

# Control System Through Android Applications On Robot Vision Of Detection Of Color Using Microcontroller

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**Abstract**— The object of the research was to discuss how to design the control system through android application on robot vision of detection of color using microcontroller. The system was in the using two software between Eclipse IDE, and Arduino IDE. The control design modelling on the robot vision consisted of smartphone camera, arduino, driver motor and dc motor. The result of the simulation is done by placing a smartphone camera as a sense of vision robot by using a serial cable to arduino. On this robot, smartphone cameras capture the images in real-time and detect colors that match the criteria, then sent via a serial cable to the arduino, in arduino receiving instructions from a smartphone in orders to perform the command flag that will be done, and forwarded to the driver motor, so that the motor moves in accordance with command instruction from arduino.

**Keywords**— Control system, Android, Smartphone, Mikrokontroller, Arduino

## I. INTRODUCTION (HEADING 1)

Industrial technology and robotic technology is currently growing rapidly, thus encouraging people to continue innovating and researching various things related to science and technology. To meet increasing human needs and facilitate human performance in various fields, such as industrial, medical, defensive, agricultural, systems in operation will greatly assist and facilitate human performance.

In modern industry, robots have taken over the position, the workers in the factories. For example in the electronic equipment industry, computer devices and the automotive industry, robots have become a major driver of the industry. The main reason is the use of robots with the robot in certain conditions may be ideal with workers, the robot has a high degree of accuracy and high efficiency, and the most important thing is the low operating costs with higher output produced.

Research related to the design of the previous robot that designing by implementing computer vision in a robot to detect the color orange on the ball pimpong and followed the ball if the ball was moved to the right hand or left fence, the

study was conducted by Reza Hilmansyah (2013). Further related research was done by Heri Sugianto (2013), the robot designed color detection by using TAOS TCS3200 to detect the color white. Further research related to carried out by NugraHadi (2013), the control system of the robot by using SMS instructions to control commands to the robot. In this study, also implements computer vision, device control, the tank drive, based on android microcontroller to detect the color of objects that will guide the robot to find the object that corresponds to the color control device that selected by the user, the reason for choosing the colors orange and green as taken of a blend of primary colors of red, yellow, and blue. Orange is a blend of red and yellow, to orange HSV its color range starts from (5, 70, 70, 0) - (10, 250, 250, 0), while the green color is a blend of red and blue, HSV color to green its range starts from (55, 50, 50, 0) - (75, 255, 255, 0).

### A. Purpose

The goal of this research is to implement a robot that can walk to look the object by color using the smartphone camera and device control.

### B. Benefit

Hopefully, by the control system through the application of research in robotic vision android color detection using this microcontroller, can provide the following benefits:

- 1) *The ability of a robot that can replace human work considered dangerous, thereby reducing the number of accidents.*
- 2) *Assist industries that require accuracy in completing the work.*
- 3) *Assist in the field of color field to determine the color that is used as command work instructions.*
- 4) *Add the other functions of the use of mobile phones and robots to facilitated an effective of human performance.*

II. LITERATURE REVIEW

A. Robot

Nowadays hardly anyone who does not know the robot, but the robot sense is not understood the same way by everyone. Most imagine robot is a machine clone human (humanoid), however is it not the only humanoid robot types.

Definition of webster refers to the understanding of many people that robots perform human tasks, whereas a more general understanding of oxford. From the definition above, there are keywords that can be explained the sense of robots such as:

- 1) Can obtain information on the environment (via sensor).
- 2) Work automatically.
- 3) Be Smart (intelligent).
- 4) Used in industry.

B. Humanoid Robot

Humanoid robot is a robot that looks a whole formed by the human body, able to interact with the equipment and the environment made for humans. In general humanoid robot having a body with a head, two arms and two legs, although there are also some forms of humanoid robots which only a portion of the human body, for example, from the waist up. Some of a humanoid robot can also has a face, complete with eyes and mouth. Icon android is a humanoid robot built to aesthetically resemble humans.



