Nominal of Money and Colour Detector for the Blind People

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Abstract. Blind people often face a detection to identify the colour object. One of important of inability from the blind is to identify a nominal of money. It is very likely occurrence of undesirable things, such us as the possibility of exchanged money, or even act of fraud. It is necessary to design an equipment that allows for detecting a colour and a nominal of money. This tool is designed using TCS3200, RGB LED, LDR as the sensors, Arduino Nano as the controller and speaker. The sensors will detect the colour of the money, then sensors will transforms the colour into analog data and Arduino Nano will process this analog data into a digital data. Arduino Nano will convert the data into the form of audio as the output result. The speaker will release the audio according to the money or colour which detected, the audio output will be identified by the blind people.

1. Introduction

Blind people often face a detention to identify the colour of an object. One of important of inability from the blind is to identify a nominal of money. So far the blind identify a nominal of money by making a fold or arrange their money with help by the other people, but it has a weakness, that if blind forget with the fold or honesty from people who make a transaction with them giving a right nominal or not [1]. From this case, it is necessary to design an equipment that allows for detecting a colour and nominal of money to support the blind. This paper describes the design of nominal of money and colour detector using a sensor and microcontroller.

2. Methods

2.1. List of materials

Table 1 is List of Materials (LoM) required in this research.

Table 1. List of materials.

Materials	Specification	Quantity
Arduino	Arduino Nano	1
Colour Sensor	TCS3200	1
RBG LED	Common cathode	1
Resistor	LDR	1
TP4056	5 V, 1A	1
Amplifier	PAM8403	1

Table 1. Cont.

Materials	Specification	Quantity
Switch	2 pin	1
Baterry	Li-ion 18650 4,2 V, 1200 mAh rechargable	1
Mp3 module	DFPlayer mini	1
Acrylic	2mm, size A4	1
Micro SD Card	4 Gb	1

2.2. Block diagram

The block diagram of this tools is represented by figure 1.

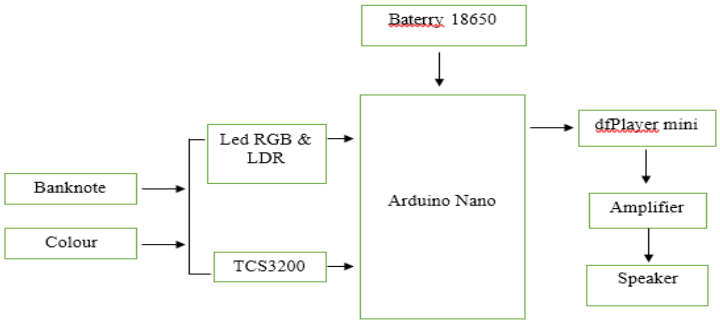

Figure 1. Block diagram.

2.3. Flowchart

The flowchart of this tools is represented by figure 2.

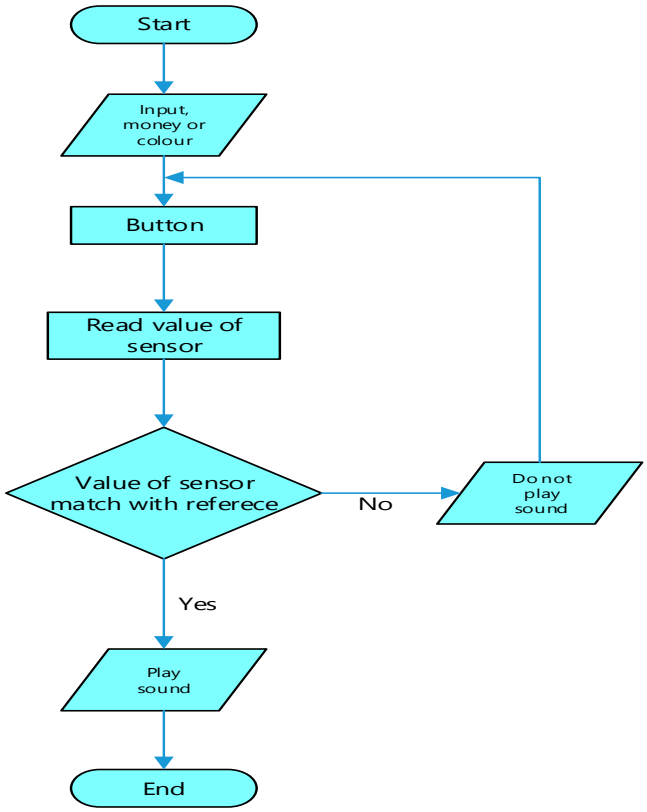

Figure 2. Flowchart.

