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COMMUNICATION APPROACH THROUGH HANDHELD DEVICES FOR DISABLED PATIENT BASED ON MORSE CODE

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ABSTRACT

Patients with severe physical disabilities might experience communication difficulties. Some injuries hinder their ability to speak, write and type even though their brain is unaffected. Thus, an alternative means of communication is required to relay the intention of the patient. A 'nurse call button' has been widely used by patients at health care centers to alert a nurse or a doctor whenever they need help. However, the key limitation of such system is that it simply produces a beep sound at the specific station and the responder has to visit the patient's room to identify their intention. Thus, in this project, an alternative communication aid is proposed utilizing widely available handheld devices such as smart phones, tablets and notes. As a result, complex sentences or instructions can be delivered to the intended respondent via several combination of "ON-OFF" signal based on Morse code. In addition, the device can also be reprogrammed according to the user preference. It is hoped that the device would be able to help the patient to communicate to other people in order to fulfill their daily needs.

Keywords: decoder, bluetooth, HC-05, Arduino, rehabilitation.

INTRODUCTION

Communicating with a person with speech and physical disabilities can be challenging. Severe multiple physical injuries might also hinder a person's ability to speak, write and type even though their brain is unaffected. While he or she remain conscious, they would have trouble to request something they need or convey their intention. Thus, Morse code has been seen as one of the simplest but yet effective means of communication for a patient with fair or good cognitive level [1]. In [2-3] studied on how gestures of human body can be used to relay information to other people or being interpreted by a device and convert them into speech, text of graphics. Besides, in [4] came out with a specific instructions on how to teach, learn and use Morse code in clinical settings including various practical teaching aids and methods.

In addition, plenty of efforts have also been given to provide a proper tool for disabled people to communicate with their non-disabled counterpart [5-9]. Most of them are based on wearables instruments such as gloves that sense the movement and generate specific interpretation out of it. Such efforts were quite expensive for a disabled persons, and thus further cost reduction need to be considered [8]. Besides, Morse code can also be used for data compression. Complex sentences can simply be represented by a set of dot and dash signals. In [10] focused on how Morse code can be used for data compression. This is very useful in various area including data transmission and storage. The combination of letter bits and pattern in different ways will allow cryptography of texts [10]. Other than that, in [11] designed an adaptive word processor based on Morse code to assist users with limited physical functionalities. As a result, they managed to establish fast interaction between the user and computer using the proposed Morse code interface. The user was also managed to complete their task faster as compared to classical input keyboard.

In this paper, the development of a device that can relay information through existing handheld devices such as smartphones is discussed. Utilizing the standard international Morse code, the following section will also explain in detail how such system can be implemented at a minimum cost as well as its performance and functionality [16].

