IOT Based Wireless Monitoring Stroke Patient with Partial Paralysis Assistance

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Abstract:
Paralysis or the inability of a muscle to move is one of the most common disabilities resulting from stroke. As many as 9 out of 10 stroke survivors have some degree of paralysis immediately following a stroke. Continued rehabilitation and therapy can help stroke survivors regain voluntary movement even years following their stroke. Our project is a prototype model for a person who is partially paralyzed or has suffered from a partial stroke. We have designed such a system where a partially paralyzed or a stroke person need not depend on an individual for basic needs such as turning on the light or adjusting bed and can communicate with a person in case of emergency just by the motion of his head. He can even ask for immediate help without having to speak. Also, we will be collecting live feedback of the patient's health parameters and sending an alert message to the patient's loved ones or his attendant whenever his health parameters show fluctuations from the normal patient's readings. This data can be very useful for the doctors for making any assumption and giving the right medical aid to the patient as the doctor can have an easy tracking view of the patient's health improvement over time. Stroke is one of the leading causes of morbidity and mortality in adults, accounting for 17.3 million deaths per year. By 2030, it is estimated that more than 23.6 million stroke patients in United States will die from an indirect result of the stroke. Stroke is a medical emergency. So, the stroke patient's continuous health analysis, monitoring and immediate catering to his needs as suggested in our prototype model would help reduce the arrival time of a medical caregiver and accordingly decrease the mortality rate.

Keywords*: Stroke, health analysis, health monitoring, health feedback, alert message*

I. INTRODUCTION

Paralysis or the inability of a muscle to move is one of the most common disabilities resulting from stroke[1]. As many as 9 out of 10 stroke survivors have some degree of paralysis immediately following a stroke. Continued rehabilitation and therapy can help stroke survivors regain voluntary movement even years following their stroke[3]. Paralysis is the inability of a muscle or group of muscles to move voluntarily. Muscles are controlled by messages sent from the brain that trigger movement[7]. When part of the brain is damaged after a stroke, messaging between the brain and muscles may not work properly. Paralysis is usually on the side of the body opposite the side of the brain damaged by stroke, and may affect any part of the body[8].

In our project, we have designed a prototype model of a system where a partially paralyzed or a stroke person need not depend on an individual for basic needs such as turning on the light or adjusting bed and can communicate with a person in case of emergency just by the motion of his head. He can even ask for immediate help without having to speak. Also, we will be collecting live feedback of the patient's health parameters and sending an alert message to the patient's loved ones or his attendant whenever his health parameters show fluctuations from the normal patient's readings. This data can be very useful for the doctors for making any assumption and giving the right medical aid to the patient as the doctor can have an easy tracking view of the patient's health improvement over time.

Most patients hospitalized for stroke develop fever. In fact, experimental evidence suggests that high body temperature is significantly correlated to initial stroke severity. Fever occurring after stroke is associated with poor outcomes[12]. Hence, we are measuring the patient's body temperature at all times and sending an alert message saying "High Temperature" on the caregiver's phone whenever any instability occurs. Analysis shows that resting heart rate has important prognostic implications for people who have suffered a stroke before. Those in the highest quintiles of heart rate (72–82; HR >72 bpm) have higher risk of death. Hence, heart rate is another must parameter of stroke patient which we are measuring at all times and alerting the caregiver on account of any major pulse variations[14].

Strokes significantly contribute to reduced gait performance. A person who is partially paralyzed isn't able to perform his daily activities[17]. The stroke patients also have difficulty in speaking. His speech may be very slurred, or when the patient speaks, the words sound fine but do not make sense. Hence, the need of a system arises which acts as an immediate assistant to the patient and cater to his needs such as turning on the light, adjusting the bed and even asking for help. Such a system is demonstrated in

our working prototype model.Stroke is one of the leading causes of morbidity and mortality in adults, accounting for 17.3 million deaths per year[19]. By 2030, it is estimated that more than 23.6 million stroke patients in United States will die from an indirect result of the stroke. Stroke is a medical emergency. So, the stroke patient's continuous health analysis, monitoring and immediate catering to his needs as suggested in our prototype model would help reduce the arrival time of a medical caregiver and accordingly decrease the mortality rate[20].

