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Implementation of Electronic Braille Alphabet Connected with Android Smartphone Device

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ABSTRACT

This research purpose is to make electronic braille that connected to Android phone. Research and developmental approaches are used for the method. Data processing and controller utilizes Arduino nano microcontroller, Bluetooth module CH05 for Arduino communicate with android mobile application via wireless Bluetooth communication, and mini solenoid are used as the actuator. Android application is used as final interface with voice and touchscreen features. The results are viable and functional braille electronics which connected to android based application as designed. Electronic braille can form braille letter patterns with character change speed that up to 500mS.

Keywords: *Embedded Systems, Mobile Application, microcontroller; Braille Electronic; Voice Recognize.*

1. INTRODUCTION

According to Info Datin 2013, around 900.000 people live with visual impairment and blindness in Indonesia. While 0,3% or equal to 11.351 people are domiciled in Bali Province. (Pusat Data dan Informasi Kementerian Kesehatan RI, 2014). The most important issue concerning blindness is the ratio of special education teacher and the special needs students (referring to the visual impairment and blindness) is not adequate. Number of special needs students in all over Indonesia are about 1.389, yet there are only 54 special education teachers. Meanwhile in Bali Province alone, there are no special education teacher for 21 special needs junior high schooler in school year 2015/2016 [2].
Sari Rudiati's study showed that there are still a lot of visual impaired high schooler that can't read Braille (Sari Rudiati, 2010). The most common mistake in recognizing braille letters happened because of the difficulty in measuring the size of the braille dots, which jumbled up one word to another (Beny Abdurrahman, *2015*). There is an urgent need of technology utilization to produce innovative products in a form of learning aid that connects to smartphone for the visual impaired students to boost their motivation.

2. OVERVIEW

2.1 Fishbone Diagram

Research method uses research and developmental approaches to create a prototype, the Latin *Six Dot Cube Braille* (a learning aid as the object of research). As shown in the fishbone diagram.

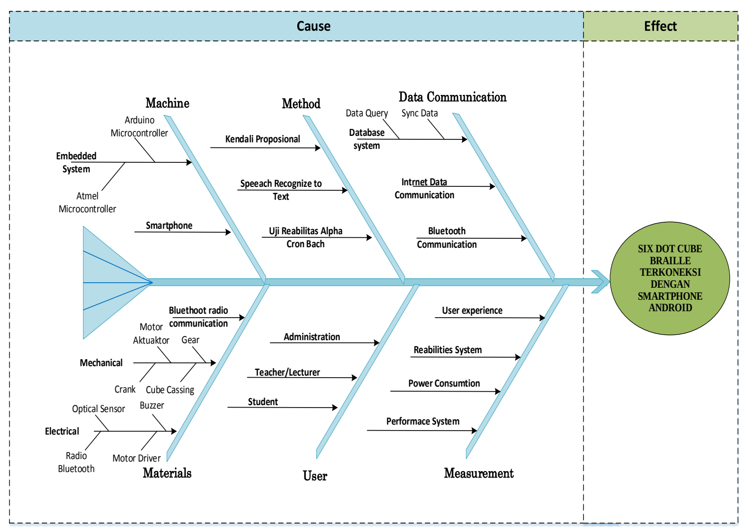


Fig. 1. Fishbone Diagram

The research purpose is to make electronic braille that connected to Android phone. Blind students can learn letters and words through the smartphone application interface. There are two approaches that can be used to learn braille letters and words through this application. The first one is voice-based recognition. Students just need to pronounce letters and words through the smartphone application. The results of the recognition of letters and words are converted into binary data and transmitted to braille electronics via Bluetooth media. Electronic braille translates the received binary data into braille letter pattern by moving the actuator on the device. This learning approach can be done independently. The second approach is to type letters on the touch screen on the smartphone application so that it requires other users to assist.

2.2 Electronic Braille Hardware Design

The device will be portable and wireless. Portable means the object is easy to carry around and wireless so that the communication can be done without cable.