SYSTEM IMPLEMENTATION

In this project, a single switch communication device was proposed to be used to relay patient or user intentions. The switch will help to produce a specific combination of several "ON-OFF" electrical pulse which will be used to determine a dot (short pulse) and a dash (long pulse) signal. A standard size Morse key was used as the input switch for the proposed system. By using Morse codification technique, the electrical signal will be characterized and converted into a form of readable words or phrases. The signal interpretation process will be carried out by an ATMEGA328P microcontroller and the results, in the form of word, character or a complete sentence, will be shown on a 16x2 LCD display. At the same time, the characters will also be transmitted wirelessly through Bluetooth module to an intended handheld device or a special Bluetooth-enabled display. A buzzer was also used to assist the user to estimate the dot and dash duration as well as to alert nearby personnel whenever the device was used [14]. As depicted in Figure-1, the care takers or doctors are expected to receive the message given by their patient and allow them to respond accordingly.
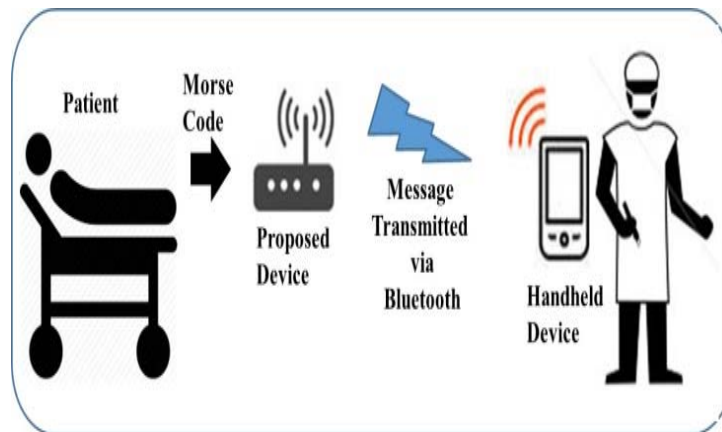
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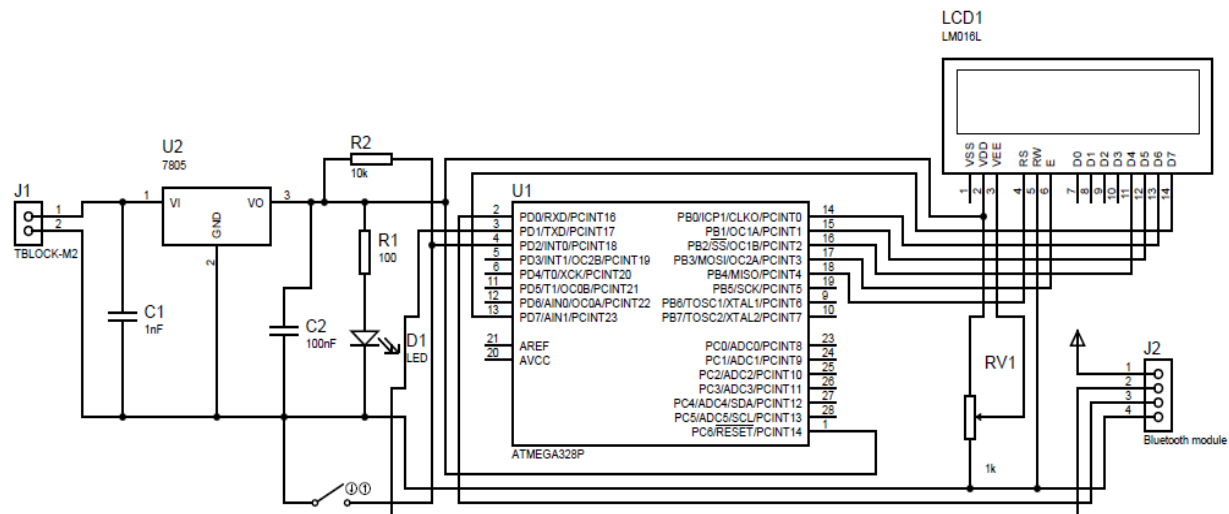**Figure-1.** Overall project functionality.

Circuit design

Figure-2. Circuit design of the system.

Figure-2 illustrates the circuit design of the proposed system. The core processing unit was based on a low cost ATMEGA328P microcontroller, embedded with Arduino bootloader. The controller comprises of 14 programmable input and output (I/O) ports including digital I/O and 8 analog input ports. Besides, it can also support up to six Pulse Width Modulation (PWM) output, 32KB flash memory, 1KB EEPROM and 2KB SRAM. The board requires regulated 5V input in order to operate. Thus, a voltage regulator, LM7805 was used to regulate and stabilize the input voltage to the controller. In order to minimize the disturbance from unwanted noise, a pair of capacitor, C1 and C2 was placed between the voltage regulators. Other than that, a pull up resistor was added to the switching circuit to provide an active high input to the microcontroller [13].

