Table of Contents

ABSTRACT

Device is made with Arduino, Sensors and can be used with smartphone (android) to detect the color of any object. Smartphone should be connected to Arduino with Bluetooth to get the output of detected color. The color name is spoken by voice from the application. Therefore, it is required to install the app to run the features. So that it is beneficial for visually impaired people to know about the object colors. Moreover, it can be helpful for kids to know the color name, with stepper motor, the objects part in industries can also be detected etc. One can easily understand the interface and work with device.

List of Figures

List of Tables

Chapter 1: INTRODUCTION

1.1 PROBLEM SUMMARY

In the studies, it is known that color plays a vital role in everyone's life for recognition. Because of this deficiency so many people face many problems in their daily life. This color vision deficiency may also cause the loss in their career opportunities. They are expected to be interested to know the color of their cloths, the color of photos and the color of objects etc. The general population who are with Achromatopsia additionally confront an unsafe circumstance in view of having partial blindness.

1.2 PURPOSE

Generally, every person wants to work by his/her self without intervene other people for support. The thing here discussed is more basically tends to the people who are physically handicapped.

People having visual impairment do know the shape/color or anything coming every day in their lives but when they face something new or want to know something then they have to take support of others. What makes them realize the thing is the color of object. For example, if a person wants to know the color of new clothes he/she wants to buy then without review of others it isn't possible for him/her to know that. Moreover, color blind person is also having difficulties while identifying color.

Another problem can be as Small Kids/Toddlers are taught every day to identify the color, pronounce the color etc. At this age, they cannot search by themselves. So the color detecting device may seem useful for them.

1.3 SCOPE AND OBJECTIVE

The main objective of this project is to develop an electronic gadget that recognizes the object color. It ought to be of ease and simple in execution. This hardware will be extremely

helpful for the visually impaired and Achromatopsia individuals. Our aim is to make a device with Arduino to detect the color and give output on android app. The device should be connected to smartphone wirelessly with Bluetooth technology. Moreover, the output should be voice enabled.

So that is helpful for blind people, colorblind people or partially blind people. Also it may helpful for small children to learn color pronunciations. Mobile application should also have as easy as possible user interface to interact, work, connect with Arduino device.

The device should have small size So that it can be taken with in pocket. It should also have rechargeable battery if different usages are required.

1.4 TECHNOLOGY/ TOOLS

We have two categories. One is hardware tools and another one is software tools.
Hardware:

- Arduino Uno (See Fig. 1) [5]
    - Arduino Uno is a microcontroller board based on the ATmega328P. It can be programmed using C/C++ from any computer.
    - We can also use Arduino Nano to compact the device.
    - It has 14 computerized input/output pins (of which 6 can be utilized as PWM outputs), 6 analog inputs, a USB connection, a 16 MHz quartz crystal, a power jack. It also has ICSP header and the reset button. It contains the whole thing anticipated to assist the microcontroller; simply interface it to a PC with a USB or power it with an AC-to-DC connector or battery to start.

- TCS3200 Color Sensor (See Fig. 2) [2]
    - The TCS3200 and TCS3210 programmable color light-to-frequency converters that combine configurable silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit.
    - In the TCS3200, the light-to-frequency converter reads an 8 x 8 array of photodiodes. 16 photodiodes have blue filters, 16 photodiodes of green

filters, 16 photodiodes of red filters, and 16 photodiodes are clear with no filters.

- HC-05 Bluetooth Module (See Fig. 3) [3]
  - HC-05 module is an easy and simple Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband.
  - Auto-reconnect in 30 min when disconnected.

- Breadboard (See Fig. 4)
  - This component is not compulsory but it can be used to make circuitry when there are many components are available.