Fig. 1. Humanoid Robot.

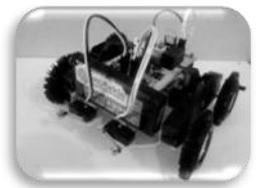


Fig. 2. Wheeled Robot

C. Wheeled Robot

Wheeled robot is a robot that moves on land that uses wheels and use the motor as the driving force. This design is more simple than using the robot foot. Wheeled robot is also better controlled with better than other types of robots (hexapod robot and humanoid robot. Shortage of wheeled robots is difficult to navigate if confronted with obstacles or barriers, such as rocky terrain, sharp derivation, or areas with low friction. Wheeled robot is the most popular among consumers, because it uses a varying number of wheels, but four wheels enough to get the static and dynamic balance. The wheels of the robot can be added according to the needs and purposes.

D. Hexapod Robot

Hexapod robot is a robot that moves by using 6 pieces of legs. Because the robot can be statistically stable with 3 feet or more, then the hexapod robot has a high flexibility. If there is a foot that does not work, then there is a possibility that robots could still walk. Moreover, not all robots are needed for the stability of the foot, the other foot can move freely to seek a new footing.

E. Computer Vision

Computer vision is the science and technology of machines that see, which means that the machine is able to extract information from images required to complete a specific task. Image data can take many forms, such as a video sequence, views from multiple cameras, or multi-dimensional data. In computer vision to apply theories and models for computer vision system development. Examples of computer vision applications include systems for:

- 1) Control of the process,
- 2) Detect events,
- 3) Modeling objects or environments,
- 4) Get Interaction

F. Color

Color is one element in an interior design of a room, the color also as an important role supporting the creation of a comfortable atmosphere and can affect the psyche of the occupants. The Selection of wrong color when used colors that were not in harmony between the elements of the room to the other, can cause the room to be uncomfortable. To change the atmosphere of a room, the easiest way is to change the color. Colors can cause effects space visually. Moreover, it also can make a small space seem bigger or vice versa. In the use of color is not absolute rule. It all depends on the creativity of our own, so the creation of the colors can create such as comfortable and attractive one. In other words, determine the color a little more human character. So from the above description helps us review a few things about the colors in order to find out more about color, color theory and its influence in the planning of the interior of a room.

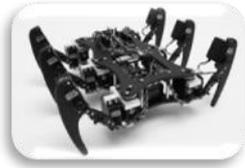


Fig. 3. Hexapod Robot

G. Android

Android is a Linux-based operating system for mobile phones such as smart phones and tablet computers. Android provides an open platform for developers to create their own applications that use by a variety of mobile devices.

Initially, Google Inc. bought Android Inc., newcomers who make software for mobile phones. Then for developing android, in the form of an Open handset Alliance, korsiun of 34 companies hardware, software, and telecommunications, including Google, HTC, Intel, Motorola, Qualcomm, T-Mobile and Nvidia.

H. Arduino

Arduino is a product name of microcontroller minimum system design that opened freely. The advantages of arduino is having its own programming language, in a arduino board, there AVR microcontroller IC component types ATmega, USB to serial conversion components, voltage regulator and the bootloader program is embedded in the microcontroller IC. Here is part of the board arduino:

- 1) USB socket
- 2) Input and Output Digital
- 3) Analog Inputs
- 4) Power Supply
- 5) Battery / Adapter

