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Color Blindness Test By Ishihara Method Based on Microcontroller System

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Abstract

Ishihara is the most commonly used conventional test for color blindness testing. Ishihara test is a collection of stacked pictorial cards and colored spots, often used to diagnose red–green deficiency. The purpose of this research is to make Ishihara method of color blindness test based on microcontroller system to get more accurate test results. This color blindness test system works by using a microcontroller (Arduino board) as a processing device that processes input data from the user's LCD touchscreen (instead of manual images) and saves the test results into a database server. The results show that this color blindness test works very well because it can distinguish between normal vision and color blindness. This tool produces test information that is more accurate than conventional tests. This tool is also able to store test results in the database server and can be accessed by users via smartphones android and personal computers.

Keywords: Ishihara method, microcontroller, Arduino, color blindness test

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1. Introduction

Color blindness is a color vision deficiency that is the inability to see differences between certain colors that can generally be distinguished by normal people [1]. A person who experiences color blindness is called visual impairment (poor color), because he can still recognize color even though it is not perfect. The most known vision defect is congenital color blindness(congenital). Color vision defects can also be experienced due to early symptoms of eye damage [2]. Color blindness can occur due to hereditary factors or because it has abnormalities in the retina, optic nerves, and there may be disorders in the brain. The decreasing properties are obtained through the X chromosome. The cause of color blindness is not only because there is an abnormality on the X chromosome, but it has to do with 19 different chromosomes and other genes. Some types of diseases such as dystrophy cone cell and achromatopsia can also cause a person to experience color blindness [3, 4].

According to the color-blind awareness, as many as 1 in 12 men (8%) and 1 in 200 (0.5%) women in the world experience visual impairment in the form of color blindness. The Republic of Indonesia's Ministry of Health's 2007 Basic Health Research Report [5] states that the prevalence of color blindness in Indonesia is 7.4%, with the highest prevalence in DKI Jakarta Province (24.3%) followed successively by Riau Islands Province (21.5%), West Sumatra (19.0%), Gorontalo (15.9%), West Papua (13.9%), West Nusa Tenggara (13.2%), East Nusa Tenggara (11.2%), Nanggroe Aceh Darussalam (12.8%), Central Sulawesi (10.4%), the lowest prevalence is in North Sumatra (1.54%), North Sulawesi (1.9%) and East Kalimantan Province (2%).

Research conducted by Emerson (2010) [6] related to color blindness in high school states that the average color-blind sufferer is a male student who is shown by the percentage of 5.17% or 65 students from 1258 students studied.

Color blindness can be partial (affecting multiple color vision) or complete. Complete color blindness is very rare [7]. Color vision that is abnormal (abnormal) actually does not affect human life much because it is not accompanied by visual acuity abnormalities [8]. Color vision abnormalities will affect when a person enters a college with a particular department/study program (engineering, medicine, graphic design, etc.) or when applying for a job (architect, army, chemist, etc.) where color blindness is one of the requirements. Therefore, the initial identification of color blindness/color blindness test needs to be done to guide the child in determining the level of education and type of work. The Ishihara method test is a conventional color blindness test developed by Dr. Shinobu Ishihara was first published in 1917 in Japan [9]. The Ishihara color blind test consists of sheets with dots of various colors and sizes arranged in a circle. This test is completed by an answer key for each problem. The test results will be compared with the answer key so that a person's normal vision status or color blindness can be determined.

This study aims to make the Ishihara method of color blindness test based on a microcontroller system. This color blindness test system works by using a microcontroller (Arduino) as a processing device that processes input data from the user's touch screen (instead of a manual image) and saves the test results into a database server. Hopefully this tool will produce more accurate test information than conventional test equipment. This tool is also able to store test results in the database server and can be accessed by users via smartphones android and personal computers.

2. Methods and Equipment

2.1. Methods

The research method used in this study uses technical engineering methods, namely by designing Ishihara method of color blindness test, implementing the design of the tool by combining hardware and software, testing the tools that have been made and retrieving the data and make a conclusion. The tool block diagram is shown in Figure 1.
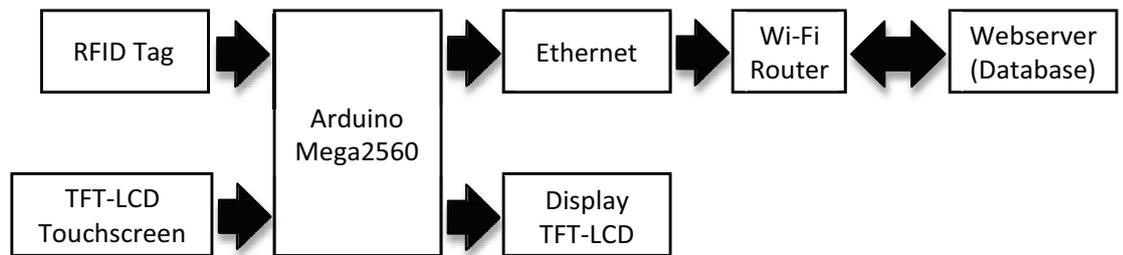

Figure 1: Block diagram of color blind test tool based on microcontroller system.