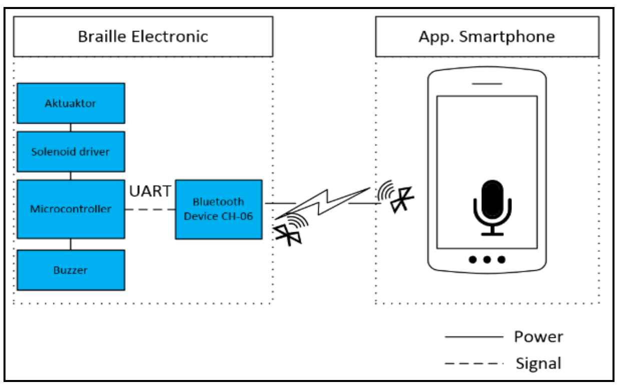


Fig. 2. Hardware block diagram of the equipment

Electronic braille hardware diagram block contains: microcontroller that function as controller and data processor, Bluetooth module HC-05 functions as wireless media transmission, actuator using mini solenoid that utilizes magnetic field induction to move the solenoid core. On/off signal from the combination of 6 solenoids is controlled to form character braille patterns. The solenoid driver is designed as simple as possible because the system only requires on/off condition to control the position.

2.3 Electronic Braille Software Design

Electronic Braille Software are built using the C programming language. IDE Arduino Sketch is used to develop the system.

Software design is pictured in figure 3. There are 4 main components of this software: (1) Initializing state, (2) main state, (3) listening state and (4) output state.

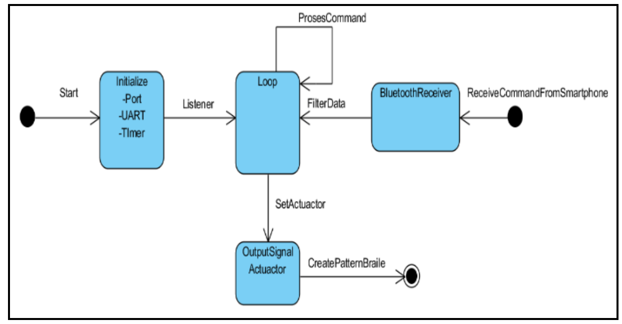


Fig. 3. Braille Electronic Software design

The system initializes and connects Bluetooth with the smartphone application automatically when the smartphone application is running. After a successful connection, the state switches to looping mode. In looping mode, the system is only in the listener state waiting for interrupt input from serial communication. When the byte stream data is received through the UART interface (Bluetooth communication), the system processes the input data received and moves the actuator to form the pattern of the received braille letters. Every time the braille letter execution process is finished the buzzer makes a beep sounding that the process is complete.

2.3 Smartphone Software Design

The Android phone software is developed by “Android Studio: Integrated Development Environment” supported by Java Runtime Environment (JRE) and Java Virtual Machine (JVM). The application design uses one activity to ease control and data transmission. Data transmission is done between activity and fragment (graphic user interface) which involves intent.
Voice recognize and text to speech utilizes API’S Google Text to Speech library which is run with threading at the background application. As shown is the activity diagram of the android based software.