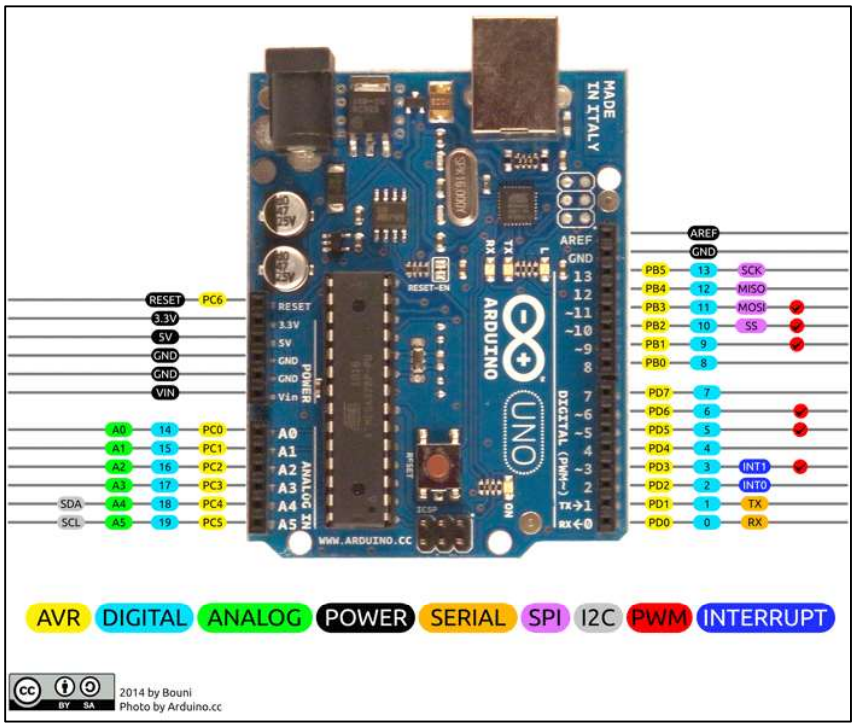


Fig. 1.1 Arduino Uno: Pin Diagram

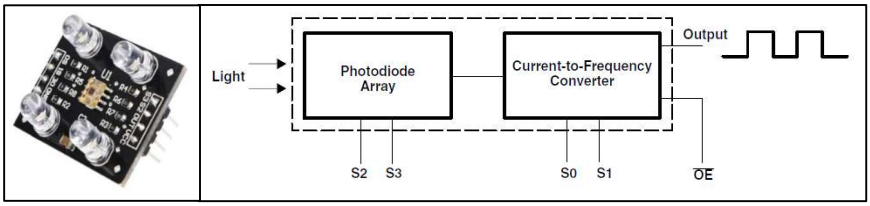


Fig. 1.2 TCS3200 Color Sensor

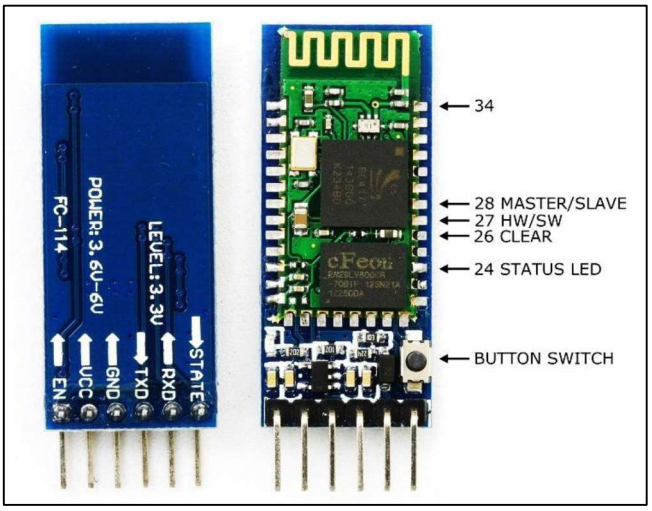


Fig. 1.3 HC-05 Bluetooth Module

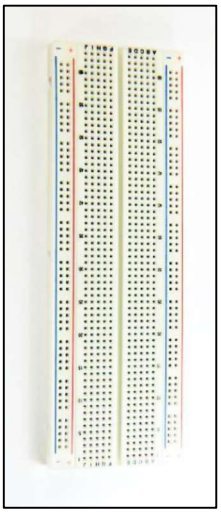


Fig. 1.4 Breadboard

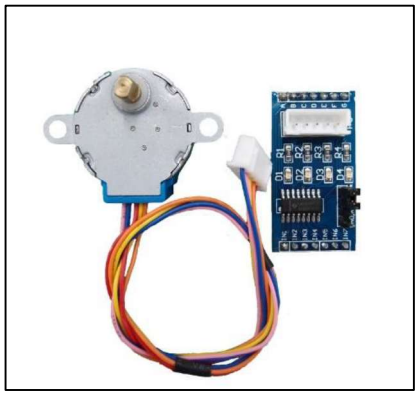


Fig. 1.5 28BYJ-48 Step Motor and ULN2003 Driver

- Power Supply [1]
  - Arduino Uno can be powered thru the USB connection or with an outside energy deliver.
  - External (non-USB) strength can come either from an AC-to-DC adapter or battery.
  - The connector might be connected through stopping a 2.1mm center excellent fitting into the board's power jack. Leads from a battery can be embedded in the GND and VIN stick headers of the power connector.
  - The board can perform on outside supply of 6 to 20 volts. Whenever provided with under 7V, in any case, the 5V stick can likewise convey substantially less than 5 volts and the board might be precarious. On the off chance that we give volts more than 12V, it might overheat and hurt the board. Along these lines, the range is 7 to twelve volts.

- Stepper Motor and Driver [4]
    - A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements.
    - 64 steps per revolution of the motor rotor, motor has an internal gear ratio of 32:1, so effectively we have 2048(32*64) steps per revolution of the motor shaft.
    - Stride Angle: 5.625° = 360 / 64 (Gear ratio)
    - Rated voltage: 5V DC
    - The ULN2003 stepper motor driver PCB provides a direct drive interface between your microcontroller and stepper motor. The PCB provides 4 inputs for connection to your microcontroller, power supply connection for the stepper motor voltage, and ON/OFF jumper, a direct connect stepper motor header and 4 LEDs to indicate stepping state.

Software:

- Android Application
    - Application is to be installed on android smartphone to work with Arduino.
    - The app is made using Android Studio. We can also make application using MIT App Inventor.

- Arduino Software
    - One time use of IDE to program Arduino in C/C++ languages.
    - Stepper Library

1.5 LITERATURE REVIEW

1.5.1 Web Search

We have searched through internet and found such similar concepts for implementation of such kind of device. The implementation is based on Arduino and use of sensors for detection. There are various Arduino boards like Nano, Uno and Mega etc. The basic differences are of its specifications and size. Many resources are found on Color Detection. Some of which websites' projects are listed below:

Hacker.io:

This article described detecting of color using Arduino. They have used Arduino Nano and TCS3200 Color Detector Sensor and LCD. Reading of colors using Arduino and sensors such as the TCS 3200. The thought will be to determine color input, and show it on a LCD. This task is a part of a greater undertaking that will be a Robot Arm that chooses an appropriate activity in view of a color detection.

Here the product is similar but the output is on LCD which is not feasible for people having vision impairment to read.

HowToMechatronics:

In this Arduino Tutorial, they have discussed how to detect colors using Arduino and the TCS230 / TCS3200 Color Sensor. The workflow described is useful. It is implemented using Arduino Mega and TCS3200 sensor and displayed the output on LCD similar to site listed above.

1.5.2 Research Publication:

Portable Camera Based Assistive Pattern Recognition for Visually Challenged Persons:

By R. Savitha and R. Ramya

This venture, a camera based assistive structure is proposed to help daze people for recognizable proof of nourishment design, dress example and hues in their everyday lives. The current traffic flag utilizing sensors technique is hard to examination and numerous segments utilized.

A computerized camera based traffic sign assessment approach simple to address, to offer clean traffic sign assessment and lessen the time put off. The gadget consolidates the accompanying overwhelming segments 1) a camera for catching dress, dinners and traffic sign pics, a mouthpiece for discourse direction enter; 2) measurements seize and investigation to do order oversee, capture dress styles, sustenance styles and site guests sign character by method for the use of a wearable PC and 3) a speaker to give the call of sound yields of dress examples and shades, suppers examples and site guests sign assessment, notwithstanding machine acclaim.

Here, implementation is costlier as camera and wearable device are to be made.

Automated Color Recognition System for Visually Challenged and Achromatopsia People using Arduino and Mobile App: [1]

By M.Anil Kumar, Dr. S. A. K. Jilani, Mr. U.Sreenivasulu, Mr. S. Javeed Hussain

This hardware equipment will be very useful for the visually challenged and Achromatopsia people. To implement this project, they used the components such as Arduino MEGA 2560, TCS3200, Bluetooth module and an android mobile. Arduino programming and App inventor programming are used for implementing the process. This paper has the advantages as

- Low cost
- Flexible in design
- Power consumption is low

Here, the concept is same as our project. The basic differences are of the size and mobile app. The Arduino board used is mega which makes the gadget somewhat bigger and the application of android is made with MIT App Inventor and seems to be difficult for Blind person to operate.