III. RESEARCH METHOD

A. Planning Research Project

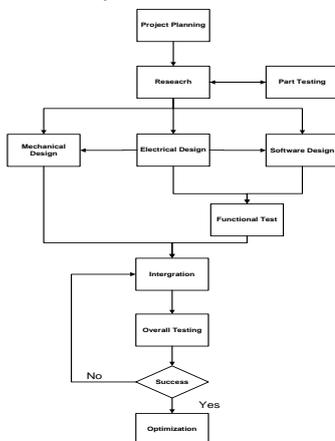


Fig. 4. Project Planning

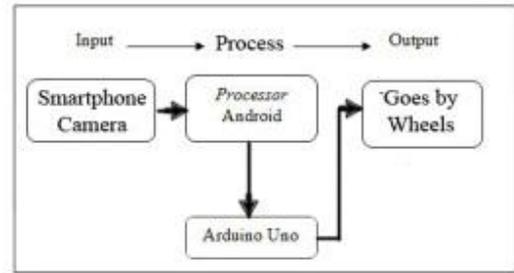


Fig. 5. Overview

In planning to the research project, there are some important things that must be determined and considered, among others:

- 1) Determination of research topics.
- 2) Estimate the need for tools and materials.
- 3) The estimated budget.
- 4) Possible implementation of applications designed..

B. Research

Once the planning system has been prepared, followed by initial studies of the application to be made. In the initial design phase of the study conducted a series of mechanical and wheeled robot components to ensure that all these components can run optimally.

C. Component Testing

At this stage of testing determined the components that will be used for function properly, or vice versa. Component testing is done using a multimeter.

1) Testing using the program:

Testing on android smartphone made by running and debug applications in real-time by connecting a USB serial cable from the laptop to smartphone android using the Eclipse IDE debugger.

Testing on the module arduinouno done by using the debugging tool Serial Monitor is provided by arduino IDE.

2) Testing using a multimeter:

- a) Module Arduino Uno.
- b) L298N Motor Driver module.
- c) Power supply

D. Mechanical System Design

In the hardware design, mechanical design is an important thing to be considered. In general, the need for mechanical design applications, among others:

- 1) The shape and size of the PCB (Printed Circuit Board).
- 2) Resilience and flexibility towards the environment.
- 3) Placement of electronic modules.
- 4) Engetesan mechanical system that has been designed.
- 5) Shape robot chassis design size.

E. Mechanical System Design

Designing hardware is generally illustrated in the block diagram as shown in the following figure:

F. Software Design

Hardware in general requires software design, among others, software for instrument control system (application), which includes the design of systems running and in use, which consists of a main program robot coding (coding android, DC motors, arduino), this process is also described flowchart of design software, as well as the design software interface on the PC to produce an ideal form of hardware robots created.

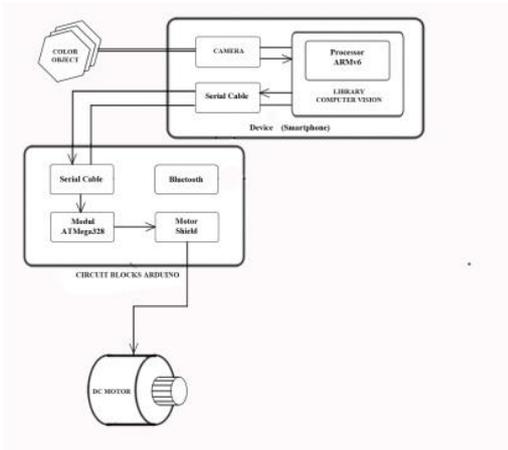


Fig. 6. Overview Block System

Fig. 7. Flowchat Main Program

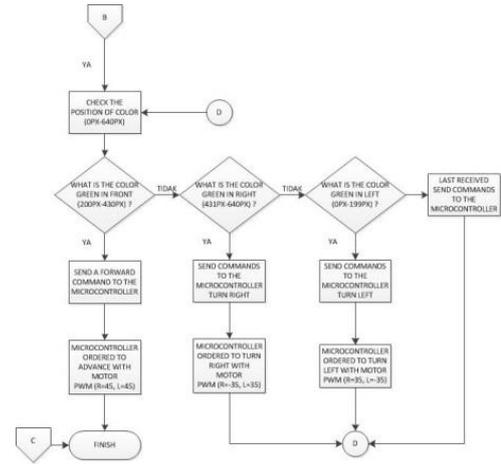


Fig. 8. Flowchat Main Program (Continued)

G. Functional Test

Functional tests carried out on the integration of electrical systems, mechanical and software that has been designed. To improve the performance of the software to control the hardware performance, and also eliminate error (Bug) of the software used.