Hardware design

The main structure of the proposed system is made of plastic in order to ensure its rigidity and lightweight features. The Morse key consists of metal bar with a plastic knob on top of it and an adjustable contact underneath. When the bar is pressed, it forms a connection between the contacts and allows electricity to flow. Mechanical switch contact may bounce several times when pressed and could cause a false input to the microcontroller. Thus, in order to eliminate the bouncing effect, a simple low pass filter was added to the output of the Morse key to reduce the voltage fluctuations generated by contact bounce [17].

Moreover, the Morse key is also changeable and user can choose to use more ergonomic Morse key connected to their device. Other than that, the position of the Morse key is also adjustable and can be put separately from the main controller in order to meet user preference. Besides, the LCD display on the device is also embedded with backlight to help the operator to key in their input more effectively.

In the aspect of sizing, the height, width and length of the proposed device is approximately 20cm,

20cm and 25cm respectively. Thus, it does not occupy large space and it allows user to place the device at any location including on the bed or on a small table. In short, the physical appearance of the device shown in Figure-3 can be reassembled depending on the patient condition and requirement.
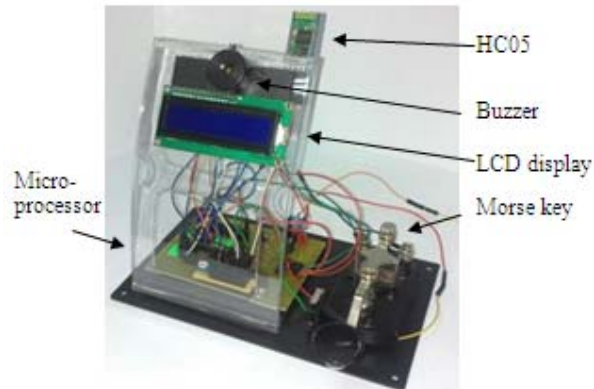

Figure-3. The hardware composition.

Communication module

Figure-4 illustrates a Bluetooth module used in the development of this project. Such devices can be used to operate in two modes which is data transfer mode and AT command mode. HC05 module comes with serial port protocol intended to be used for wireless serial communication setup. The module can be connected to serial port or microcontroller terminal through serial communication line including RXD and TXD signal port. HC05 can also be configured to work in master, slave or loopback setup. There are plenty of slave configured Bluetooth application such as Bluetooth printer, Bluetooth speaker, microphone and so on. In this project, the HC05 Bluetooth module was set to work in master mode with baud rate of 9600. AT commands shown in Table-1 were used to set the address of the module as well as the data rate settings. Once completed, mobile devices such as laptop or smartphone can be used to scan and detect the availability of the Bluetooth transmission from the device. Next, both devices will be paired to establish connection between them in order to allow data exchange [12].
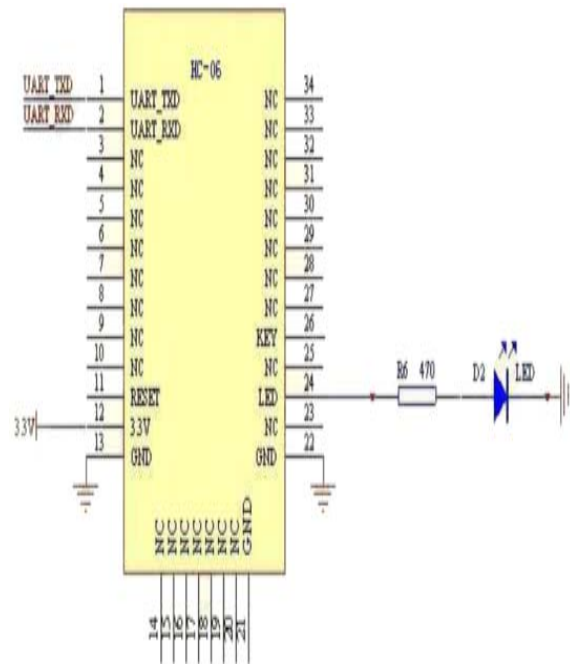

Figure-4. HC-05 Bluetooth module.