Chapter 2: PROJECT MANAGEMENT

2.1 PROJECT PLANNING:

2.1.1 Project Development Approach and Justification:

To solve actual problems in an industry setting, software engineer or a team of engineers must incorporate a development strategy that encompasses the process, methods and tools layers and generic phases. This strategy is often referred to as process model or a software engineering paradigm or project development approach.

A process model for software engineering is chosen based on the nature of the project and application, the methods and tools to be used, and the controls and deliverables that are required.

Our project is based on Rapid Application Development (RAD) Model. This software development approach is as described as below.

RAD model is an incremental software development process model that emphasizes an extremely short development cycle. If requirements are well understood and project scope is constrained, the RAD process enables a development team to create a "fully functional system" within short time periods (60-90 days).

RAD approach encompasses the following phases:

Business Modeling:

The flow of information among business functions is modeled in such a way that answers following questions:

What Information drives the business?

What Information generated?

Who generates it?

Where does Information go?

Who Process it?

Data Modeling:

The flow defined as part of business modeling phase is refined into a set of data object that are needed to support the business.

Data Modeling answers a set of specific questions that are relevant to any data processing application. It enables software engineer to identify data objects and their relationship using a graphical notation.

Process Modeling:

The data objects defined in the data modeling phase are transformed to achieve the information flow necessary to implement a business function processing description s are created for adding, modifying, deleting or retrieving a data object.

Application generation:

RAD process works to reuse existing program components or create reusable components.

Testing and turnover:

The RAD process emphasizes reuse; many of the program components have already been tested. This reduces overall testing time. However, new components must be tested and all interfaces must be fully exercised.

2.1.2 Project Plan

1. Introduction:

This section describes the objective of the project and helps in easy maintenance and retrieval of all the details about projects undertaken by an organization by providing information about each and every module and phase. Interaction between client and developer for requirement gathering plays a crucial role in the analysis phase of SDLC. This phase consumes major time for project development. If carried out manually it increments the total development time which may lead to customer dissatisfaction.

2. Project Organization:

This describes the way in which the development team is organized the people involved and their roles in team.

3. Risk Analysis:

This describes possible project risks like likelihood of those risks arising and the risk reduction stratifies, which are proposed. The significant risk in our system development is requirement error and omissions. Therefore, cost of fixing the requirement errors at later stages in process can be very high. Experiments have shown that SDLC reduces number of problems associated with the requirement specification. Furthermore, the overall development cost may be lower if a SDLC is developed.

4. Hardware and Software Requirements:

This describes the hardware and the support software required to carry out the development. Sufficient resources should be provided at proper time to achieve the goal of developing the project as planned (described abvoe).

5. Work Breakdown:

This describes the breakdown of the project into activity and identifies the milestones and deliverables associated with each activity. Roles and responsibility of the user in each activity is assigned.

6. Project Schedule:

This describes the dependencies between activity the estimate time requires to reach each milestone and allocation of people to activities.

2.1.3 Milestones And Deliverables

Management needs information. As software is tangible, this information can only be provided as documents that describe the state of the software being developed without this information it is impossible to judge progress at different phases and therefore schedules cannot be determined or updated.

Milestone is an end point of the software process activity. At each milestone there should be formal output such as report that can be represented to the management. Milestones are the completion of the outputs for each activity. Deliverables are the requirements definition and the requirements specification.

Milestone represents the end of the distinct, logical stage in the project. Milestone ` may be

internal project results that are used by the project manager to check progress. Deliverables are usually Milestones but reverse need not be true. We have divided the software process into activities for the following milestone that should be achieved.

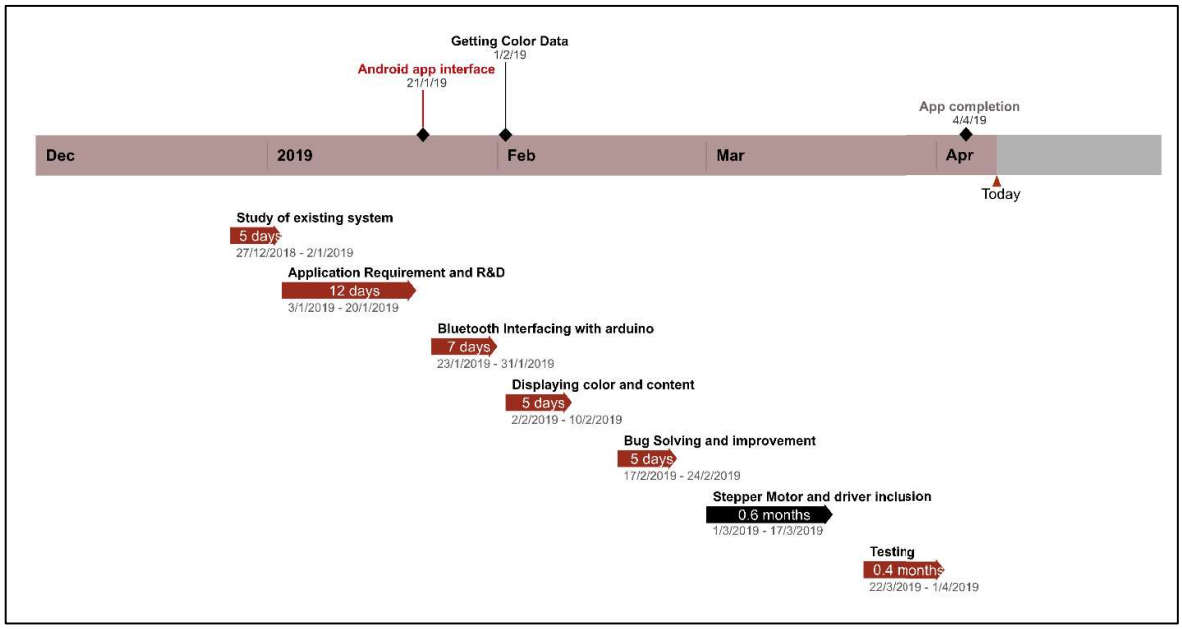


Fig. 2.1 Milestones and Deliverables

2.1.3 Roles and Responsibilities

We are two members in team. Each member has done work as of his responsibility. We worked together on some component. We both worked on modules like android user interface, functionality, stepper motor incorporating, speaking with voice, etc. Other project related reasearch and documentation are also done by both of us.