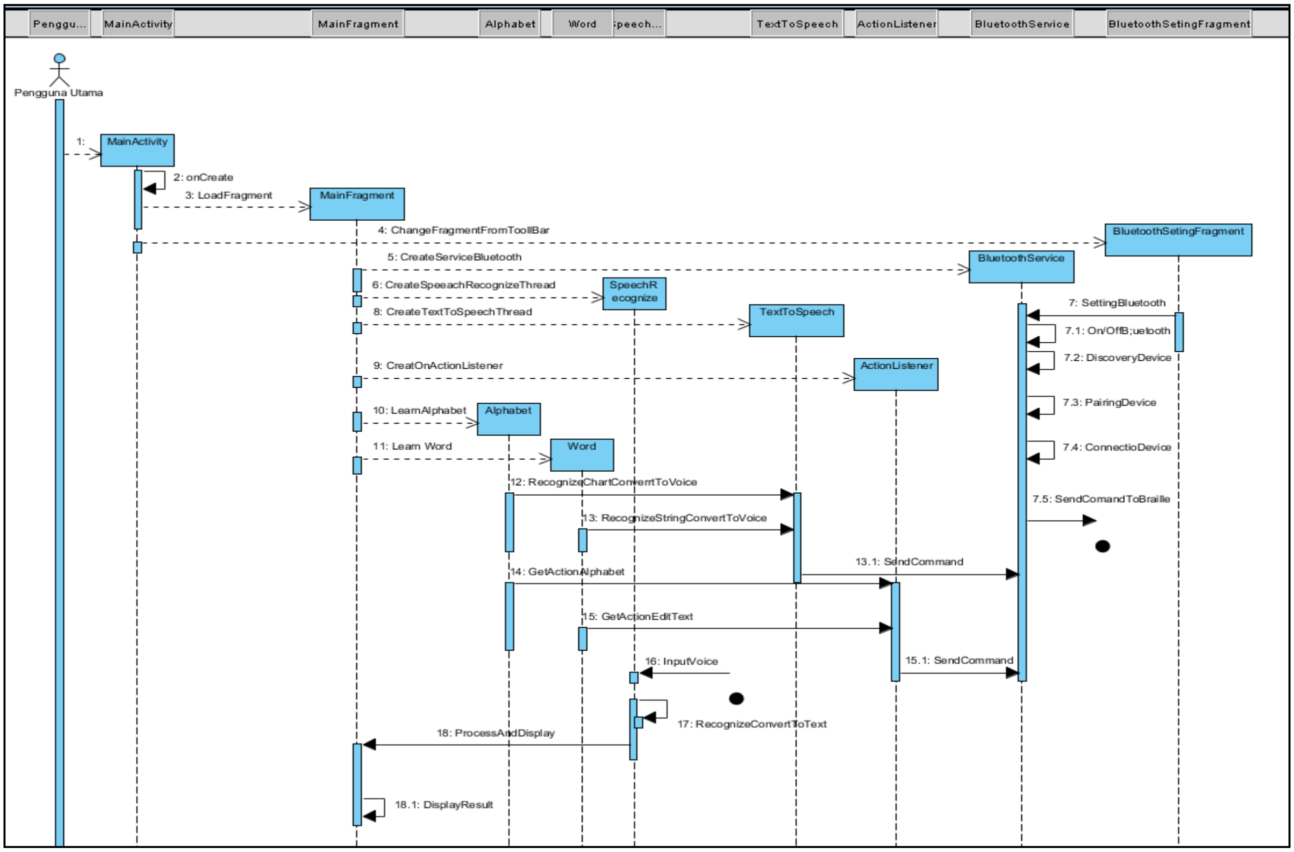
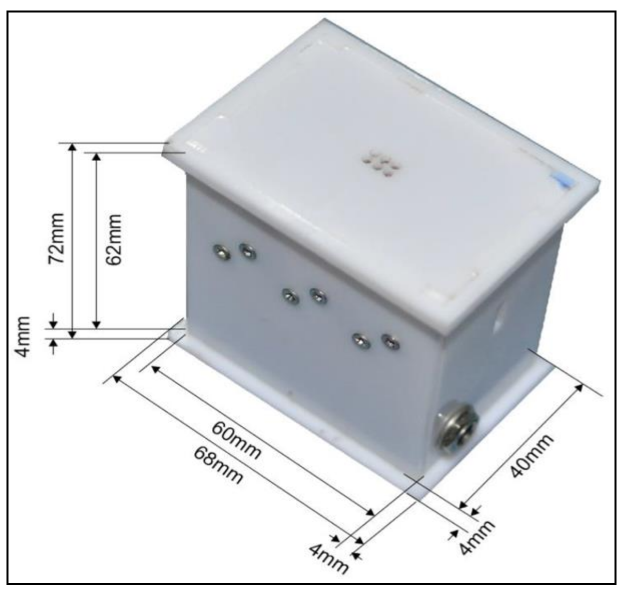


Fig. 4. Mobile Aplication Software Design

The smartphone application connects with electronic braille at the first time the application started. If the connection is successful, the application sends the characters to the braille electronics and braille electronics responds by moving the dot braille and making a beep when the command has finished. The connectivity phase has been completed and the application is ready to run. If the connection fails, the user can connect manually through the settings menu found on the application menu bar. Users can choose to use voice-based or character-based application via the buttons on the fragment menu.

3. RESULTS

Braille hardware is designed and built to be compact and easy to operate. Size of the braille pattern is standardized based on the standard braille. Distance between each dot is approximately 2.5mm with dot diameter around 1.5 mm. The size and spacing of braille electronics follows international standards (Standard dimensions for the UK Braille Cell). This size is usually applied to braille paper. Braille electronics in this application are electronic mechanical drive systems (not display or sign). Braille dots are made of metal material which is moved using solenoid electronics so that it is easier to touch.