2.4. Circuit diagram

Figure 3 show the circuit diagram of this tool.

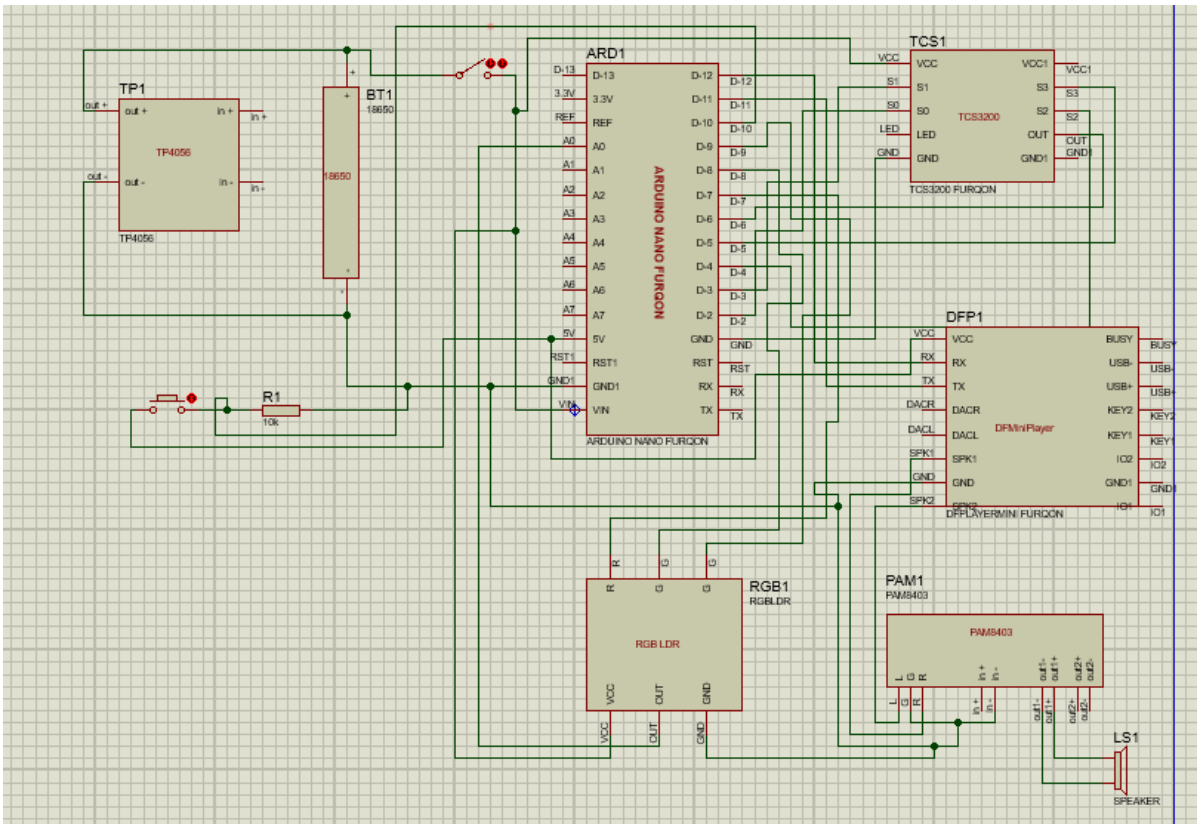

Figure 3. Circuit diagram.

2.5. Arduino nano

The controller of this tools is using Arduino Nano, the specification of Arduino Nano is represented by Table 2.

Table 2. Arduino nano specification.

Spesification	Component
Microcontroller	ATMega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB
SRAM	2 KB
Clock Speed	16 Mhz
Analog I/O	6
Digital I/O	14
DC Current Per I/O	40 mA
Input Voltage	7-12
Weight	7 g

Arduino Nano could be easily programmed by using Arduino IDE with another electronic device such as a computer by using USB port [2, 3].

2.6. Colour sensor

Colour sensor is component that could identify the colour of the object to be electrical value. In this research use TCS3200. It has two main component, there are photodiode and frequency converter [4, 5]. Photodiode will release a current which value is proportional to the colour detected, this current will be converted into a signal which frequency is proportional to its current. TCS3200 has 4 filter mode, red filter, clear, green filter and blue filter [6]. TCS3200 identify the colour and give serial output in RGB value to the Arduino Nano [7]. To set filter mode is by use S2 pin dan S3 pin as the Table 3 [6]. Figure 4 is the pin of TCS3200.