2.1.4 Group Dependencies

When assets are assigned, the following stage is to recognize conditions between undertakings. An errand has a reliance on the off chance that it includes an action, asset, or work item that is in this manner required by another undertaking. Conditions come in numerous structures: a test plan can't be executed until a work of the product is conveyed; code may rely upon classes or modules worked in before stages; a UI can't be worked until the plan is assessed. It is the venture supervisor's duty to work with everybody on the building group to distinguish these conditions. The undertaking director should begin by taking every module and adding reliance data to it: each assignment in the chose module is

given a number, and the quantity of any errand that it is subject to ought to be recorded beside it as a forerunner.

We have additionally distinguished conditions among the modules and sub modules in our undertaking. At that point we have isolated our work according to conditions.

2.2 PROJECT SCHEDULING

"Software project scheduling is an activity that distributes estimated efforts across the planned duration by allocating the effort to specific software engineering tasks."
(refer fig. 2.1)

2.3 RISK MANAGEMENT

Risk management consists of a series of steps that help a software development team to understood and manage uncertain problems that may arise during the course of software development and can plague a software project.

Risks are the dangerous conditions or potential problems for the system which may damage the system functionalities to very high level which would not be acceptable at any cost. so in order to make our system stable and give its 100% performance we must have identify those risks, analyze their occurrences and effects on our system and must prevent them to occur.

2.3.1 Risk Identification

Risk distinguishing proof is a first precise endeavor to determine dangers to extend plan, booking assets, venture improvement. It might be done as a group procedure utilizing conceptualizing approach.

Technology risk:
Specialized dangers concern usage, potential plan, interfacing, testing, and maintenance problems.

- Application Corruptness

- Garbage Collection
- People Risks: These dangers are worries with the group and its individuals who are taking part in building up the framework.
- Leaking a critical information Failure of the organization
- Lack of information
- Lack of clear item vision.
- Technical staff struggle.
- Poor correspondence between individuals.

Tools Risks:

These are progressively worried about devices used to build up the framework

- Tools containing infection
- Shockable equipment
- Improper wiring with arduino
- Short-circuit

General Risks: General Risks are the dangers, which are worried about the assets and resources.

- Rapidly evolving necessities.
- Lack of assets can make incredible damage proficiency and auspicious profitability.
- Changes in necessities can make an incredible mischief execution, planning and schedule of building up the framework.
- Insufficient arranging and assignment distinguishing proof. Basic leadership clashes.

2.3.2 Risk Analysis

"Risk analysis = risk assessment + risk management + risk communication."

Risk analysis is employed in its broadest sense to include:

Risk assessment

Involves identifying sources of potential harm, assessing the likelihood that harm will occur and the consequences if harm does occur.

For this project It might be:- System/App Crash.

Risk management

Assesses which dangers recognized in the hazard evaluation process require the executives and chooses and actualizes the plans or activities that are required to guarantee that those dangers are controlled.

Safety measures gone out on a limb negligible are as under:-

- Periodical reinforcements are assumed to keep away from real misfortune if there should arise an occurrence of framework crash.

Risk communication

Includes an intelligent discourse among partners and hazard assessors and hazard administrators which effectively illuminates different procedures.

Steps gone out on a limb correspondence is as under:-

- Probability of specific risks is consulted with clients.
- All the conceivable risks are drilled down amid correspondence and venture is created dealing with that risks.

2.4 ESTIMATION

2.4.1 Effort Estimation

As per COCOMO II,

Estimation of efforts for embedded software projects is:

Effort = 3.6 $(KLOC)^{1.20}$ PM

Time of Development= 2.5 $(Efforts)^{0.32}$ Months

For our project, KLOC (Line of Code) would be nearly 2.

So, Efforts = 3.6 $(2)^{1.20}$ PM = 8.27062815598 PM

Time of Development = 2.5 $(8.27062815598)^{0.32}$ Months = 4.91532600388 Months

Number of People Needed: 2

2.4.2 Cost Analysis

The project is funded by Student Startup & Innovation Policy of Government Engineering College, Rajkot, so the equipments are provided by government itself.

Table 2.1 Costs and Hardware

Sr. No.	Description	Quant.	Rate per quantity	Approx. expenditure**	Justification
1	Uno R3 Arduino ATmega328P with USB Cable	1	500	500	Arduino UNO is built with power plug whereas Arduino Nano uses the mini-b USB without the power plug for external power source.
2	Jumper Wires Male to Male, male to female, female to female, 120 Pieces	1	250	250	To connect Arduino with components and breadboard.
3	840 Points Bread Board or Solderless Pieces Circuit Test Board	1	200	200	To interconnect components.
4	HC-05 Bluetooth Module	1	500	500	HC-05 Bluetooth Module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup.
5	TCS3200 Color Recognition Sensor	1	1000	1000	In the TCS3200, the light-to-frequency converter reads an 8 x

	Detector Module				8 array of photodiodes. Whereas in the TCS3210, the light-to-frequency converter reads a 4 x 6 array of photodiodes.
6	Stepper Motor 28BYJ-48 + Driver Board ULN2003	1	400	400	This is the possible easiest solution for providing power to the motor.
Total Expenditure				2850	

Chapter 3: System Requirements Study

3.1 USER CHARACTERISTICS

There are many different users interact with product based on the usage. For example, as the product targets the blind, color blind or visionary impairment people, then they are the users using product. The main pupose for them is to have simple user interface and working model without having any complexity.

Other types of users are associated with industry. For example to detect color in industry, the product needs to be perfectly working without any compromise. To add industry specific involvment, we made a demo with stepper motor that will work to identify colors and move the object with motor.

In other examples, kids can also be included in users. They can understand the basic color names and pronounciations.

3.2 HARDWARE AND SOFTWARE REQUIREMENTS

Hardware:

(refer Table 2.1 Costs and Hardware)

Software:

Android Mobile with our application,

Arduino IDE (to change the program according to industry software)

Android Studio for application modification

3.3 CONSTRAINTS

3.3.1 Regulatory Policies

In our project, as arduino is open source plateforom based on easy to use hardware with software, there is not any restriction for that. Other harware modules are as of now free to use but commercial bunch productions may be restricted based on module production companies. Android app should be use with certified android phone.

3.3.2 Hardware Limitations

Here, in our project we have used hardware that are cost efficient and perfectly fit for our requirement. Moreover, using complex harware kits are necessary if industry specification is needed.

3.3.3 Interfaces to Other Applications

The bluetooth module should be properly integrated with application. As of now, the current module works perfectly with mobile but based on interfacing components, the connectivity and data reading methods may change.

3.3.4 Parallel Operations

As of now ,not more than one bluetooth devices can be connected to same mobile to get more colors. Even not more than one device can be connnected to an arduino. While fetching data from the bluetooth, application display previous color name and speak name.

