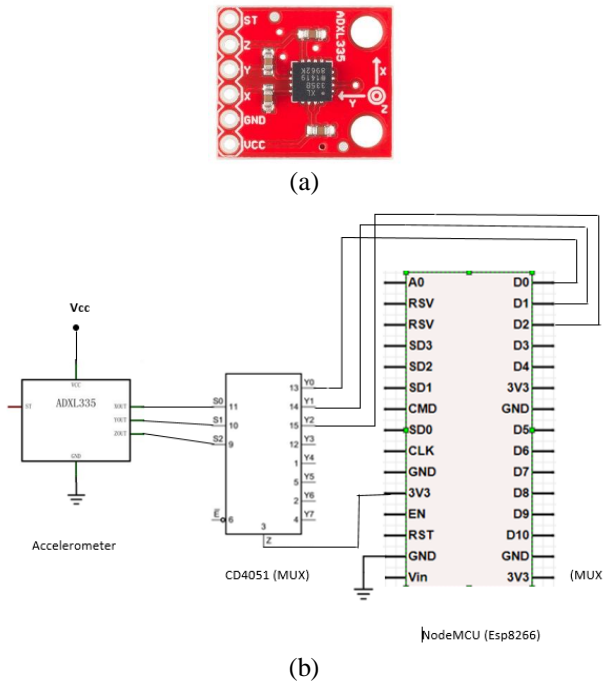


Fig. 3. (a) 3-axis analog accelerometer ADXL335. (b) Interfacing accelerometer using a multiplexer with NodeMCU.

3. Interfacing LED to Node MCU

In the proposed system the device used to display message based on the output computed from the NodeMCU from the readings of the accelerometer via the analog MUX is 0.96" I2C OLED Display as shown in the figure 4(a). This 0.96" I2C OLED Display is an OLED monochrome 128x64 dot matrix display module. It follows the I2C (two wire interface) protocol to communicate serially with the NodeMCU. It is a 4-pin display module with the four pins being VCC, GND, SCL (serial clock line), and SDA (serial data line). It is used to display the message on the screen based on the tilt of the patient's hand. It is interfaced with the Node MCU as shown in figure 4(b).



(a)

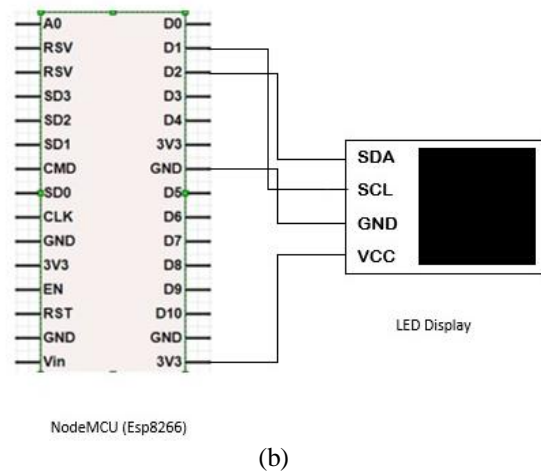


Fig. 4. (a) 3-axis analog accelerometer ADXL335. (b) Interfacing accelerometer using a multiplexer with NodeMCU.

B. Software Implementation –

1. Microcontroller Programming

The Node MCU ESP8266 has been programmed using the Arduino IDE. The accelerometer has been connected to the Node MCU. The static acceleration of gravity caused by the tilt angle of the patient's hand is calculated by the accelerometer ADXL 335 and the data is sent to the Node MCU through the analog MUX. This data is compared with a preset range of values of static acceleration of gravity for each direction of tilt, which is calculated by analyzing and collecting the range of values for each direction of tilt of the accelerometer. This value is used by the program of Node MCU to decide whether it should display the message on the Node MCU based on the tilt direction or send an emergency message to the patient's caretaker via the Blynk application. After the display of each message, it is also programmed to turn on the buzzer at a particular tone to alert the person or caretaker nearby. A different tone is given for the emergency signal to help the caretaker distinguish the emergency signal from different messages.

2. Algorithm for Node MCU ESP8266

Require:

Inputs from Accelerometer.

Ensure:

Connected to Wi-Fi.

Notions:

X: measure the static acceleration of gravity of x-axis.

Y: measure the static acceleration of gravity of y- axis.

Z: measure the static acceleration of gravity of z- axis.

BZ: pin connected to buzzer.

BV: Blynk virtual pin.