In this study, color blindness test method is based on microcontroller using Arduino ATMega 2560 controller. Input and output devices used are RFID and TFT-LCD touch-screen with control resistive touch. RFID is used as input which serves as a card reader as an initial identification while the TFT-LCD touchscreen serves to facilitate users in using color blindness test kits.

This color blindness test tool uses a TPLINK MR3020 type router that supports GSM/CDMA/4G LTE networks on USB Modem ports with 1 LAN Port and AP/3G/4G/ WISP feature options with data transfer speeds of up to 150Mbps. Researchers used the Arduino Ethernet shield as a component of the tool used as an interface between the device and the web server. Programming this tool includes Arduino input and output programs using the Arduino IDE software version 1.8.4. As for making the display on the TFT-LCD display, the Nextion Editor application software is used.

This tool works when the user provides input through RFID tags, the system will read the suitability of the input data with the database. If the input data is in accordance with the database, then on the LCD screen the tool will display the main page (main page) which contains 2 (two) menu choices, namely (1) tool usage guide and (2) start a color blindness test consisting of 17 questions on plate Ichihara. If the user chooses the 2nd menu, the questions and answer choices will appear, where the correct/incorrect answers will be accumulated by the system. If the user answers all the questions correctly then the result will show that the vision is normal while if there is an incorrect answer (wrong) then it shows trichromation or chromation results depending on how many incorrect answers. Provisions for incorrect answers are as follows: (1) if the answer is incorrect there is in question number 1 to question number 15 then the result is

trichromation, namely the situation where there is one color cone in the eye in a weak condition; (2) if the answer is not correct at number 16 and number 17 then the result is chromized, namely the condition that he does not have one of the color cones on the eye; and (3) if all the answers are wrong on all questions, the user has a total color blindness.

2.2. The equipment

Design of a microcontroller-based color-blind test equipment was built by several hardware and software applications in the form of an application program. The tools and materials used in this study are

1. The laptop systems used in this study as follows:

    (a) Memory: 1024MB RAM.

    (b) System model: HP Mini 210-1000.

    (c) Processor: Intel Atom CPU N450 @ 1.66GHz (2 CPUs), 1.7 GHz.

2. Microsoft Windows 7 ultimate 32bit operating system

3. The software used:

    (a) Arduino IDE 1.8.4, which is used to program the board mega Arduino.

    (b) Nextion editor, used to design the LCD interface

    (c) Web browser, is used to access the web.

    (d) Blender, used to make tool design.

    (e) Microsoft word 2010, to complete writing.

    (f) Xampp, used as a server temporary before the web is uploaded to public IP (internet protocol).

    (g) Web Browser, to access the web

    (h) Notepad ++, is used as a text editor for programs web (PHP, HTML, CSS, SQL).

    (i) Fritzing 0.9.3. used to create layout and schematic circuits.

4. The measuring instrument used is a digital multimeter.

3. Results

This tool works when receiving input data originating from an RFID Tag (patient card) containing the patient's identity data that has been previously registered. If the data received is appropriate or registered in the tool database system, it will automatically go directly to the main page that contains the option to start the test or help page. To start the test on this tool, the user must press the start test button on the start page which will display the question / question of the Ishihara method of color blindness which is 17 items. Each question has a choice of answers that can be selected by the user, each answer will be stored and calculated by the microcontroller system. Figure 2 is the realization of the form of the Ichihara method of color blindness based on the microcontroller system.
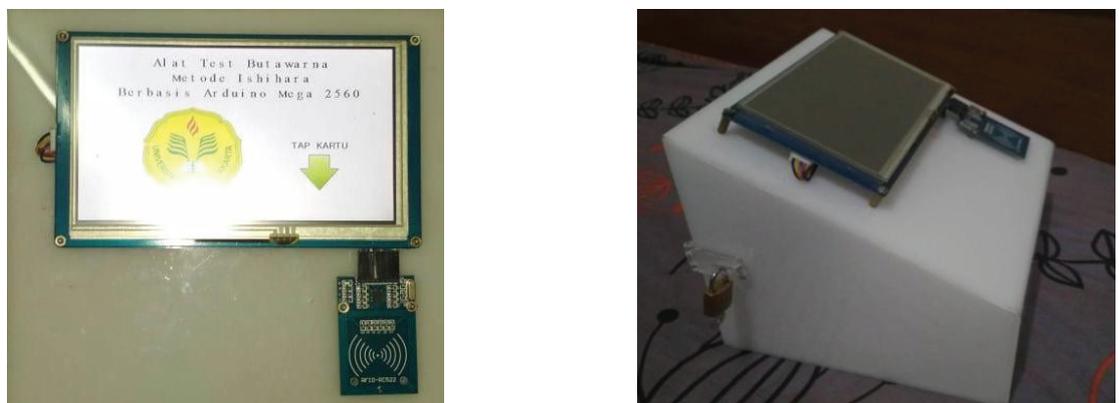

Figure 2: Ishihara method of color blind test based on microcontroller system.