II. LITERATURE SURVEY

1. *Jaired Collins, Joseph Warren, Mengxuan Ma, Rachel Proffitt and Marjorie Skubic*

Stroke Patient Daily Activity Observation System:

Abstract: Stroke is a leading cause of long-term adult disability. Stroke patients can recover through rehabilitation programs prescribed by occupational therapists (OT); however, an individualized rehabilitation program can reduce recovery times compared to traditional ones. In this paper, we propose a daily activity observation system (DAOS) that uses a Kinect v2 sensor to collect and retrieve motion data. The DAOS has a robust interface to extract depth and skeleton data, and supports data collection in an unstructured kitchen environment. Depth data are used to perform action recognition and track problematic movements, while skeleton data are used to calculate mean velocities of hand joints, max extensions, symmetry of hand movements, and other assessment metrics for therapists. Histogram of oriented 4D normals is used for action recognition. The action recognition accuracy is 97% on a multi-class kitchen action dataset. Through action recognition and accurate assessment, we present a novel system that can assist therapists and their ability to provide quality care to stroke patients.

Conclusion: We presented a novel solution for occupational therapists to create customized care for stroke rehabilitation patients. Through a daily observation system using a Kinect v2, we collect depth information and skeleton data. With these data, we are able to recognize several actions with a high degree of certainty by implementing HON4D as a global descriptor. In addition to activity recognition, we are able to perform assessment on critical metrics such as arm extension, mean velocity, max velocity, hand trajectories, and chest sway. With the extensive knowledge our daily observation system reports, a therapist can see problem areas or improvements over time to provide superior, personalized care for a stroke patient.

2.*Yasuhisa Hasegawa, Yasuyuki Mikami, Kosuke Watanabe, Zeinab Firouzimehr and Yoshiyuki Sankai*

Wearable Handling Support System for Paralyzed Patient:

Abstract: This paper introduces a new wearable handling support system for a person who has trouble in motor capability of his or her upper limb. The support system is used as not only a support system to make his upper limb active in daily life but also a rehabilitation system to reduce manual loads of physical therapists. The system measures three rotation angles of patient's head: pitch, roll and yaw to control three degrees of freedom of the support system; angle of elbow joint, angle of wrist joint and hand close/open, respectively. Hemiplegia patient who has paralysis of one half of the patient body can use both arms cooperatively by wearing the handling support system on the paralysis side. In our experiments, the system helps pouring task from POP bottle to a glass, while an upper limb on paralysis side of a user grasps the POP bottle and the other upper limb grasps the glass.

Conclusions: This paper introduced a new wearable handling support system for a person who has trouble in motor capability of his or her upper limb. The support system is developed as not only a support system to make his upper limb active in daily life but also a rehabilitation system to reduce manual loads of physical therapists. The system measures three rotation angles of patient's head: pitch, roll and yaw to control three degrees of freedom of the support system; angle of elbow joint, angle of wrist joint and hand close/open, respectively. Through some experiments about the pouring task from POP bottle to a glass, it is confirmed that the system has enough working angles of each joints and enough assistive force to carry the POP bottle. A wearer can intuitively operate this system without any skill or training process. One of our future works is to increase the grasping force of the assistive hand in order to widen its application field in daily life.

3. *F. Sayegh, F. Fadhli, F. Karam, M. BoAbbas, F. Mahmeed, J. A. Korbane, S. AlKork, T. Beyrouthy*

A Wearable Rehabilitation Device for Paralysis

Abstract: With the huge development and the latest technological advancement in mechatronics, prosthetic devices have acquired interest in many different fields such as medical and industrial fields. A prosthetic device can be an external wearable mobile machine that covers the body or part of it. It is generated by pneumatics and electric motors. It can be installed on an upper and lower limb. Moreover, it can be used for different purposes such as rehabilitation, power assistance, diagnostics, monitoring, ergonomics, etc. Most of the existing wearable devices face different problems in terms of size, cost and weight; they are huge, expensive and heavy. Therefore, the goal of this project is to design a portable, lightweight and low-cost rehabilitation system for people with a paralyzed hand. The wearable device allows a user to perform specific movements and exercises to

train the patient's impaired hand. Thus, the user gradually starts to restore the functionality of his hand.