1. START

```

2. Read (X, Y, Z);
3. n = 0;
4. LED display "*****";
5. if (var 510<=x<=550) && (var 530<=y<=570) && (var
585<=z<=620)
6. LED display "Name: XYZ";
7. LED display "Contact Number: 123";
8. BZ = 1;
9. Delay();
10. BZ = 0;
11. end if
12. else if (var 520<=x<=560) && (var 630<=y<=670) &&
(var 510<=z<=545)
13. LED display "Need water";
14. BZ = 1;
15. Delay();
16. BZ = 0;
17. end if
18. else if (var 495<=x<=540) && (var 440<=y<=480) &&
(var 535<=z<=580)
19. LED display "Need food";
20. BZ = 1;
21. Delay();
22. BZ = 0;
23. end if
24. else if (var 425<=x<=460) && (var 540<=y<=575) &&
(var 525<=z<=560)
25. LED display "washroom";
26. BZ = 1;
27. Delay();
28. BZ = 0;
29. end if
30. else if (var 620<=x<=675) && (var 530<=y<=570) &&
(var 490<=z<=555)
31. LED display "Emergency";
32. tone( BZ, 523, 200);
33. Delay();
34. n = 1;
35. BV = n;
36. end if
37. END
    
```

3. Blynk Application

Blynk application was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data and visualize it. It works over the internet i.e., it communicated with the Node MCU over the internet with the help of the Wi-Fi module present in the ESP8266. As shown in the figure 5. The architecture of the Blynk application allows the user to use Blynk libraries to program the application in the Arduino IDE. This allows easy and efficient communication with the microcontrollers with the help of Wi-Fi. We use the application of sending a notification to the caretaker in case of an emergency.

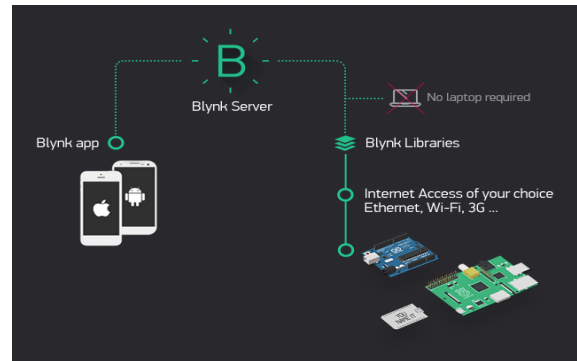


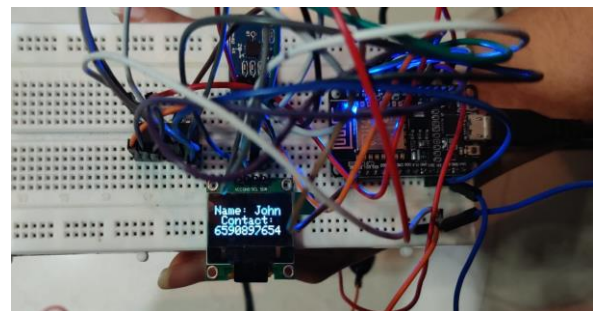
Fig. 5. Blynk Application.

When the patient tilts the accelerometer in backward direction this triggers the Node MCU to send an emergency signal to the care taker's phone through the internet in which the application made using Blynk would be installed.

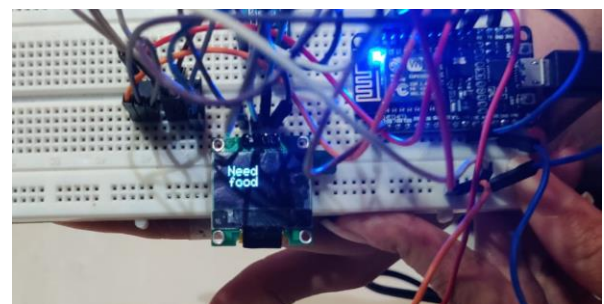
IV. RESULT

Normalization of the tilt angle in each direction using the different trial samples obtained and arriving at a particular range instead of a single value for the extent of tilt in each direction turned out to be highly effective and convenient to display the messages. A large range of tilt depending upon the different scenarios displayed the desired messages with 100% accuracy at all the trials performed.