H. Integration or Assembly

The process of merging the electrical module and supporting components in the controller, as well as Android smartphones that are integrated into the mechanical structure that has been designed. Then the whole system functional testing.

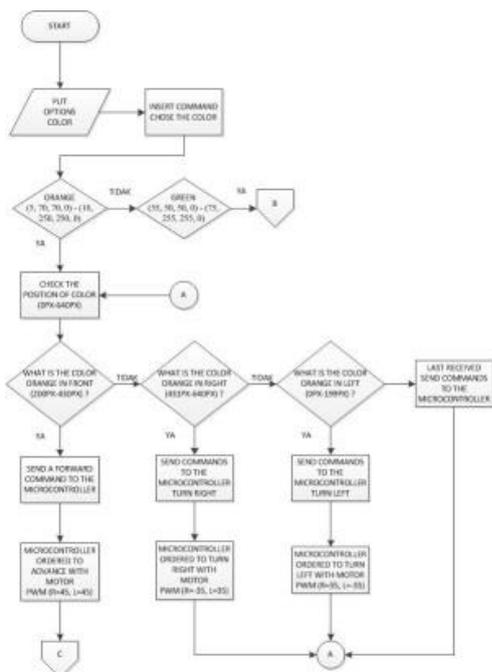
I. Collecting Material

At this stage, the collection of tools and materials to be used for the manufacture of micro modules in the form of hardware that includes android smartphones, motor drivers, modules Arduino Uno, DC motors, and power supply. Do also collecting supporting software.

On the collection of basic components include:

- 1) Smartphone android,
- 2) Module Arduino Uno R3,
- 3) Motor DC,
- 4) Driver Motor L298N,
- 5) Frame,
- 6) Wheel and belt,
- 7) Power suply / battery.

At this stage the software collection gathering supporting software that will be used to implement a control system with Computer Vision on android smartphone and drive system drives the robot tank. Software is the Eclipse IDE as a compiler listing program in java programming language for



Android and Arduino IDE bases as compilers and program listings uploader C++ language for Arduino Uno module.

J. Manufacture Component

Phase manufacture (assembling) is where all objects are created, both in hardware and in software which is the compiler.

In the manufacture of the Eclipse IDE software as Android serves as a compiler compiler listing android applications using the Eclipse IDE and also to upload programs to your android smartphone.

Arduino IDE as Arduino Uno serves as a compiler compiler source code listing on arduino uno using the Arduino IDE, as well as to upload the program to the module arduino uno as well as debug on arduino.

IV. RESULT AND STUDY

A. Discussion Selection Componen

1) Selection Smartphone.

In the manufacture of Control System Through Android Apps On Robot Vision Color Detection Using Microcontroller, smartphone use is Asus Zenfone 5, because this smartphone is immersed android version 4.4.2 (Kit-Kat) so that the minimum API in the use of Bluetooth API, has been fulfilled. And also this smartphone has a resolution of 8 megapixel camera, so the image quality will be better, and have a capacity of 2 gigabytes of RAM for faster processing.

In the discussion there are many options smartphone to run application programs created with a variety of experiments on the smartphone itself. Smartphones are used for systems made its effectiveness using 2 Gigabyte RAM, and using a 8 Megapixel camera. The reason is because in making application testing using RAM 1 Gigabyte, where 1 Gigabyte of RAM feels heavy in the processing of the image capture of the smartphone, and for the 8 Megapixel camera chosen as the test using a 5 Megapixel camera pictures look blurry and unstable in the shooting. For the FPS (frames per second) that is used is the default minimum smartphone device itself, as used in this study using a smartphone Asus Zenfone 5, the default minimum fps is 640x480 pixels, if larger fps or enlarge it to fit the screen, it will experience a slowdown in the image capture.