Conclusion: We designed a hand wearable device for patients with paralysis. The user can select between two different modes:active or passive. In addition, the device can perform different types of therapy exercises. It can also monitor the user's health like the temperature, pulse, ECG and oxygen. For the future work, the wearable device can be installed for both hands. Also, the numbers of exercises and health sensors can increase. More studies should be done about the recovery time speed.Moreover, the patient can do the therapy exercises through fun interactive games using Virtual Reality technology. The wearable device should be tested on patients to prove the effectiveness of this rehabilitation system.

III. METHODOLOGY

We are using renesas microcontroller which belongs to RL78 family. R5F100LEA is a 16-bit microcontroller which has three sections namely power section, control section and communication section. Power section includes 12V pins, 5V pins and ground pins. Power supply to the chip is given with the help of the adaptor which is a 12V adaptor. This is then step down to 5V with the use of 7805 voltage regulator as the components on this chip operates with 5V supply. Components like DC motor and relay require 12V for their functioning. Ground is taken common for all components.

When the power supply is given through the 12V adaptor to the controller LCD displays the project name followed by system start message which is sent to the mobile. Lcd used in our project is 16X2 i.e. it has a Panel with 2 rows and 16 column and with blocks as shown below with 5x7 pixel-selection pattern. JHD162A is one such LCD which is used here. Lcd is used to display temperature, heart rate and vibrations the patient's body and also depicts different conditions.

Once the connection between the device and amazon cloud server is established the initial conditions of the various components are checked such as bed, light and mp3 speaker. Initially bed rotates up and down, light gets on and after some delay gets off and a welcome voice is heard from the speakers. Temperature sensor LM35 is used to record the temperature changes in one's body. LM35 is an integrated analog temperature sensor whose electrical output is proportional to Degree Centigrade. LM35 sensor does not require any external calibration or trimming to provide typical accuracies.The LM35 temperature sensor is used to detect precise centigrade temperature. The output of this sensor changes describes the linearity.

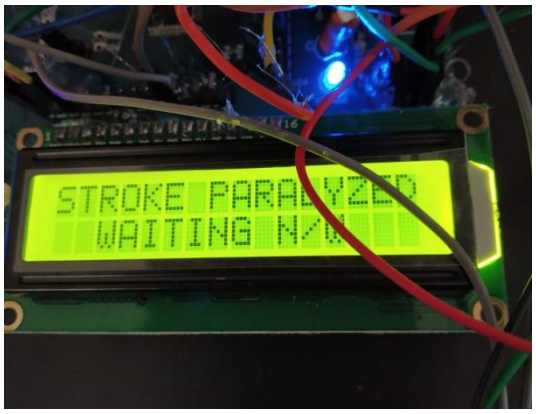

Figure 1.0: Initial display

The o/p voltage of this IC sensor is linearly comparative to the Celsius temperature. The operating voltage range of this LM35 ranges from-55˚ to +150˚C and it has low-self heating. This is operated under 4 to 30 volts. Temperature sensor is connected to one of the eight analog channels present in the microcontroller.It's connected to P2.0 analog channel. LM35 senses the temperature of the body and is recorded in the cloud server . If the temperature rises above 40˚ Celsius then a message is sent to the mobile saying the patient is having high temperature and this is also displayed on the lcd.

