SPECIAL CALCULATOR FOR THE BLIND WITH INPUT BRAILLE CODE BASED ON MICROCONTROLLER

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SPECIAL CALCULATOR FOR THE BLIND WITH INPUT BRAILLE CODE BASED ON MICROCONTROLLER

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Abstract

This paper describes about a calculator designed specifically for people with the Blind. Calculators are designed differently with calculators are generally used by people who can see normally. This special calculator uses a microcontroller as a data processor. This special calculator uses several pieces of push button which is compiled based on input braille code. The braille code data will be converted by the microcontroller into the numbers to be calculated. This special calculator using an MP3 Player Module for a sound as a medium to guide blind people to operate this special calculator. Operations that can be performed by a special calculator is operating addition, subtraction, multiplication, division, powers and roots. In addition, a special calculator can also look for the results of the division (DIV) and look for the rest of the division (MOD). The maximum number of digits that can be generated is as much as 8 digits. The number of values can be entered is limited to integers and the calculation results are limited two decimal places. Design and implementation as well as the results of testing on this special calculator indicates that this particular calculator has been functioning properly

Keywords: *Special Calculator, Microcontroller, Blind, Braille.*

1. Introduction

Limited ability to look for the blind is not an obstacle for the visually impaired to learn. Likewise in mathematics. However, the availability of the application of computer technology specifically for the blind are very limited. For example is an electronic calculator. Currently, calculators can only be used by people who can see normally so that blind people only rely on the ability to remember to do the calculations because they could not use calculators available today. However, the calculation with a great value would be very difficult for the blind to be able to count them quickly.

The above problems, encourage researchers to design a Special Calculator that can be operated by the blind. Special calculator is expected to help the blind in the calculation.

2. Literature Review

a. Braille

Braille is a system of writing that used touch by blind people. This system was originally designed by a Frenchman named Louis Braille that could not be seen since childhood. When the age of 15 years Louis Braille could transform the ordinary into the Latin writing touch paper (Anonim, 2014**). Figure 1**. shows the arrangement of dots that form characters in Braille code.

Figure 1 *Sequence dots Braille code*

This special calculator uses Braille code for the alphabet to determine the numbers because the alphabetical order a to i have in common with a sequence of numbers from 1 to 9, while the letter j has similarities with the number 0. However, distinguishing between letters and numbers is the additional symbol in writing numbers. **Figure 2.** shows the use of braille code for numbers.

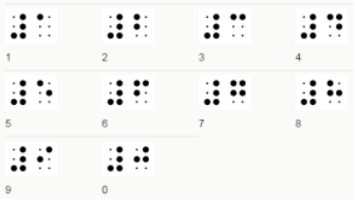


Figure 2 *The Braille code for numbers (Anonim, 2015)*

b. Structure of Tuts on a Braille typewriter

Arrangement of the keys on a Braille typewriter arranged from left to right, namely the composition of dots 3 2 1 4 5 6 as shown in **Figure 3.**

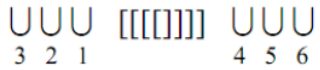


Figure 3 *Sequence button Braille Writer (Risjord,2009)*

Arrangement on a Braille typewriter keys became standard used in the design of a special calculator.

3. Design

The design of this Special Calculator consists of hardware design, software design and mechanical desing

a. Hardware desing

Hardware design is done to determine the components that will be used in a special calculator. **Figure 4.** shows the overall system design special calculator.

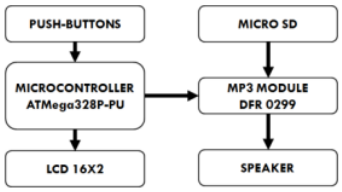


Figure 4 *Block diagram of the system*

The sections on the block diagram above are described below.

Push-buttons block contains a number of push-buttons. Push-buttons are arranged according to the layout of the keys on a braille typewriter. Push buttons are used to enter numbers and arithmetic operations. Data from the push-buttons will be read by the microcontroller.