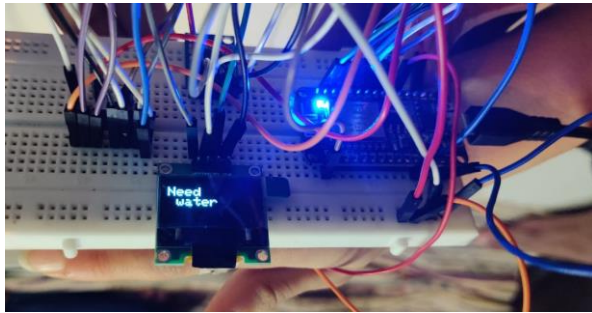
The four tilts were right, left, down and up with the messages need food, need water, washroom, and emergency, respectively. Each tilt along with the message displayed on the LED and the buzzer was turned on at the set frequency. The tilt action for emergency was also equipped with a feature of sending the message to the care taker's phone via "Blynk" app.



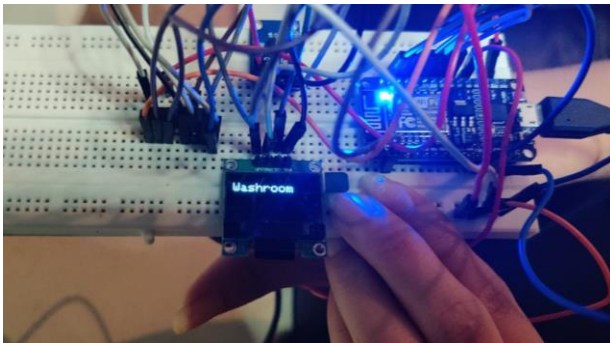
(a)



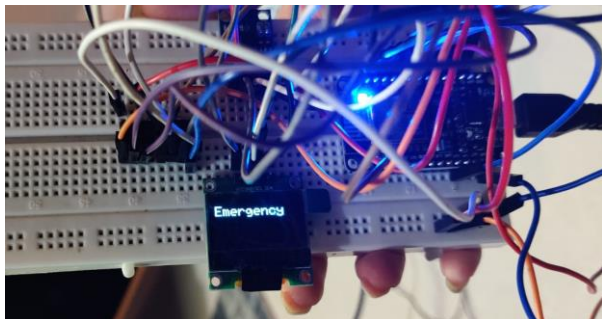
(b)



(c)



(d)



(e)

Fig. 6. (a) LED displaying name and contact number during static position. (b) LED displaying “NEED FOOD” on right tilt. (c) LED displaying “NEED WATER” on left tilt. (d) LED displaying “WASHROOM” on forward tilt. (e) LED displaying “Emergency” on backward tilt.

V. CONCLUSION

A very efficient, secured, and reliable assistance can be provided to the paralysed patients which aids them to overcome the difficulty to convey their basic needs via simple messages to their caretakers by just tilting their hands. The pre-set configurations for each tilt display the messages as and when there is a tilt detected in the patient’s hand. Also, the buzzer’s presence in the device ensures that no message is left unnoticed by the caretaker. The proposed solution can be modified by using a digital multiplexer for the Analog multiplexer which is an up gradation of the technology which also in turn reduces the hardware of the device. An overview of the device shows that

it is simple, cost effective and easy to use and can be used by patients with all kinds of paralysis cases. Having said that this system has a vast future scope with the ability to monitor various other vitals and parameters of the human body, this serves to be a great device in assisting the paralysed patients with easy and effective communication process with very less efforts from the patient’s end.

VI. FUTURE SCOPE

With the growth trend of biomedical technology, one can incorporate many other methodologies to this device. Flex sensors are being rapidly developed and find a wide range of applications everywhere. They detect the amount of deflection or bending and can be incorporated to the existing proposal. Integrating the flex sensors to each finger along with the wrist device at its position increases the number of recordings of the movement that can be made, which in turn increases the number of messages that can be conveyed.

One of the most advanced and biocompatible technology, “magnetic skin” can be used as an alternative for the fabrication that is required for the existing proposal. The advantage of the magnetic skin is that it can also be made to match the colour complexion of the skin, thus camouflaging it when it is worn to measure change in different parameters. Down the lane this method could possibly make one of the best ways to implement the idea and also reduce the fabrication process to a very large extent.

Also, the idea has a scope to process EEG signals in fully paralysed patients who are completely deprived of the capability of motor responses. This method can be used to convey different messages from the signals processed.

VII. ACKNOWLEDGMENT

We would like to thank BMS College of Engineering and the department of medical electronics for giving us the golden opportunity to take up this project. We would also like to express our special thanks of gratitude to our guide, professor S Y Pattar whose valuable inputs guided us through this wonderful project on the topic ‘Automated Assistance for Paralytic Patients’ and whose support helped us in implementing the hardware. We extend our gratitude to the faculty in-charge Dr. Joshi Manisha S. Working on this project helped us discover the upcoming fields of research and hone our practical skills.

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