Heart rate of a person is also sensed using pulse rate sensor. Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses

Accelerometer can be used for tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration. The ADXL335 gives complete 3-axis acceleration measurement. The output signals of this module are analog voltages that are proportional to the acceleration. Accelerometer measures motion in 3 axis, they are x,y and z axis. Here we are using two axis x and y. Z axis is used for 3 dimension imaging purpose. Normal accelerometer for x and y axis is in the range of 150-160. One accelerometer is used in hand and one is used for head. The reading of the accelerometer fixed on hand is recorded and data is stored on amazon cloud server. If the reading deviates from the set value i.e., 150-

160 this implies that the person is trying to move the hand. This can be used for any part of the body but as a prototype we are showing it for hand.

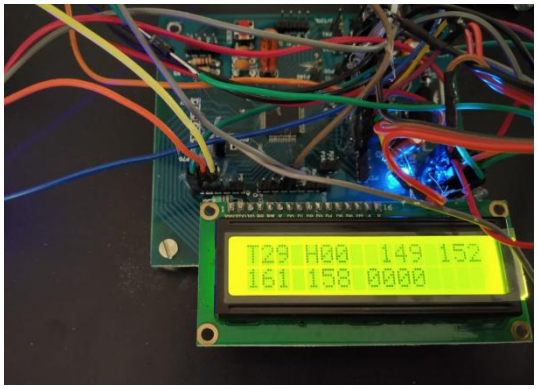

Figure 1.1: Readings displayed on lcd

The relay module is a separate hardware device used for remote device switching. With it you can remotely control devices over a network or the Internet. The Relay module houses two SPDT relays and one wide voltage range, optically isolated input. When power flows through the first circuit, it activates the electromagnet, generating a magnetic field that attracts a contact and activates the second circuit. When the power is switched off, a spring pulls the contact back up to its original position, switching the second circuit off again. Similarly if the x-axis value goes beyond 190 range a voice message is received which tells that patient is in need of help. In case of emergency or patient is in very uncomfortable position and unfortunately no one is around him he has to just bend his head in backward direction and a voice message saying "I need help" will be heard through speaker and there is an alert message sent to the mobile. Same accelerometer has y-axis reading which is used to give another two commands. This is used to adjust the bed. Patient need not depend on another person for this reason. He has to just move his head towards the left. As y-axis value increases beyond 190 range the bed goes up. Similarly when he bends his head towards right the y-axis value reading goes below 140 range and in turn the bed goes down.

To demonstrate the bed going up and down DC motor along with driver is used. DC motor converts direct current electrical energy into mechanical energy. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills.

L293 driver circuit is used to driver the DC motor. A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. H-bridge is a circuit which allows the voltage to be flown in either direction. In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently.In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Here in our project motor of 3.5 rpm is used, whereas for real time a motor with higher rpm can be used.

General Packet Radio Service (GPRS) is a packet oriented mobile data standard on the 2G and 3G cellular communication network's global system for mobile communications (GSM). GPRS was established by European Telecommunications Standards Institute (ETSI) in response to the earlier CDPD and i-mode packet-switched cellular technologies. It is now maintained by the 3rd Generation Partnership Project (3GPP).General Packet Radio Service works by allowing data to be stored into 'packets'. This data is then transmitted in an efficient manner across the mobile network. GPRS however is much faster than the cellular network systems. This type of networking system can be used worldwide without difficulty. GPRS devices are extremely versatile. The devices allow the owner to use it for many different things. Any device that has GPRS capability will allow the user to have not only mobile communication but also access to the internet for things such as e-mail, and internet browsing. Some devices even have the ability to act as a means of communication between two individuals. You can even adjust various settings on the device in order to keep track of things like changes in temperature, sound and motion. GPRS devices also have the ability to further its functionality by allowing the user to add on things like cameras and GPS receivers.

GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. From the below circuit, a GSM modem duly interfaced to the MC through the level shifter IC Max232. The SIM card mounted GSM modem upon receiving digit

command by SMS from any cell phone send that data to the MC through serial communication.