Microcontroller block contains a microcontroller ATmega328P. This microcontroller is a microcontroller with RISC architecture which has 131 instruction execution. Most instructions can be diekseskusi in one clock cycle.[4] In designing this Special Calculator, ATMega328P microcontroller input functioned as a data processor. Data input will be converted into numbers and displayed on the LCD. In addition, the microcontroller serves to set the MP3 DFPlayer DFR0299. **Table 1.** shows the configuration of the pins on the microcontroller used in the design.

Table 1 *Pins Configuration on the microcontroller*

Pin Number	Pin	Using
2	PD0	RX (Modul MP3)
3	PD1	TX (Modul MP3)
4	PD2	Bit 7 LCD
5	PD3	Bit 6 LCD
6	PD4	Bit 5 LCD
11	PD5	Bit 4 LCD
13	PD7	2 E LCD
14	PB0	*Push Button* 7
15	PB1	*Push Button* 8
23	PC0	*Push Button* 1
24	PC1	*Push Button* 2
25	PC2	*Push Button* 3
26	PC3	*Push Button* 4
27	PC4	*Push Button* 5
28	PC5	*Push Button* 6

LCD 16x2 block contains 16x2 character LCD monitor. The LCD is used to display information about the input data and calculation results. **Figure 5** shows the LCD components used in the design.

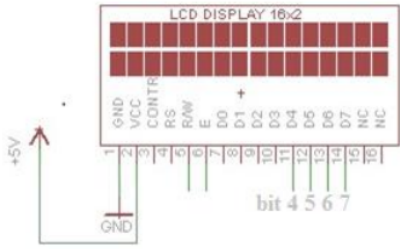


Figure 5 *LCD 16x2*

MP3 Module block contains Mini MP3 DFPlayer Mini DFR0299 modules. This module has the ability to decode WMV and MP3 sound documents.[5] This module will run a sound document based on the instructions of the microcontroller. **Figure 6** shows the MP3 module components used in the design.

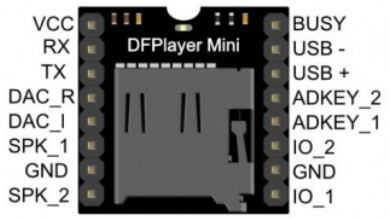


Figure 6 *MP3 DFR0299 Module*

Micro SD block containing pieces of SD Card. The SD Card contains a collection of sound recordings in MP3 format extension. The sound of a

document to be executed by the MP3 DFPlayer DFR0299 module to read numbers, value, calculation and results of calculation operations.

Speaker block contains Speaker. It serves to produce sound from MP3 DFPlayer DFR0299 module.

b. Software design

Software design is done to determine the program flow in the microcontroller. The provisions allowed in this Special calculator is as follows:

- Total number entered is only limited to 8 digits.
- The value to be processed is limited to two values.
- Operations that can be done is to increase operations, subtraction, multiplication, division, value quotient, the remaining quotient, rank, and roots.
- Results can be displayed is 8 digits including decimal digits after the decimal point.
- The number of digits after the decimal point is limited to two digits.
- The number entered can be voiced by the system.
- The value to be calculated can be voiced by the system.
- Calculation results can be voiced by the system.

The main flow chart on microcontroller as the main controller special calculator is shown in **Figure 7.**

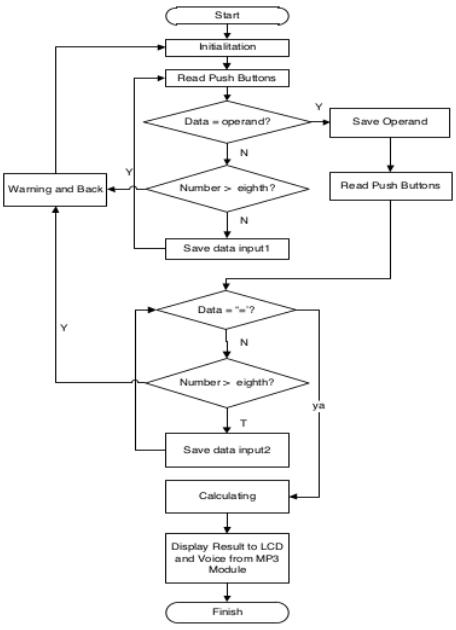


Figure 7 ***Flow diagram of the main program***

Description of the main flow chart described in the following section.