2) Selection of Microcontroller.

Microcontroller used in this system is a microcontroller ATmega328 with reliability possessed a large amount of memory about 2K as well as the ease of uploading program into the microcontroller itself.

B. Checking the Circuit

After all the stages of a system controller Through Android Application On Robot Vision of Detection of Color Using Microcontroller, then the next stage is the process of testing tools and create discussion about the performance of the tools were made late. To get the final result is as expected, the test tool must be done by meticulously and carefully. By doing this test, expected to be obtained based robot android smartphone reliable.

C. Module Arduino Uno Testing

Checking Module Arduino Uno is done by connecting a 9 volt battery to the module arduinouno.

TABLE I. TESTING ARDUINO UNO.

Input Voltage	LED Condition
0 Volt	Off
+ 9 Volt	On

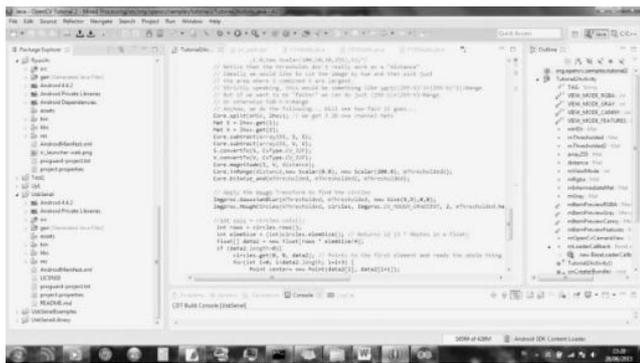


Fig. 9. Compiler Eclipse IDE



Fig. 10. Compiler Arduino IDE



Fig. 11. Green LED Lighted On Module Arduino Uno.

TABLE II. TESTING APPLICATIONS ON ANDROID.

Condition	Serial Output
The position ball to the x-axis on screen smartphone <200	Left
The position ball to the x-axis on screen smartphone > 430	Right
430 < The position ball to the x-axis on screen smartphone < 200	Middle
Diameter ball < 80 (pixel)	Stop



Fig. 12. Display Screenshot Of Android Smartphones

TABLE III. TESTING OF DC MOTORS.

DC Motor Moves		Result
Right Dynamo	Left Dynamo	
Move Forward	Move Forward	Move Forward
Move Backward	Move Forward	Turn Right
Move Forward	Move Backward	Turn Left
Move Backward	Move Backward	Move Backward
Not moving	Not moving	Stop

D. Application on Android Testing

Testing is done by running the application on android smartphone and use the debugging features in the Eclipse IDE. In debug mode is also used to take screenshots at the time the application is running.

E. DC Motor Testing

PWM (Push Width Modulation) is influenced by the resolution of the PWM itself. Suppose the digital PWM 8 bit PWM resolution means  $2^8 = 256$ , meaning the PWM output value has 256 variations, variations ranging from 0-255 that represents a duty cycle of 0-100% of the output PWM speed control here as the robot during the maneuver. Below is described in the table on the validation test Motor DC:

In the implementation of the programming using the Arduino IDE to drive the dc motor that uses the command "HIGH and LOW", which describes the "OFF - ON" of his condition. Prior to execution of command "HIGH" and "LOW" it must first be initialized at the beginning of the program so that these variables are known by the program / compiler used.

In Table 3, already described there are 5 navigation commands, namely:

1) Command Forward

Advanced command is used as a forward command the robot to condition the ball is still in the far distance in this case the ball is smaller radius of 80 pixels. PWM setting for the command "Forward" is "255". Advanced commanded the robot in particular both for the dc motor rotates simultaneously which has a forward direction (forward).

2) Command Right

Command right is used to command the robot to spin to the right. PWM setting for the "Right" is "255" Rotate Right to give orders to the robot in particular both for the dc motor that has a direction different spin to the right motor rotates backward (backward) while the left motor rotates forward (forward).