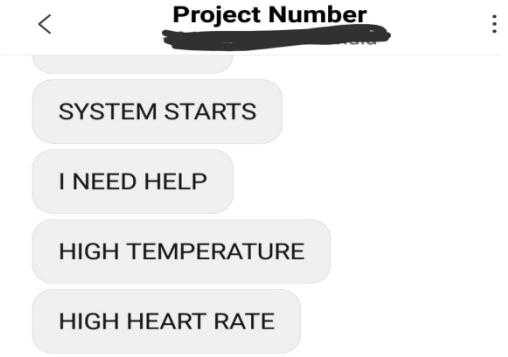

Figure 1.1: Alert messages

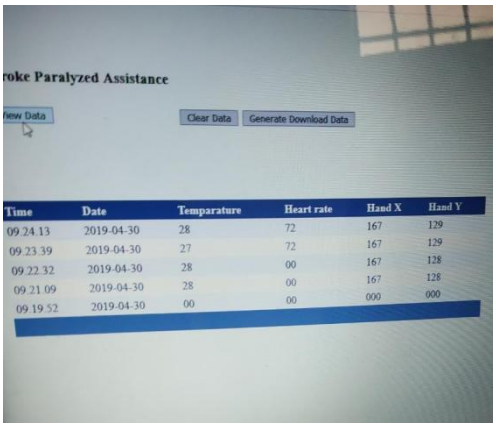

Figure 1.2: Data stored in cloud

While the program is executed, the GSM modem receives command 'STOP' to develop an output at the MC, the contact point of which are used to disable the ignition switch. The command so sent by the user is based on an intimation received by him through the GSM modem 'ALERT' a programmed message only if the input is driven low. The complete operation is displayed over 16×2 LCD display. GPRS and GSM in the project is used to update the data on amazon cloud server and to send alert messages to the mobile respectively. Amazon cloud server stores the date, time when the readings such as temperature, heart rate, accelerometer reading of the hand is taken. GSM sends respective messages like start of the system, high heart rate, high temperature and so on.

IV. RESULT

GPRS Send Test Case: Input: Upload Microcontroller Code with GPRS string -> Define Amazon server account created IP address ->Insert SIM Expected output: Sent GPRS string matches with application. Actual output: Define GPRS string will be received in browser page.Result: Successful

GPRS Receive Test Case: Input: Upload Microcontroller Code with GPRS Receive string ->Define Amazon server account created IP address ->Insert SIM, Button in created browser page.Expected output: Received GPRS string matches with application.Actual output: Define GPRS string will be received in microcontroller, and respective operations are performed.Result: Successful

GSM SMS Send Test Case: Input: Upload Microcontroller Code with SMS string -> Define SMS Receiver mobile number -> Insert SIM.Expected output : Sent SMS string matches with application. Actual output: Define SMS string will be received in receiver mobile. Result: Successful

GSM SMS Receive Test Case: Input: Upload Microcontroller Code with SMS Receive AT Commands -> Insert SIM -> Send Required SMS from user mobile or Android Application..Expected output: Received SMS string matches with application. Actual output: SMS Received with defined string, and respective operation are performed in Microcontroller. Result: Successful

V. COMPARISON

There are various research that has been carried out, which many focuses on rehabilitation after strokes. Post strokes, exercise become an important part of one's life. Physiotherapy is very common in such patient which enable them to improve recovery of the function and mobility of strokes.

A recent study highlighted that a person who encountered a strokes has a high risk of suffering an addition strokes after a small strokes or transitory ischemic attack. A long term monitoring of strokes patient is necessary to keep the track of stroke recovery and assess the patient response to therapist treatment technique.

Our project focus on these feature since there will be continuous track of stroke patients behaviors through alert message and data stored in cloud. Hence, this help us to assess the patient's response to the treatment. Since, they are continuously monitored the risk additional stroke after small strokes can be tracked. Our project also focuses on helping the patient in being independent in regards to the basic needs.