a. **Initialization** is the initial part of the program. In part this is done the port settings and variables to be used.
b. **Read push buttons** is process of reading the input of the push buttons. furthermore, the data is converted into a character by the microcontroller.
c. Furthermore, the first value has been entered will be stored in the variable input1.
d. If the entered data exceeds 8 digits, the system will give a warning and return to the beginning of the program.
e. The next, the system will ask for input operation to be used, the '+', '-', '*', '/', '%', ':', or '^'.
f. Furthermore, the second value that has been entered will be stored in the variable input2.
g. If the entered data exceeds 8 digits, the system will give a warning and return to the beginning of the program.
h. The next, the system will wait for input '=' to enter the calculation process.
i. The calculation results will be displayed on LCD and read by the system through DFPlayer Mini MP3 module.

4. Result and Discussion

Product that is the result of a special calculator research are shown in **Figure 8.**

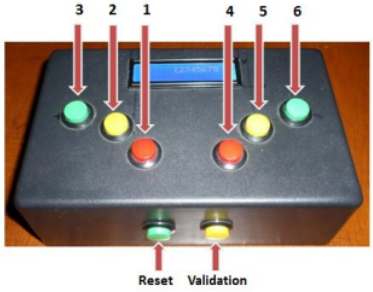


Figure 8 *Special Calkulator for the Blind*

This special calculator has a dimension of 18 x 11 x 6 cm. It has weight of 540g. It uses battery power supply so that the portable to carry around.

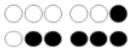
Testing

This special calculator testing is performed to determine whether the device or system is functioning correctly or not. This test consists of testing the input, testing the number of digits input, the test results of mathematical operations and output the sound from MP3 DFPlayer DFR0299 module that is controlled by the microcontroller.

Tests on Input

Test input is done to test the input character of the digits 0 to 9 and symbols for math operations, the '+' to the sum, '-' for subtraction, '*' for multiplication, '/' for the division, '%' for the remainder of the results for (MOD), ':' to the quotient of (DIV), '^' for the powers of, and '√' to the value of the root. Input test results are shown in **Table 2**.

Table 2 *Results of testing input*

Number	Push Button Input	Displayed on LCD	Voice
1		0	Ya
2		1	Ya
3		2	Ya
4		3	Ya
5		4	Ya
6		5	Ya
7		6	Ya
8		7	Ya
9		8	Ya
10		9	Ya
11		+	Ya
12		-	Ya
13		*	Ya
14		/	Ya
15		%	Ya
16		:	Ya
17		^	Ya
18		√	Ya
19		=	Ya

The test results in **Table 2** have shown that all the characters needed on this Special Calculator has been able to function properly.

Testing The number of digits entered

In this test done by inserting some numbers to the number varie[1] Results of testing the number of digits entered are shown in **Table 3.**

Table 3 *Test results The number of digits entered*

Number	Digits entered	digits allowed	Validation
1	12	12	√
2	431	431	√
3	467	467	√
4	4671	4671	√
5	4367	4367	√
6	42211	42211	√
7	124561	124561	√
8	143267	143267	√
9	411578	411578	√
10	356892	356892	√
11	57236178	57236178	√
12	78218263	78218263	√
13	424272849	42427284	×
14	1234567890	12345678	×
15	9678437861	96784378	×

The test results in **Table 3** have shown that special calculator is only permitted number of digits is allowed a maximum of 8 digits.