Table-1. Commonly used AT commands for HC05 module.

AT commands	Description
AT :	Check the connection
AT + NAME	See default name
AT+ADDR	See default address
AT+VERSION	See version
AT+UART	See baudrate
AT+ROLE	See role of module (1=master,0=slave)

Program development

The source code for this project was written in Arduino C-language. According to international Morse code standard, dot duration is one time unit long and a dash consists of three time units long. The gap between letter should be within three dot duration or three time units long. Besides, the gap between words shall be set to seven time units long. In order to evaluate between the dot

and dash input, the duration of the input pulse was measured in millisecond and a pulse threshold value was introduced in the programming code. If the duration of the input pulse exceeded the threshold value, the input will be considered as a dash input. Similarly, if the input pulse measured was less than the threshold value, it will be considered as dot input. Besides, in order to form letter or word separation, the duration between the first input and the second input was also being measured. If the delay was longer than the duration set for letter separation, a space character will be sent to the output display. Figure-5 demonstrates the code implementation to measure the dot and dash input.

```
boolean pulse(){
if (pulseLength > pulseThreshold)
return DASH;
else
return DOT; }
boolean nextletter(){
if(millis()-startN > letterSeparation)
return true;
else
return false;}
boolean putSpace(){
if (millis() - startS > wordSeparation)
return true;
else
return false;}
```

Figure-5. Determination of dash and dot input.

In addition, four special instructions were also introduced in this project to assist user to operate the system. For example, if the system detected four dashes, a "go to toilet" sentence will be displayed directly. These special instructions can also be modified depending on user preference. The code implementation for this feature is shown in Figure-6 [15].

```
if(code == '>'){
lcd->setCursor(1,0);
lcd->print("GO TO TOILET");
Serial.println("TOILET");}

if(code == '<'){
lcd->print("WANT TO EAT");
Serial.println("WANT TO EAT");}

if(code == '^'){
lcd->print("WANT TO DRINK");
Serial.println("WANT TO DRINK");}

if(code == '~'){
lcd->print("WANT TO SLEEP");
Serial.println("WANT TO SLEEP");}
```

Figure-6. Code implementation for special instructions.

RESULTS AND DISCUSSIONS

Figure-7 indicates the input pulse sample obtained from the Morse key during the test. The dot input is represented by the pulse with a shorter duration while the pulse with a longer duration is considered as a dash. In Figure-6, the given input was a character U("dot dot dash"), space, B("dash dot dot dot"), space, N("dash dot") space, I ("dot dot"), space, S("dot dot dot") space and A("dot dash"). A few sets of pulse threshold, letter separation and word separation values were also tested and as a result, the most convenient combinations for producing the desired dot and dash pulse were 200ms, 500ms and 2000ms respectively.
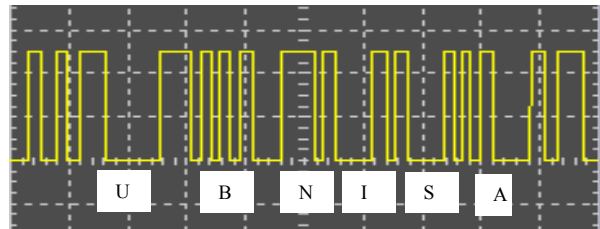

Figure-7. Pulse sample from the Morse key.