3.3.5 Higher Order Language Requirements

Here C and Java, two higher order languages are required to be made product working. C is used in arduino programming whereas Java is used for android application programming.

3.3.6 Reliability Requirements

Fetching time and too much buffer data from bluetooth on android may show some unexpected behaviour. Disconnecting and reconnecting the bluetooth with android is tried as much as possible to be reliable.

3.3.7 Criticality of the Application

When the very much perfection is required when color is identified, the product may be inacurate. More than one mobile phone try to connect with one module may make it critical.

3.3.8. Safety and Security Consideration

Main concerns about safety and securities are supplying of power, bluetooth intervene, making wires convered with insulators etc.

3.4 ASSUMPTIONS AND DEPENDENCIES

Here, it is assumed that now the connecting nunber of user and device is one for single user. Anyone having application can connect to the one module. The MAC should be dynamically manage in setting in application.

Dependency Libraries:

Android Studio libraries

SoftwareSeiral.h (for Arduino)

Stepper.h (for Arduino)

Chapter 4: SYSTEM ANALYSIS

4.1 STUDY OF CURRENT SYSTEM

Current systems, that are based on speaking color name are either note speaking whole color name or either not include any hardware devices to detect. There are some android apps available that can detect color based on photo capture and then speak the color name. The blind user doesn't feel without hardware to understand the object scenario.

There are some applications that are created with MIT app creator software but we choose Android studio to build the app,

4.2 PROBLEM AND WEAKNESS OF CURRENT SYSTEM

Not all colors are detected. But mostly around 1500 colors can be detected. Sometimes the re-detecting the color may slightly differ with previous values. There is not yet the settings about speech are defined. So the default voice is there to speak the color in US. The program needs to be changed for larger industry specific usages.

4.3 REQUIREMENT OF NEW SYSTEM

USER REQUIREMENT:

User should be aware about the knowledge of basic mobile phone and connective of the same with Arduino. Voice is specially added in the benefit of users having blindness.

SYSTEM REQUIREMENT:

To connect the user phone with Arduino using Bluetooth, the user needs to have android application to be installed. Detected colors are also appearing on the same application. The voice is added to make it easier for visionary impaired person to work. The hardware defined above is required as a system to run the product. However, modification required more software and hardware tools like computer, software etc.

4.4 FEASIBILITY STUDY

An essential result of the primer examination is the assurance that the framework is practical or not. The principle point of the attainability examine action is to decide if it would be monetarily and in fact plausible to build up an undertaking. The practicality

think about action includes the investigation of the issue gathering of all pertinent data identifying with the item, for example, the diverse information things which would be contribution to the framework, the handling required to be completed on these information, the yield required to be delivered by the framework just as the different limitations on the conduct of the framework.

4.4.1. Does the system contribute to the overall objectives of the organization?

The main objective is to make it helpful to people and industry. Nowadays, industries are implementing the color detecting using either AI or camera technology. So it may seem unfitting in industry but as the same time, if we consider the cost then our product is less costly.

4.4.2 Can the system be implemented using the current technology and within the given cost and schedule constraints?

Current technology including AI will give more accuracy and constraints but may become costlier for making product but.

4.4.3 Can the system be integrated with other system which are already in place?

Yes, the system can be integrated with other system. For example, if the system is built with Raspberry Pi instead of Arduino, then also it is possible to construct the working product.

4.5 REQUIREMENTS VALIDATION

A Requirements validation is concerned to check whether the requirements actually define the system, which the customer wants? Requirements validation is important because errors in requirements document can lead to extensive rework costs when they are subsequently discovered.

Requirements validation is important because errors in a requirement document can lead to excessive rework costs when they are subsequently discovered during development or after the system is in service. The cost of making a system change resulting from a requirements problem is much greater than repairing design and coding errors. The reason for this is that a change to the requirements usually means that the system design and that the system must be retested.

The main user requirements are fulfilled with this product. However, if user is expecting more control over voice and smaller product size, then it would make it costlier.

4.6 FEATURES OF NEW SYSTEM

Color Detection:

The system can be able to detect the color from object, cloth, etc. The color displaying in LED or LCD cannot be identified.

Bluetooth connectivity:

The system is able to control via Bluetooth. It is only available when the user phone in that area. The detected color is also send via Bluetooth.

Speaking the color name:

It enables voice speech of detected color when it is connected to Arduino based product.

4.7 FUNCTIONS OF SYSTEM

Following functions are used in our project:

Sending Color from Arduino to android,

Bluetooth Discovery

Moving to other activity after successful connection

Fetching color data every after 8 seconds

Match color and speak out

4.8 CONTEXT DIAGRAM

A system context diagram (SCD) in engineering is a diagram that defines the boundary between the system, or part of a system, and its environment, showing the entities that interact with it. This diagram is a high level view of a system. It is similar to a block diagram.

(fig. on next page)