Tests on the Add Operations

In this test done a few added two values. The test results are shown in **Table 4.**

Table 4 *Results of testing add operations*

No.	ADD operations	Result	Valida-tion	Voice
1	1 + 1	2	√	√
2	12 + 2	14	√	√
3	29 + 56	85	√	√
4	34 + 45	79	√	√
5	56 + 66	122	√	√
6	100 + 34	134	√	√
7	125 + 456	581	√	√
8	678 + 345	1023	√	√
9	3794 + 2634	6428	√	√
10	23189 + 48729	71918	√	√
11	7283 + 38104	45387	√	√
12	391790 + 378830	770620	√	√
13	2103759 + 83950	2187709	√	√
14	12345678 + 12345678	24691356	√	√
15	35890527 + 67135649	NA	×	×

The test results in **Table 4** have shown that the special calculator was able to add two values correctly with the terms of the sum of no more than 8 digits.

Tests on the Subtraction

In this test do some subtraction of two values. The test results are shown in **Table 5.**

Table 5 *Results of testing subtraction operations*

No.	SUB Operations	Result	Valida-tion	Voice
1	1 – 1	0	√	√
2	2 – 15	-13	√	√
3	12 – 3	9	√	√
4	34 – 45	-11	√	√
5	173 – 567	-394	√	√
6	498 – 2	496	√	√
7	3794 – 2634	1160	√	√
8	4567 – 672	3895	√	√
9	35890 – 67149	-31259	√	√
10	739 – 281739	-281000	√	√
11	345 – 5	340	√	√
12	31673 – 356175	-324502	√	√
13	23154616 – 7830827	15323789	√	√
14	341 – 24617566	-24617225	√	√
15	6282940 – 6253	6276687	√	√

The test results in **Table 5** show that has a special calculator can perform subtraction operation correctly.

Testing on multiplication operation

In this test done several multiplication of two values. The test results in multiplication operations are shown in **Table 6.**

Table 6 *Results of testing multiplication operation*

No.	MUL operations	Result	Validation	Voice
1	12 * 4	48	√	√
2	5 * 67	335	√	√
3	34 * 45	1530	√	√
4	45 * 435	19575	√	√
5	654 * 12	7848	√	√
6	123 * 112	13776	√	√
7	3794 * 2634	9993396	√	√
8	5555 * 123	683265	√	√
9	7754 * 8957	69452578	√	√
10	87 * 65479	5696673	√	√
11	123456 * 5	617280	√	√
12	905 * 65486	59258495	√	√
13	987 * 648	639576	√	√
14	5647 * 1836	10367892	√	√
15	35890 * 67149	NA	×	×

The test results in **Table 6** have shown that the special calculator was able to multiply two values. Condition, the multiplication result is not more than 8 digits.

Testing division operation

In this test done some division of two values. The test results are shown in **Table 7.**

Table 7 *Results of testing division operation*

No.	Division operations	Result	Validation	Voice
1	1 / 2	0,5	√	√
2	34 / 9	3,77	√	√
3	3 / 98	0,03	√	√
4	34 / 45	0,75	√	√
5	120 / 65	1,84	√	√
6	22 / 543	0,04	√	√
7	1234 / 765	1,61	√	√
8	8173 / 764	10,69	√	√
9	765321 / 411	1862,09	√	√
10	2342416 / 98	23902,2	√	√
11	358 / 16149	0,02	√	√
12	7304618 / 876	8338,6	√	√
13	32298456 / 8736	3697,16	√	√
14	8652984 /976 8261	0,88	√	√
15	31965321 /9855 98	32,43	√	√

The test results in **Table 7**. have shown that special calculator can perform operations division properly. Decimal division results are restricted to two decimal places.