In Figure-8, the delay between dot and dash was too long and such signal was read as two separate character E(dot) and T(dash) instead of a single character A(dot, dash). Similarly, in Figure-9, the delay between the first pulse (dash) and the second pulse (dot) exceeded the letter separation time and as a result, character E and R were printed out. Likewise, the gap between the first two dots and the following two dashes showed in Figure-10 also producing two separate characters I and M. Besides, the maximum reachable distance for data transmission was also been tested and it was learnt that in a line of sight (LOS) condition, the device were able to establish connection within 100 meters.
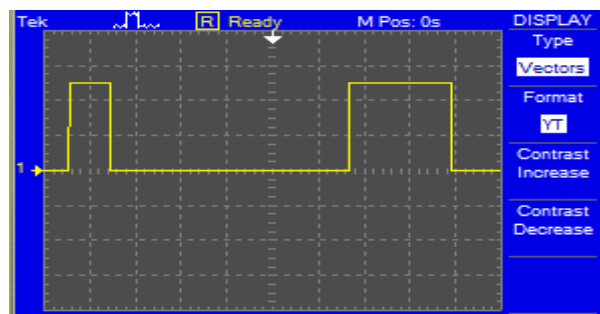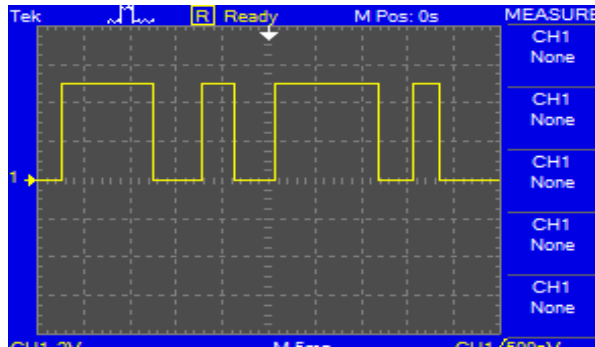

Figure-8. Dot-dash input.

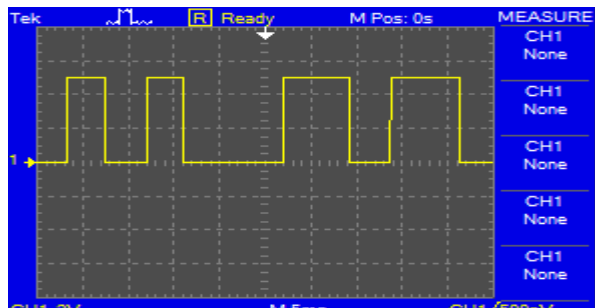**Figure-9.** Dash-dot-dash-dot input.

Figure-10. Dot-dot-dash-dash input.

Besides, on the receiver's end, user can use any Bluetooth-serial application software available for android, iPhone or laptop. In this project, a 'BT Term' apps designed for android device was used and the output was shown in Figure-11. The apps will keep on receiving words or sentences from the device as long as there was input given by the user through the Morse key.
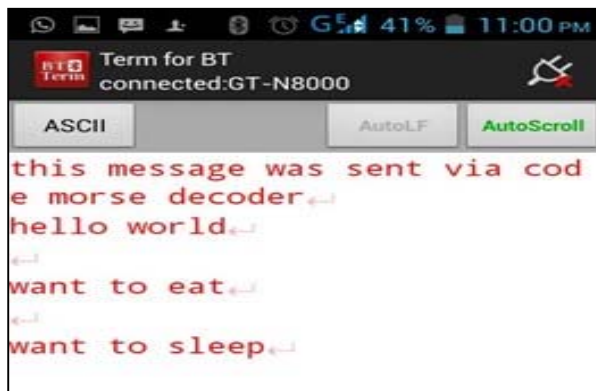

Figure-11. The output from BT term apps.

CONCLUSIONS

In this paper, a communication device for disabled patient has been successfully developed based on Morse codification. Countless possible improvements can be made especially on the detection of the dot and dash pulses. Practically, it is quite difficult to produce consistent pulse duration as it requires a lot of practice. For a longer transmission distance, a GSM or XBEE module can also be considered. In conclusion, it is hoped that this project could help to aid people with severe physical injuries to communicate to other people around him and express his intentions.

REFERENCES

[1] C. H. Yang, C. H. Luo, Y. L. Jeang and G. J. Jon. 2000. A novel approach to adaptive Morse code recognition for disabled persons. Mathematics and Computers in Simulation. 54(1-3): 23-32.