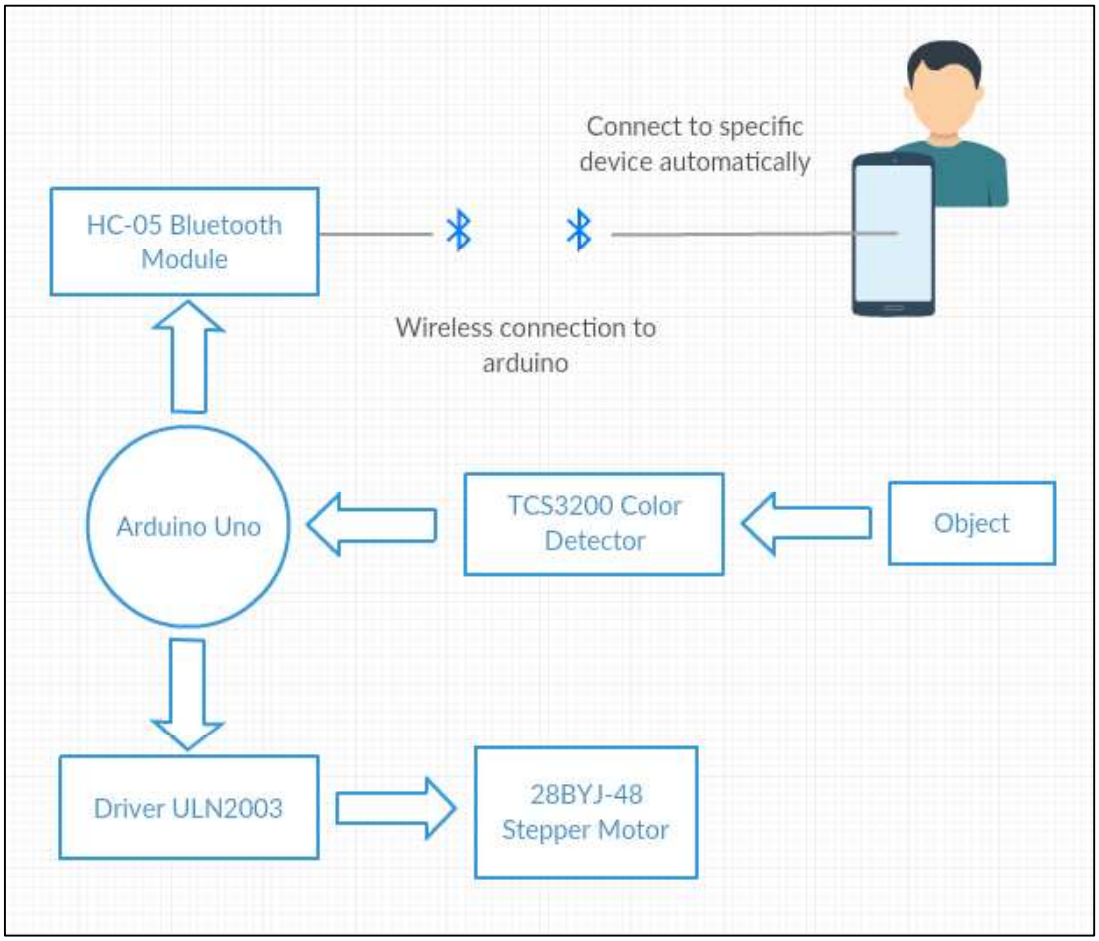


Fig. 4.1 Context Diagram

4.9 DATA FLOW DIAGRAM

(fig. on next page)

Flow Chart:

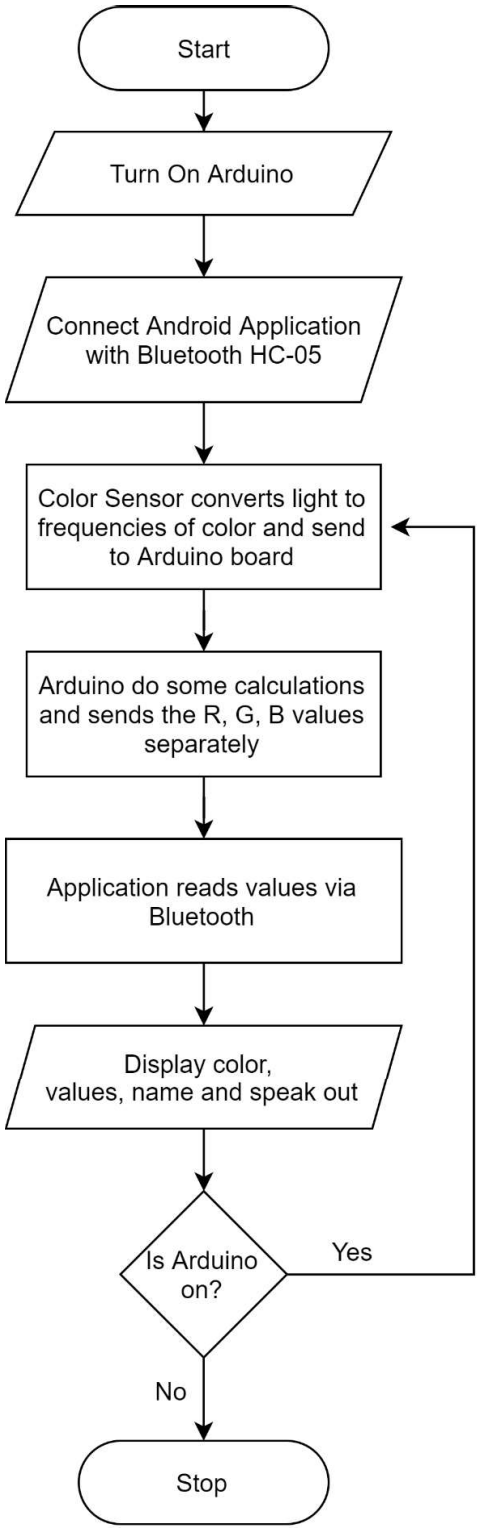


Fig. 4.2 Flowchart

4.10 PROCESS SPECIFICATION, DECISION TABLE, CALCULATIONS

Sensor Analysis:

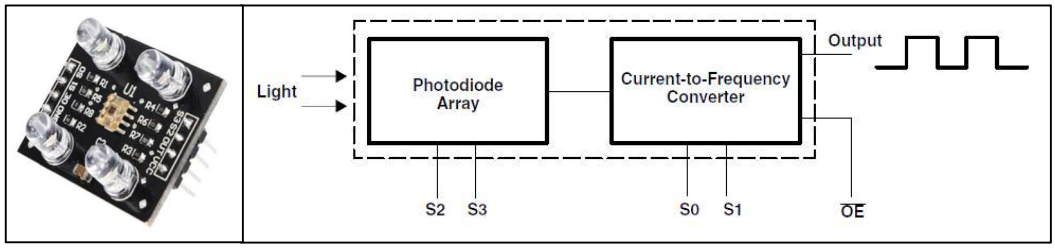


Fig.4.3 TCS3200 Color Sensor

In the TCS3200, the light-to-frequency converter reads an 8 x 8 array of photodiodes. 16 photodiodes of blue filters, 16 photodiodes of green filters, 16 photodiodes of red filters, and 16 photodiodes are clear with no filters.

The full-scale output frequency may be scaled by one in every of three preset values through two control input pins. With digital inputs and digital output, we can direct interface to a microcontroller or other logic kit.

Photodiode having same color are connected in parallel. Pins S2 and S3 are used to select the group of active photodiodes (red, green, blue, clear). Photodiodes are 110 µm x 110 µm in size.They are on 134-µm centers. [2]

Table 4.1 TCS3200: Selectable Options

S0	S1	OUTPUT FREQUENCY SCALING (f_o)
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

S2	S3	PHOTODIODE TYPE
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

Calculations:

After experimenting different formulae, we get an expression with which we can get the desired color values.