3) Commands Left

Command left is used to command the robot to spin to the left. PWM setting for the "Left" is "255". Turn left to give commands to the robot in particular both for the dc motor that has a direction different spin to the right motor rotates forward (forward) while the motor is left silent.

4) Command Backward

The command is used as a command retreat backwards robot with testing conditions by using bluetooth. PWM setting for the "Backward" is "255". Mudur gave orders to the robot in particular both for the dc motors that have the same spin direction backward (backward).

5) Command Stop

Command stop is used to stop the second round wheel commands (stop the movement of the robot). Stop giving commands to the robot, especially the dc motor to stop the

rotation of the wheels. Explanation of the Arduino IDE command as follows:

*F. Overall System Testing*

Testing of the whole system is done when all components have been installed on the frame. Tests conducted to examine the effect of light intensity on the object detection sensitivity and mechanical speed of approaching objects. The test is performed by placing the ball at a distance of a few centimeters from the robot and calculates the time required by the robot to approach the ball with the power of light or power fluorescent lamps in the room is in use.

TABLE IV. TESTING OVERALL DISTANCE THE DETECTED UP NOT DETECTED (CM).

Color	Range (cm)					Information
	10-50	60-100	110	120	130	
Orange	√	√	√	X	X	"√" that is detected, and "x" that is not detected
Green	√	√	√	X	X	

TABLE V. TESTING OVERALL ORANGE COLOR SYSTEM IN ROOM WITH LIGHT POWER 20 WATT WITH A DISTANCE OF 30 CM.

Trial to-	Initial Range Ball (cm)	End Range Ball (cm)	Time Required	Power of Light
1	30	10	11 sec	20 watt
2	30	13	14 sec	20 watt
3	30	12	25 sec	20 watt
4	30	12	45 sec	20 watt
5	30	11	15 sec	20 watt
6	30	13	15 sec	20 watt
7	30	14	11 sec	20 watt
8	30	16	15 sec	20 watt
9	30	13	16 sec	20 watt
10	30	14	13 sec	20 watt

TABLE VI. TESTING OVERALL ORANGE COLOR SYSTEM IN ROOM WITH LIGHT POWER 20 WATT WITH A DISTANCE OF 50 CM.

Trial to-	Initial Range Ball (cm)	End Range Ball (cm)	Time Required	Power of Light
1	50	12	29 sec	20 watt
2	50	11	17 sec	20 watt
3	50	12	28 sec	20 watt
4	50	11	24 sec	20 watt
5	50	10	38 sec	20 watt
6	50	13	40 sec	20 watt
7	50	12	29 sec	20 watt

8	50	12	28 sec	20 watt
9	50	10	36 sec	20 watt
10	50	13	45 sec	20 watt

TABLE VII. TESTING OVERALL ORANGE COLOR SYSTEM IN ROOM WITH LIGHT POWER 20 WATT WITH A DISTANCE OF 80 CM.

Trial to-	Initial Range Ball (cm)	End Range Ball (cm)	Time Required	Power of Light
1	80	9	103 sec	20 watt
2	80	11	97 sec	20 watt
3	80	13	89 sec	20 watt
4	80	10	97 sec	20 watt
5	80	11	94 sec	20 watt
6	80	13	84 sec	20 watt
7	80	10	121 sec	20 watt
8	80	12	116 sec	20 watt
9	80	13	97 sec	20 watt
10	80	14	97 sec	20 watt

TABLE VIII. TESTING OVERALL SYSTEM COLOR GREEN IN ROOM WITH LIGHT POWER 20 WATT WITH A DISTANCE OF 30 CM.

Trial to-	Initial Range Ball (cm)	End Range Ball (cm)	Time Required	Power of Light
1	30	9	15 sec	20 watt
2	30	11	14 sec	20 watt
3	30	10	19 sec	20 watt
4	30	12	15 sec	20 watt
5	30	10	21 sec	20 watt
6	30	11	15 sec	20 watt
7	30	13	11 sec	20 watt
8	30	14	15 sec	20 watt
9	30	12	14 sec	20 watt
10	30	11	21 sec	20 watt

TABLE IX. TESTING OVERALL SYSTEM COLOR GREEN IN ROOM WITH LIGHT POWER 20 WATT WITH A DISTANCE OF 50 CM.