[2] Mukherjee K. and Chatterjee D. 2015. Augmentative and alternative communication device based on eye-blink detection and conversion to Morse-code to aid paralyzed individuals. In: IEEE International Conference on Communication, Information and Computing Technology. pp. 1-5.

[3] Iida A., Campbell N., Iga S., Higuchi F. and Yasumura M. 2000. A speech synthesis system with emotion for assisting communication. In: ISCA Tutorial and Research Workshop on Speech and Emotion. pp. 1-6.

[4] King T. W. 1999. Modern Morse code in rehabilitation and education: New applications in assistive technology. Allyn and Bacon, Boston, USA.

[5] Kramer J. P., Lindener P. and George W. R. 1991. Communication system for deaf, deaf-blind, or non-vocal individuals using instrumented glove. United States Patent US 5,047,952.

[6] Penner H. C. 1990. Hand-held finger movement actuated communication devices and systems employing such devices. United States Patent US 4, 905, 001.

[7] C. H. Luo and C. H. Shih. 1996. Adaptive Morse-coded single-switch communication system for the disabled. International Journal of Bio-Medical Computing. 41(2): 99-106.

[8] Luna P. S., Osorio E., Cardiel E. and Hedz P. R. 2002. Communication aid for speech disabled people using Morse codification. In:2nd Joint IEEE Engineering in Medicine and Biology and 24th Annual Conference and the Annual Fall Meeting of the Biomedical

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Engineering Society EMBS/BMES Conference. pp. 2434-2435.

[9] T. W. PhLic. 2016. Web accessibility by Morse code modulated haptics for deaf-blind. International Journal of Child Health and Human Development. 9(3): 361-369.

[10] A. Nugaliyadde, K. N. Manatunga and K. H. D. Perera. 2014. Compression using Morse code and data patterns. PNCTM. 3: 18-21.

[11] Akkari N., Alfattni G., Alghamdi H., Alzahrani M. and Alkhammash M. 2014. Adaptive word processor based on Morse code. In: IEEE International Conference on Web and Open Access to Learning. pp. 1-6.

[12] F. D. M. Fauzi, T. Mulyana, Z. I. Rizman, M. T. Miskon, W. A. K. W. Chek and M. H. Jusoh. 2016. Supervisory fertigation system using interactive graphical supervisory control and data acquisition system. International Journal on Advanced Science, Engineering and Information Technology. 6(4): 489-494.

[13] M. T. Miskon, A. S. Ibrahim, Z. I. Rizman and N. Ismail. 2015. Steering control method based on TSL1401 linear sensor array. ARPN Journal of Engineering and Applied Sciences. 10(1): 351-356.

[14] M. T. Miskon, Z. I. Rizman, W. A. K. W. Chek and F. D. H. M. Fauzi. 2014. Fitness cycling device with graphical user interface based on IEEE 802.15.4 transceiver for real time monitoring. Journal of Applied Environmental and Biological Sciences. 4(12): 108-114.

[15] M. T. Miskon, Z. I. Rizman, F. D. H. M. Fauzi, A. S. Ibrahim, M. Y. M. Zain, N. 'U. Ahmad and N. H. R. Husin. 2013. Test bed implementation of IEEE 802.15.4 WSN for outdoor environment. World Applied Sciences Journal. 23(23): 109-114.

[16] F. D. H. M. Fauzi, Z. I. Rizman, M. T. Miskon, N. Mohamad and N. H. R. Husin. 2013. Analyzing and optimizing WiFi access point performance. Journal of Basic and Applied Scientific Research. 3(12): 289-298.

[17] Mohamad T. M., Ruhani A. R., Zairi I. R., Fadhli D. H. M. F., Ahmad S. I., Mohamad Y. M. Z. and Nur H. R. H. 2013. Effect study of telecommunication tower's RF signal on IEEE802.15.4 based WSN. In: International Conference on Computing, Mathematics and Statistics. pp. 1-7.