The first test aims to ensure that the application program made on the tool works well. Testing is done by testing the menu buttons and seeing how they appear on the LCD screen. Table 1 is the result of testing the tool program that is viewed from the display on the LCD screen when the user does a color blindness test.

The second test is carried out by testing the use of tools to 10 (ten) users who have different RFID tags. The end result of a color blindness test using this tool is then compared with the results of conventional color blindness tests (using a book). The test results of the color blindness test are shown in Table 2.

In Table 2 shows that the test results using a color blindness test compared to the test results using color-blind test books (conventional), shows results that are not different between the two. From the series of tests, it can be seen that this tool can work well in identifying a person's color blindness.

TABLE 1: Test results of tool program.

input(button)	Test criteria (action after being pressed)	Display
Help	Help page	
Start Test	1	
Each answer choice in problem no. 1	Problem no. 2	
Each answer choice on problem no. 17	Acknowledgments and returning to the home page	
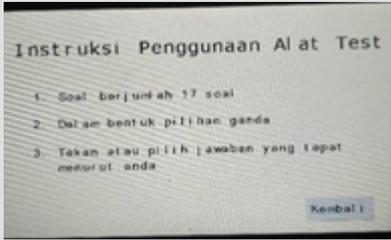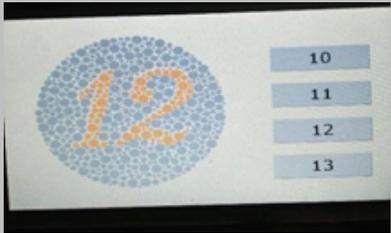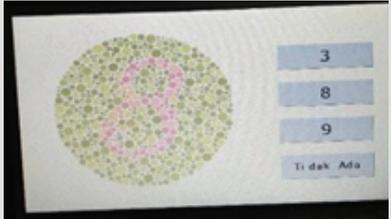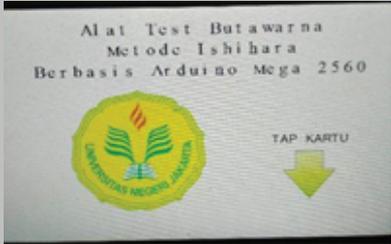
4. Discussion

In general, color blindness test equipment that is made can work well based on testing on hardware devices through electronic measurements, as well as testing application programs made for tools. Electronic testing to determine the RFID tag reading distance range on the RFID reader obtained the reading distance of a minimum of 10mm and a maximum of 20 mm. This shows that when a user (patient) uses a patient card in the

TABLE 2: Test results using a color blindness test.

No.	No. id	Test results using a color blindness test	Test results using a color blindness test book	Results
1	E34d262	Not color-blind	Not color-blind	Suitable
2	537f232	Not color-blind	Not color-blind	Suitable
3	409eFbb	Not color-blind	Not color-blind	Suitable
4	108696d	Not color-blind	Not color-blind	Suitable
5	E0c184c	Not color-blind	Not color-blind	Suitable
6	337b242	Not color-blind	Not color-blind	Suitable
7	60b77dc	Color-blind	Color-blind	Suitable
8	23b9272	Not color-blind	Not color-blind	Suitable
9	C04edbb	Not color-blind	Not color-blind	Suitable
10	4081f9b	Color-blind	Color-blind	Suitable

form of an RFID tag, the user does not need to physically attach the card directly to the color blindness test kit.

In testing the application program that was made for this tool, the results were quite good. The test results are obtained in the form of actions that occur after touching each button contained in the display of questions such as the example number 9 when one of the answer buttons is pressed, the next question page will appear, which is number 10, and so on.

The complete tool testing is done by testing several users who have variations in color blindness. The test results show that the results obtained through this tool are exactly the same as the results obtained through conventional tests using the Ichihara color blindness test book. The test results using this color blindness test kit will be stored in the system database and can then be used to view the history of tests that have been carried out by users/patients. In addition, the results of this test can be printed so that the user gets a record of the test results in the form of print outs.

The results of this study in the form of products or tools that can be applied to the usual agency agencies to receive employees or members and require color blindness testing as one of the selection series in addition to the center of public health such as clinics, laboratories, health centers and hospitals in using technological advancements can make it easier for medics to carry out color blindness tests.

5. Conclusion

Conclusion of this research is the color blindness method based on the microcontroller system is as follows:

1. Through a series of tests, both electronic testing and testing the use of application programs, obtained results that the color blindness test system based on microcontroller can work well in accordance with the design/design tool.

2. The results of the tests carried out by comparing the color blindness test method of the Ichihara method based on the microcontroller system (Arduino Mega2560) with a conventional test tool showed that the Arduino-based Ichihara method of color blindness testing works very well. This tool can distinguish normal vision and color blindness and type because it does not have the difference in the acquisition of test scores with conventional test equipment. This tool is also able to save the results of the tests that have been carried out.

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