Table 3. Filter mode TCS3200.

S2	S3	Photodiode
L	L	Red
L	H	Blue
H	L	Clear
H	H	Green

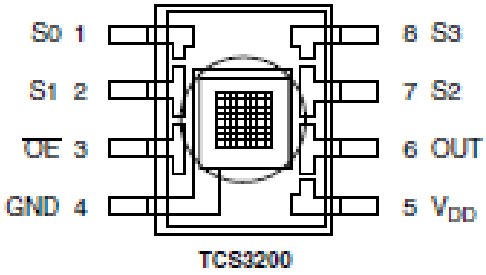

Figure 4. TCS3200.

2.7. RGB led and LDR (Light Dependent Resistor)

Both of this component could be used as RGB sensor to detect the colour of an object. At the first the RGB led will emit red, green and blue alternately to the object that will be detected. The reflected colour will affect the value of resistance of the LDR and expressed in the RGB output. Figure 5 is the Schematic of sensor RGB from LDR.

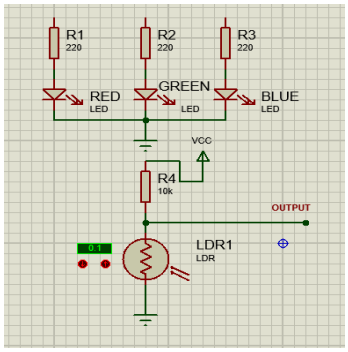

Figure 5. Schematic of RGB led and LDR.

2.8. TP4056

TP4056 is a module that used to recharge the battery. This module has 2 led indicator, which is red and blue. Red led indicates battery charging is still going, while blue led indicates the battery is full. When the battery is fully charged, the system will cut off, so the current does not flow to the battery. TP4056 work with USB and adapter [8].

2.9. DFPlayer mini

DFPlayer mini is a module that used for the music player. This module could work alone (standalone) or work with another microcontroller with serial communication RX/TX [9].

2.10. PAM8403

PAM8403 is an amplifier that can be used for a sound amplifier, the power of this amplifier is 3 watts with 5 volt DC source. The magnitude of this amplifier can be adjusted with potentiometer contained in this module [10].

2.11. Design

This equipment is using acrylic 16 cm x 5 cm x 7 cm for the case, all materials will be inserted in this case. The case looks like as the follows. Figure 6 is the design and component position of this tools.

Figure 6. Design and component position.

3. Results and discussion

3.1. Sensor recitations and data mapping

To read the sensor recitations is by using serial communication in Serial Monitor from Arduino IDE. Sensors recitation is done for 4 times to get ADC value for each position. The output from TCS3200 are R, G, B meanwhile the output of LDR are RL, GL, and BL. There are 4 positions of money, it has 4 possibilities positions. This tool is tested with Rupiah 2016 emissions. The left table is the ADC of the money or colour, and the right table is the mapping data of ADC. Mapping of ADC is by making an interval of data (See in Table 4 until Table 19).

Table 4. ADC of Rp.1000.

Position	R	G	B	RL	GL	BL
1st	58	59	51	23	31	64
2nd	63	68	56	18	23	64
3rd	56	63	60	18	26	53
4th	61	66	59	22	29	62

Table 5. Mapping ADC of Rp.1000.

1st Position	2nd Position	3rd Position	4th Position
56≤ R ≤60	61≤ R ≤65	54≤ R ≤59	59≤ R ≤63
57≤G ≤61	66≤ G ≤71	61≤ G ≤66	64≤ G ≤68
49≤ B ≤54	58≤ B ≤63	58≤ B ≤63	57≤ B ≤62
21≤RL≤26	16≤ RL ≤22	16≤RL ≤21	20≤ RL ≤26
31≤GL≤37	21≤ GL ≤27	24≤GL ≤30	27≤ GL ≤32
62≤BL≤68	48≤ BL ≤53	51≤ BL≤58	60≤ BL ≤67

Table 6. ADC of Rp.2000.

Position	R	G	B	RL	GL	BL
1st	63	70	61	20	27	61
2nd	60	65	57	20	26	51
3rd	58	64	57	25	31	58
4th	66	68	57	23	30	62

Table 7. Mapping ADC of Rp.2000.