Testing find the reminder of division operation

In this test conducted searches through the remainder of the division. The test results for the remainder of the operation (MOD) are shown in **Table 8.**

Table 8 *The test results for the remainder of the operation (MOD)*

No.	MOD operations	Result	Validation	Voice
1	1 % 5	1	√	√
2	12 % 3	0	√	√
3	25 % 23	2	√	√
4	1 % 123	1	√	√
5	23 % 231	23	√	√
6	123 % 22	13	√	√
7	1500 % 15	0	√	√
8	1426 % 241	221	√	√
9	527 % 261	5	√	√
10	62418 % 368	226	√	√
11	63832 % 35184	28648	√	√
12	3691 % 371047	3691	√	√
13	3526798 % 21	16	√	√
14	2638194 % 3624937	2638194	√	√
15	64819374 % 34839	18834	√	√

The test results in **Table 8** have shown that special calculator can determine the remainder of of the division properly.

Operation Testing the value of the division (DIV)

This testing is done on a process of finding the value of the division. The test results are shown in **Table 9.**

Table 9 *Results of testing the value of the division (DIV)*

No.	DIV operations	Result	Validation	Voice
1	1 : 1	1	√	√
2	1 : 12	0	√	√
3	32 : 4	8	√	√
4	54 : 27	2	√	√
5	271 : 34	7	√	√
6	3719 : 352	10	√	√
7	2715 : 359	7	√	√
8	254 : 3514	0	√	√
9	8462 : 22	384	√	√
10	4628 : 472	9	√	√
11	72990 : 2892	25	√	√
12	27394 : 46820	0	√	√
13	762 : 38293	0	√	√
14	72937 : 4826	15	√	√
15	83729203 : 9758362	8	√	√

The test results in **Table 9**. have shown that a special calculator can determine the value of the division properly.

Testing power operations

In this test done several powers on a number of values. The test results are shown in **Table 10.**

Table 10 *Results of testing the powers operation*

No.	Power operations	Result	Validation	Voice
1	1 ^ 1	1	√	√
2	11^ 1	11	√	√
3	35 ^ 0	1	√	√
4	35 ^ 2	1225	√	√
5	12 ^ 3	1728	√	√
6	7 ^ 4	2401	√	√
7	26 ^ 4	456976	√	√
8	21 ^ 2	441	√	√
9	3625 ^ 2	13140635	√	√
10	214 ^ 4	NA	×	×
11	374 ^ 21	NA	×	×
12	12 ^ 12	NA	×	×
13	5 ^ 34	NA	×	×
14	20 ^ 10	NA	×	×
15	33 ^ 30	NA	×	×

The test results in **Table 10** have shown that a special calculator can determine the value of powers at a value. Condition, results of powers does not exceed 8 digits correctly.

Tests on Root Operation

In this test done calculating a root value at a value. Root operation test results are shown in **Table 11.**

Table 11 *Results of testing root operation.*

No.	Root operations	Result	Validation	Voice
1	√1	1	√	√
2	√4	2	√	√
3	√7	2,65	√	√
4	√13	3,6	√	√
5	√16	4	√	√
6	√19	4,36	√	√
7	√25	5	√	√
8	√36	6	√	√
9	√345	18,57	√	√
10	√1000	31,62	√	√
11	√4839	6956	√	√
12	√53790	231,92	√	√
13	√468943	684,79	√	√
14	√6782966	2604,41	√	√
15	√67218943	8198,71	√	√

The test results in **Table 11** have shown that a special calculator can determine the value of the root of a decimal value limit value by two digits after the decimal point.

5. Conclusion and Future

Design and test results on this particular calculator have shown that this particular calculator function properly. This is shown by the following capabilities:

a. Input of push buttons that form Braille code has can be converted into a numeric value.
b. The calculator can process mathematical operations properly. The requirement, the number of calculation result does not exceed 8 digits and decimal value calculation results is able to display up to two decimal places.
c. the data is entered, the calculation operation and the results of calculations can be voiced by MP3 DFR0299 module which is controlled by the microcontroller.

Continued research of this particular calculator is adding the ability to be able to count more than two values.

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