Trial to-	Initial Range Ball (cm)	End Range Ball (cm)	Time Required	Power of Light
1	50	13	29 sec	20 watt
2	50	10	21 sec	20 watt
3	50	12	27 sec	20 watt
4	50	9	36 sec	20 watt
5	50	11	37 sec	20 watt
6	50	12	37 sec	20 watt
7	50	10	39 sec	20 watt
8	50	14	19 sec	20 watt
9	50	19	42 sec	20 watt
10	50	10	44 sec	20 watt

TABLE X. TESTING OVERALL SYSTEM COLOR GREEN IN ROOM WITH LIGHT POWER 20 WATT WITH DISTANCE 80 CM.

Trial to-	Initial Range Ball (cm)	End Range Ball (cm)	Time Required	Power of Light
1	80	9	133 sec	20 watt
2	80	11	117 sec	20 watt
3	80	13	115 sec	20 watt
4	80	10	122 sec	20 watt
5	80	11	114 sec	20 watt
6	80	13	92 sec	20 watt
7	80	10	111 sec	20 watt
8	80	12	95 sec	20 watt
9	80	13	100 sec	20 watt
10	80	14	90 sec	20 watt

V. CONCLUSION AND SUGGESTION

A. Conclusions

Control System Through Android Apps On Robot Vision Color Detection Using Microcontroller basically created as a development Draft Implementation on Robot-based Computer Vision Android Smartphone used as a navigation robot that uses artificial intelligence technology Computer Vision and to show that the android technology is not only used for mobile, but as a tool in the field of automation of driver jobs, object detection, and color detection.

Based on the results of experiments conducted can be concluded that the study Control System Through Android Apps On Robot Vision Using Microcontroller, main processor functions are on android smartphone while arduino as a slave processor module as the driving motor. Because of the limitations resource on mobile devices, which makes android smartphone device matrix data processing speeds result in frames per second (fps) application is reduced so that the application can be better used, and the picture looks like video processing. In this system also uses serial communication cable, where communication lines can be run well between the smartphone and the arduino uno.

Please note the selection of smartphones there are many options to run application programs created with a variety of experiments on the smartphone itself. Smartphones are used for systems made its effectiveness using 2 Gigabyte RAM, and using a 8 Megapixel camera. The reason is because in making application testing using RAM 1 Gigabyte, where 1 Gigabyte of RAM feels heavy in the processing of the image capture of the smartphone, and for the 8 Megapixel camera chosen as the test using a 5 Megapixel camera pictures look blurry and unstable in the shooting. For the FPS (frames per second) that is used is the default minimum smartphone device itself, as used in this study using a smartphone Asus Zenfone 5, the default minimum fps is 640x480 pixels, if larger fps or enlarge it to fit the screen, it will experience a slowdown in the image capture.

The advantages of the concept of development of this system is that we can utilize existing resources, in this case android smartphones are quite popular and powerful as a navigation system by implementing computer vision robot that can not only detect the object distance is detected however, can detect the shape and color of the object with excellent accuracy, and also in taking pictures with a camera, the system is to apply the x axis, and radius, so for a very good level of positioning accuracy compared cmucam.

using android smartphone resource limitations, especially the problems of cache memory so great, because most smartphone memory cache has been used by the android operating system itself, other deficiencies in this system, for color accuracy in the determination of the color of the object to be detected, for a very long rangenya , it could be when you want to detect the color orange, red color can be detected even if vaguely.

B. Suggestions

Development of the robot system is still much to be developed related problems cache memory optimization, improved battery power, increase frames per second, load calculation robot, so the robot can navigate better. And objects in the detection can be more broadly not only the color of any object.

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