1st Position	2nd Position	3rd Position	4th Position
61≤ R ≤66	58≤ R ≤62	56≤ R ≤60	64≤ R ≤68
68≤ G ≤72	63≤ G ≤68	62≤ G ≤667	66≤ G ≤71
59≤ B ≤64	55≤ B ≤60	55≤ B ≤59	55≤ B ≤60
18≤RL ≤25	18≤ RL ≤24	22≤ RL ≤27	22≤RL ≤27
25≤ GL≤31	24≤ GL ≤30	29≤ GL≤33	28≤GL ≤33
59≤BL ≤65	49≤ BL ≤56	56≤ BL ≤62	60≤BL ≤66

Table 8. ADC of Rp.5000.

Position	R	G	B	RL	GL	BL
1st	58	60	60	17	24	57
2nd	56	57	52	15	25	55
3rd	50	64	60	19	28	61
4th	59	70	62	21	31	61

Table 9. Mapping ADC of Rp.5000.

1st Position	2nd Position	3rd Position	4th Position
56≤ R ≤60	54≤ R ≤58	48≤ R ≤59	57≤ R ≤62
58≤ G ≤68	55≤ G ≤65	62≤ G ≤67	68≤ G ≤72
58≤ B ≤62	50≤ B ≤60	58≤ B ≤62	60≤ B ≤65
15≤ RL ≤21	13≤ RL ≤18	17≤ RL ≤22	19≤RL≤24
22≤GL ≤27	23≤ GL ≤28	26≤ GL ≤32	29≤RL≤34
55≤ BL ≤61	53≤ BL ≤60	59≤ BL ≤65	60≤BL≤66

Table 10. ADC of Rp.10.000.

Position	R	G	B	RL	GL	BL
1st	63	71	56	20	32	59
2nd	59	67	52	18	26	45
3rd	57	60	47	18	27	48
4th	62	69	54	24	31	53

Table 11. Mapping ADC of Rp.10.000.

1st Position	2nd Position	3rd Position	4th Position
61≤ R ≤66	57≤ R ≤62	55≤ R ≤60	60≤ R ≤65
69≤ G ≤73	65≤ G ≤70	58≤ G ≤63	67≤ G ≤72
54≤ B ≤59	50≤ B ≤55	45≤ B ≤49	52≤ B ≤54
18≤ RL ≤25	16≤ RL ≤21	16≤RL≤23	22≤RL ≤26
30≤ GL ≤35	24≤ GL ≤30	25≤GL≤30	29≤GL ≤34
57≤ BL ≤64	43≤ BL ≤49	46≤BL≤51	51≤BL ≤58

Table 12. ADC of Rp.20.000.

Position	R	G	B	RL	GL	BL
1st	60	59	51	18	22	47
2nd	52	52	48	20	23	48
3rd	52	61	59	18	22	48

Table 13. Mapping ADC of Rp.20.000.

1st Position	2nd Position	3rd Position	4th Position
58≤ R ≤63	50≤ R ≤54	50≤ R ≤60	63≤ R ≤67
57≤ G ≤62	50≤ G ≤56	59≤ G ≤63	62≤ G ≤66
49≤ B ≤53	46≤ B ≤50	57≤ B ≤60	54≤ B ≤58
16≤ RL ≤21	18≤ RL ≤22	16≤ RL ≤22	21≤RL≤28
20≤GL ≤25	21≤ GL ≤26	20≤ GL ≤26	27≤GL≤32
45≤ BL ≤51	46≤ BL ≤52	46≤ BL ≤52	65≤BL ≤72

Table 14. ADC of Rp.50.000.

Position	R	G	B	RL	GL	BL
1st	63	62	50	24	28	58
2nd	60	60	51	20	23	42
3rd	63	60	52	20	26	48
4th	71	68	52	26	30	60

Table 15. Mapping ADC of Rp.50.000.

1st Position	2nd Position	3rd Position	4th Position
61≤ R ≤65	58≤ R ≤63	61≤ R ≤65	69≤ R ≤74
60≤ G ≤64	58≤ G ≤63	58≤ G ≤66	66≤ G ≤71
40≤ B ≤53	49≤ B ≤53	50≤ B ≤55	50≤ B ≤56
22≤ RL ≤27	18≤ RL ≤23	18≤ RL ≤24	24≤RL≤29
26≤GL ≤32	21≤ GL ≤27	24≤ GL ≤30	28≤GL≤34
56≤ BL ≤61	40≤ BL ≤46	44≤ BL ≤50	58≤BL≤64

Table 16. ADC of Rp.100.000.