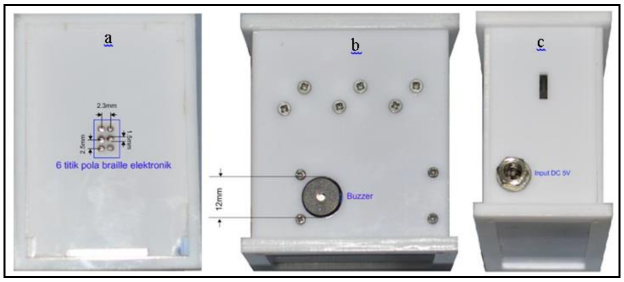


Fig. 5. Electronic Braille Form

The casing is made of acrylic material and is designed to be easy to carry and use. Electronic braille dimensions are made to be easily grasped by the users. Buzzer is added on the side to provide voice signals for users.

The user interface implementation is designed simple to make it easy for users. It is made simple to maximize functionality and connectivity. The display of user interface more emphasized on the companion users. The implementation of the smartphone software is shown at figure 6.

Fig. 6. User Interface mobile application

Alphabetic arrangement is made using grad View which is arranged with one dimension array. To maximize the display without burdening the application memory, word shape is made using Text Adapter. With this kind of programming techniques, we can achieve efficient memory allocation for display and dynamically configurable word font.

4. DISCUSSIONS

We do an experiment to 10 university students with 60 repeated examinations that gives results:

Table 1: Result test voice recognize Word use Google API'S (in Bahasa)

Voice Word	Word Recognize	Voice Word	Word Recognize
Saya	Saya	Budi	Budi
Buku	Buku	Mereka	Mereka
Data	Data	Punya	Punya
Kaca	Kaca	Toko	Toko
Mungkin	Mungkin	Boneka	Boneka
Kamu	Kamu	Atau	Atau
Lagi	Lagi	Belum	Belum
Apa	Apa	Tanda	Tanda
Sudah	Sudah	Seru	Seru
Makan	Makan	Titik	Titik
Kode	Kode	Orang	Orang
Produksi	Produksi	Dewasa	Dewasa
Kaki	Kaki	Dagang	Dagang
Tiga	Tiga	Sampai	Sampai
Minuman	Minuman	Badan	Badan
Coba	Coba	Jauh	Jauh
Tinggi	Tinggi	Koneksi	Koneksi
Bantu	Bantu	Huruf	Huruf
Lembar	Lembar	Jam	Jam
Deteksi	Deteksi	Riset	**Reset**

Table 2: Result test voice recognize character alphabet use Google API'S (in Bahasa)

Voice	Recognize	no. of correct	no. of false
A	A, Ah, Ai	16	4
B	B	60	0
C	C	60	0
D	D, Dek	56	4
E	E,Eh	38	32
F	F	60	0
G	G	60	0
H	H, Hah	42	3
I	I, Ih	59	1
J	J	60	0
K	K,Call, Kah	52	8
L	L	60	0
M	M	60	0
N	N	60	0
O	O, Oh, How	18	42
Q	Q	60	0
R	R,Air	58	2
S	S, Tes	54	6
T	T	60	0
U	U, Bu, Uh, Hu	52	8
V	V	60	0
W	W,Wey	59	1
X	X	60	0
Y	Y	60	0
Z	Z, Cat	58	2

Result of the trial shows higher error rate in vocal letter character compared to the word recognition. This is because Google API'S is designed for word based recognition not letters. To minimalize the errors in letters recognition, filter and letter mapping is done by Regular expression (Regex) into letter dictionary
A ← Ah, Ai ; D←Dek; E← Eh; H←Ah; K← Call, Kah; O ←Oh, How; R←Air; S←Tes; U← Bu, Uh, Hu; W←Wey; Z←Cat.
If the length of the string is more than 1, letter recognition error will probably happen and it needs to be mapped inside the letter dictionary to find the character match intended. Trials for word recognition show high correct rate. From all the words, there is one word that is difficult to recognize and that is 'Riset' which is recognized as 'Reset'.

5. CONCLUSIONS

From the trials, it can be concluded that the product is working as per the system design engineered. The electronic braille device can form letter and word pattern with input given by voice or touchscreen in android based application. Error in recognizing the letters can be minimized by applying filter and mapping string which is detected inside of the character. The electronic braille is capable of changing the character up to every 500mS.

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