To get desired RGB values from the frequencies, we have to calibrate the values.In ordered to calibrate to correct values, we have to first get frequencies of rgb for white color. Frequencies are indirectly proposonal to the rgb values. [4]

We use pulseIn(pin,value) function here to get frequencies.This function reads a pulse (either HIGH or LOW) on a pin. For example, if value is HIGH, pulseIn() waits for the pin to go from LOW to HIGH, starts timing, then waits for the pin to go LOW and stops timing. Returns the length of the pulse in microseconds or gives up and returns 0 if no complete pulse was received within the timeout. [5]

Frequncies for white color : R=33, G=36, B=26

$$Normalized\ R/G/B\ Value\ = \frac{255\ * R/G/B\ value\ of\ White\ Color\ Time\ Period}{Time\ Period\ new\ of R/G/B}$$

eq.(1)

It can be written as:

$$Normalized\ Red\ Value\ of\ Color = \frac{255 * 33}{Red\ time\ period\ of\ Color}$$

$$= \frac{8415}{Red\ time\ period\ of\ Color}$$

eq.(2)

Similarly,

$$Normalized\ Green\ Value\ of\ Color = \frac{9180}{Green\ time\ period\ of\ Color}$$

eq.(3)

$$Normalized\ Blue\ Value\ of\ Color = \frac{6630}{Blue\ time\ period\ of\ Color}$$

eq.(4)

Chapter 5: SYSTEM DESIGN

Here, in our project, we don't require any database design as of now. It can be possible to store detected color data to database and give it online access but as this time, the functionality of specific model is more important.

5.1 INPUT/OUTPUT DESIGN

Sketch Diagram:

Table 5.1 Pin Description

Arduino Pin	Component Name	Component Pin
4	TCS3200 Color Sensor	S0
5		S1
6		S2
7		S3
8		Out
GND		GND, OE
5V		VCC
10 (RX)	HC-05 Bluetooth Module	TX
11 (TX)		RX
5V		VCC
GND		GND
2	ULN2003 Driver	In1
3		In2
12		In3
13		In4

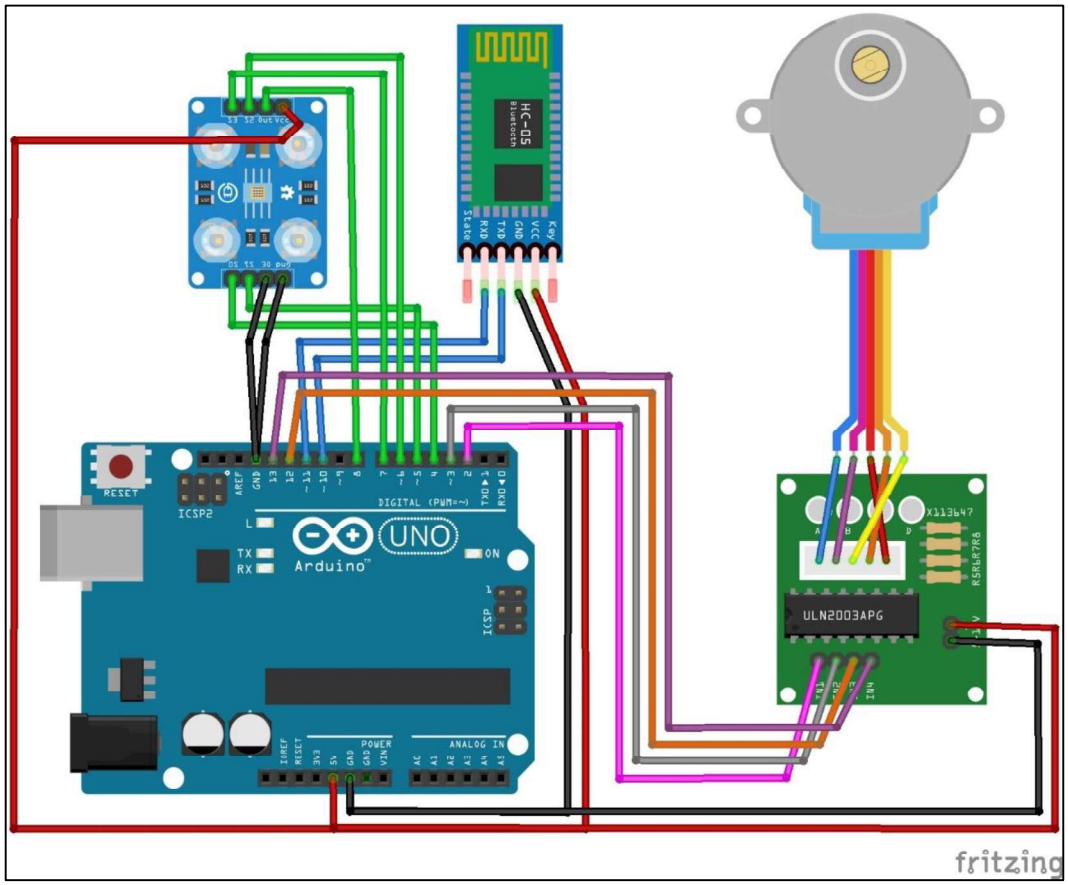


Fig. 5.1 Sketch Diagram

Chapter 6: IMPLEMENTATION

6.1 IMPLEMENTATION ENVIRONMENT

Implementation of this project is dominated by: quality, reliability/availability, clear information access whereas respecting security.

The project is a result of a bunch of agreement. The team is having 2 members. The team structure depends on the no. of individuals within the team, their ability levels and also the downside issue.

This Application is essentially graphical user interface connected information access system. User will simply run through this technique. it's user friendly interface. The implementation of Arduino and detecting color was done in previous semester. In these semester, our main focus is on application building and the use of stepper motor. Right now single user can access particular product.

6.2 PROGRAM/MODULES SPECIFICATION

Our Arduino program uses the “Stepper.h” library provided by Arduino to work with stepper motor easily. Here our stepper motor model is 28byt-48. The driver to work with stepper motor is ULN2003.