Position	R	G	B	RL	GL	BL
1st	56	68	56	18	28	53
2nd	51	64	52	15	25	46
3rd	57	67	55	15	27	48
4th	54	67	54	19	32	62

Table 17. Mapping ADC of Rp.100.000.

1st Position	2nd Position	3rd Position	4th Position
54≤ R ≤58	49≤ R ≤54	55≤ R ≤59	52≤ R ≤57
66≤ G ≤71	62≤ G ≤66	65≤ G ≤70	65≤ G ≤72
54≤ B≤58	50≤ B ≤56	53≤ B ≤58	52≤ B ≤56
16≤ RL ≤22	13≤ RL ≤17	13≤ RL ≤19	17≤RL≤22
26≤ GL≤31	23≤ GL ≤28	25≤ GL ≤30	30≤GL≤36
51≤ BL ≤57	44≤ BL ≤49	46≤ BL ≤52	60≤BL≤67

Table 18. ADC of colour.

Colour	R	G	B
Red	45	90	70
Yellow	48	57	57
Green	71	53	62
Light green	50	47	47
Blue	90	73	50
Dark blue	100	93	64
Orange	33	79	6
Pink	32	78	54
Black	103	109	87
White	43	46	36

Table 19. Mapping ADC of colour.

Colour	RL	GL	BL
Red	43≤ RL≤47	89≤GL≤93	69≤ BL≤73
Yellow	46≤ RL≤50	55≤GL≤59	65≤ BL≤70
Green	69≤ RL≤75	50≤GL≤55	60≤ BL≤66
Light green	48≤ RL≤53	45≤GL≤49	45≤ BL≤50
Blue	88≤ RL≤93	71≤GL≤76	48≤ BL≤52
Dark blue	98≤ RL≤103	90≤GL≤100	60≤ BL≤68
Orange	30≤ RL≤40	77≤GL≤80	61≤ BL≤72
Pink	30≤ RL≤35	75≤GL≤84	52≤ BL≤58
Black	102≤ RL≤107	108≤GL≤113	85≤ BL≤93
White	40≤ RL≤50	43≤GL≤54	33≤ BL≤45

3.2. Trial

This tool is tested by using some different sample of rupiah 2016 emission and some colour, this trial is 4 times for each colour or money. Table 20 is the result of the sensing colour trial, and Table 21 show the result of trial sensing of nominal.

Table 20. Result of colour.

Colour	Result
Red	Red
	Red
	Red
	Red
Pink	Pink
	Pink
	Pink
	Pink
Green	Green
	Green
	Green
	Green
Light green	Light green
	Light green
	Light green
	Light green
Blue	Blue
	Blue
	Blue
	Blue

Table 20. Cont.

Colour	Result
Dark blue	Dark blue
	Dark blue
	Dark blue
	Dark blue
Orange	Orange
	Orange
	Orange
	Orange
White	White
	White
	White
	White
Yellow	Yellow
	Yellow
	Yellow
	Yellow
Black	Black
	Black
	Black

Table 21. Result of nominal detector.

Money	Result
Rp.1000	Undetected(error)
	Rp.1000
	Rp.1000
	Rp.1000
Rp.2000	Rp.1000 (Error)
	Rp.2000
	Rp.1000 (Error)
	Rp.2000
Rp.5000	Rp.5000
	Rp.5000
	Rp.5000
	Rp.5000
Rp.10.000	Rp.10.000
	Rp.10.000
	Rp.10.000
	Rp.10.000
Rp.20.000	Rp.20.000
	Rp.20.000
	Rp.20.000
	Rp.20.000
Rp.50.000	Rp.50.000
	Rp.50.000
	Rp.50.000
	Undetected(error)
Rp.100.000	Rp.100.000
	Rp.100.000
	Rp.100.000
	Rp.100.000

The result of the trial for the colour is always true for 4 time trial, but the tool has a some error to detecting a nominal of money, it is because the data ADC of money with different nominal is almost same. Sensing of nominal money depends on the physical condition of money.

$$error = \frac{total\ error}{total\ trial}\ x\ 100\%$$

$$error = \frac{4}{28}\ x\ 100\%$$

$$error = 14{,}3\%$$

4. Conclusions

Based on the test that has been done can be taken several conclusions:

- The design of colour and nominal of money detector works well but has some error.
- This tool has an error if the nominal value of money included in the box is the 2004 emission money, this is because the ADC value of the nominal of money 2004 has the same ADC value at different nominal on emissions 2016 banknotes.
- Sensing of money depends on the physical condition of the money to be detected.

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