Table column for comparison:

Year	Name	Result
2008	Wearable Handling Support System for Paralyzed Patient	introduction of a new wearable handling support

		system for a person who has trouble in motor capability of his or her upper limb
2017	A Wearable Rehabilitation Device for Paralysis	a portable, lightweight and low-cost rehabilitation system for people with a paralyzed hand
2017	Stroke Patient Daily Activity Observation System	a daily activity observation system (DAOS) to collect and retrieve motion data
2019	Current Paper : IOT Based Wireless Monitoring Stroke Patient with Partial Paralysis Assistance	Alert system for assistance and interaction of patients

VI. CONCLUSION

In this project we have designed a system which helps a person suffering from stroke or partially paralyzed to interact like a normal person and various parameters of his body such as temperature, heart rate, and vibrations are measured. We presented preliminary results from a patient using the embedded IoT system and showed that the data can be used to analyze the stroke patient. Data like temperature and heart rate indicates the doctor about the patient's health parameters. Accelerometer in the hand gives the indication of any motion by the patient. All these are stored in amazon cloud server and can be accessed by far of places. The accelerometer in the head produces four commands and hence patient is able to vary the inclination of the bed, turn on the light and send a voice message in case emergency. Additionally it can be designed to turn on and off fan, tv and other devices. An additional DC motor can be used for the lower half of the bed. Additional commands can be added which helps the patient interact better.

VII. FUTURE DEVELOPMENT

In 2013 approximately 6.9 million people had an ischemic stroke and 3.4 million people had a hemorrhagic stroke.In 2015 there were about 42.4 million people who had previously had a stroke and were still alive. Between 1990 and 2010 the number of strokes which occurred each year decreased by approximately 10% in the developed world and increased by 10% in the developing world.In 2015, stroke was the second most frequent cause of death after coronary artery disease, accounting for 6.3 million deaths. About 3.0 million deaths resulted from ischemic stroke while 3.3 million deaths resulted from hemorrhagic stroke. About half of people who have had a stroke live less than one year.[2] Overall, two thirds of strokes occurred in those over 65 years old.

Paralysis is a loss of muscle function for one or more muscles. Paralysis can be accompanied by a loss of feeling (sensory loss) in the affected area if there is sensory damage as well as motor. In the United States, roughly 1 in 50 people have been diagnosed with some form of permanent or transient paralysis. Paralysis is most often caused by damage in the nervous system, especially the spinal cord. Other major causes are stroke, trauma with nerve injury, poliomyelitis, cerebral palsy, peripheral neuropathy and so on. Temporary paralysis occurs during REM sleep, and dysregulation of this system can lead to episodes of waking paralysis. Drugs that interfere with nerve function, such as curare, can also cause paralysis.

To the best of our knowledge, we are the first to develop such a system wherein we use headband to generate commands which helps a paralyzed person to interact same as a normal human by just moving head. We record the day-to-day reading of his development. As patient can be monitored in this way it reduces the need of an individual to keep an eye on the patient. A paralyzed person, to certain level can try becoming independent. The different body parameters recorded is stored in cloud server, it can be viewed by the doctor from a far of place and hence in case of any emergency he can suggest any first aid.

For the future work, the number of health sensors can increase and hence helping the patient further. We can add devices like fan, which works in a similar fashion as that of light. We can design a system to switch on and off TV and radios. If a patient is not attended for long and he needs water or food then an alert message can be sent to the mobile. Relatives and doctors can have a better check on patient with the help of this system.

VIII. ADVANTAGES

The advantages of our project work are:To keep the track of the development in the patients' health. To avoid any injuries. To provide users, health care professionals and caregivers with highly personalized health feedback. Costeffective. Helps to identify behavior analysis. Helpful in health monitoring. We get to know the present situation of patients with the help of alert sms on our phones. It is also used to store the patient's health data in amazon cloud for further medication. It helps the patient to adjust the bed according to the requirement. Help to capture the little movement in the body. Ultimately, stroke patient's continuous health analysis and monitoring would help reduce the arrival time of a medical caregiver and accordingly decrease the mortality rate.

The applications of our model includes: In hospitals for getting the live feedback of all patients. Can be used by any family member to keep a track or get an alert whenever the patient's health goes down. Through data storage and analysis, we are presenting a novel system that can assist therapists and their ability to provide quality care to stroke patients.

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