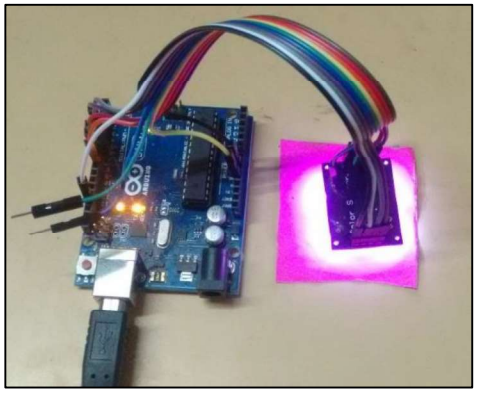
Stepper motor specifications:

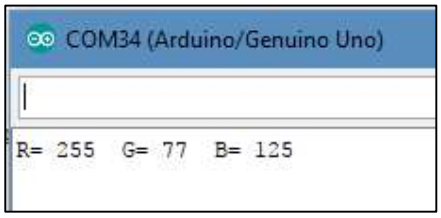
- Stride Angle 5.625 = 360 / 64(Gear ratio), i.e., there are 32 steps per revolution.
- 32 steps per revolution of the motor rotor, motor has an internal gear ratio of 64:1, so effectively we have 2048(32*64) steps per revolution of the motor shaft. [8]

Result/Snapshots

We tried different types of colors to recognize it. Output was the same as what was desired. We can get nearby RGB values with the sensor which is sufficient to sense the color. Here are some snapshots, which give the understanding of color detection of sensor without Bluetooth sensor.

Color Paper Photo



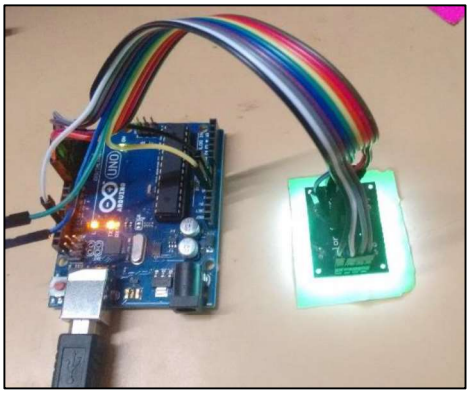


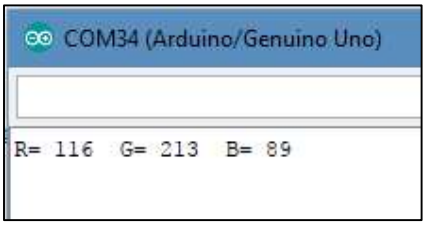
Output on Serial Monitor

[R, G, B] = [255, 77, 125]

Fig. 6.1 Color Detection Example 1

Color Paper Photo





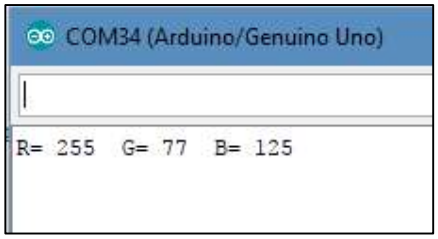
Output on Serial Monitor

[R, G, B] = [116, 213, 89]

Fig. 6.2 Color Detection Example 2

[R, G, B] = [255, 77, 125]

Color Paper Photo



Output on Serial Monitor

Fig. 6.3 Color Detection Example 3

Implementation

Below are some snapshots of project with stepper motor and Bluetooth sensor.

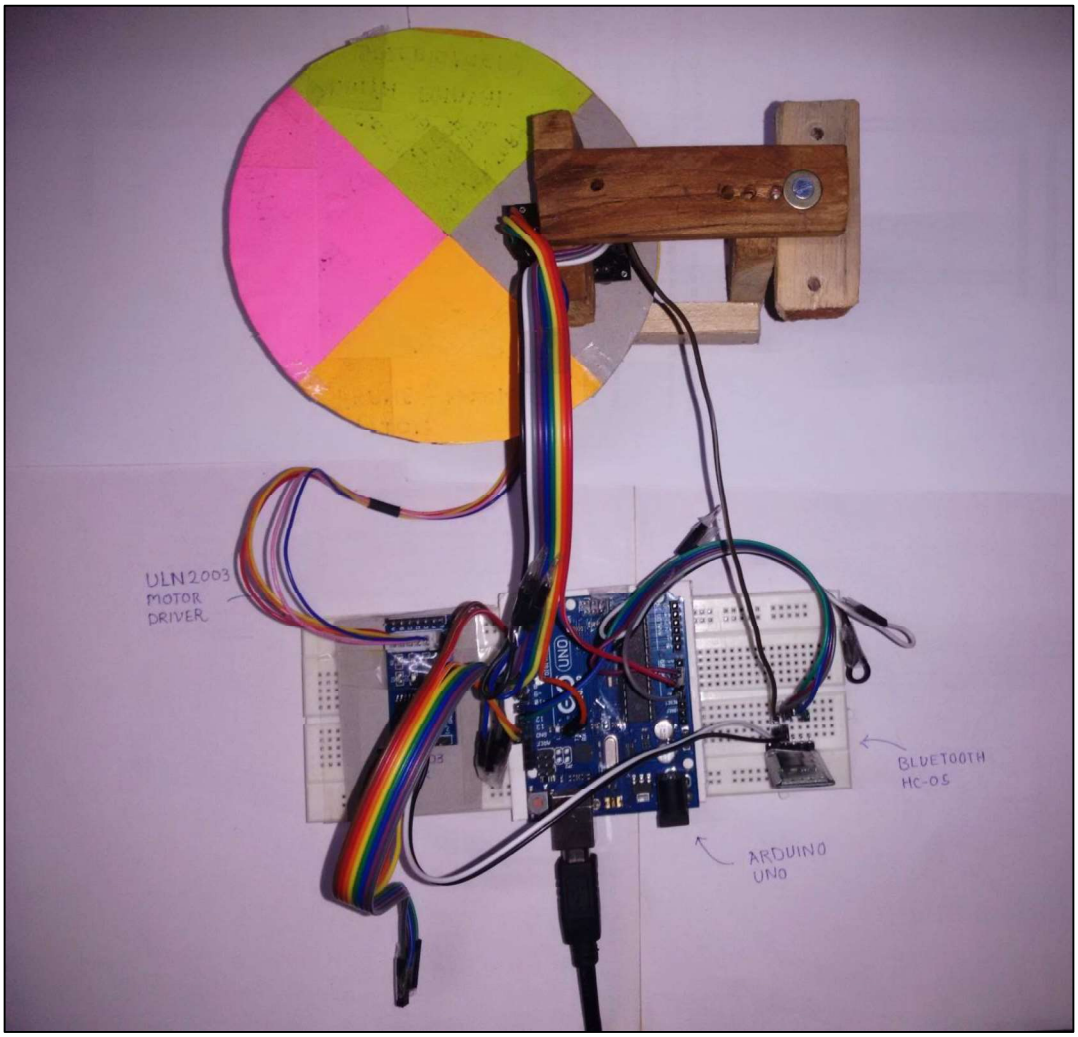


Fig. 6.4 Implementation of project

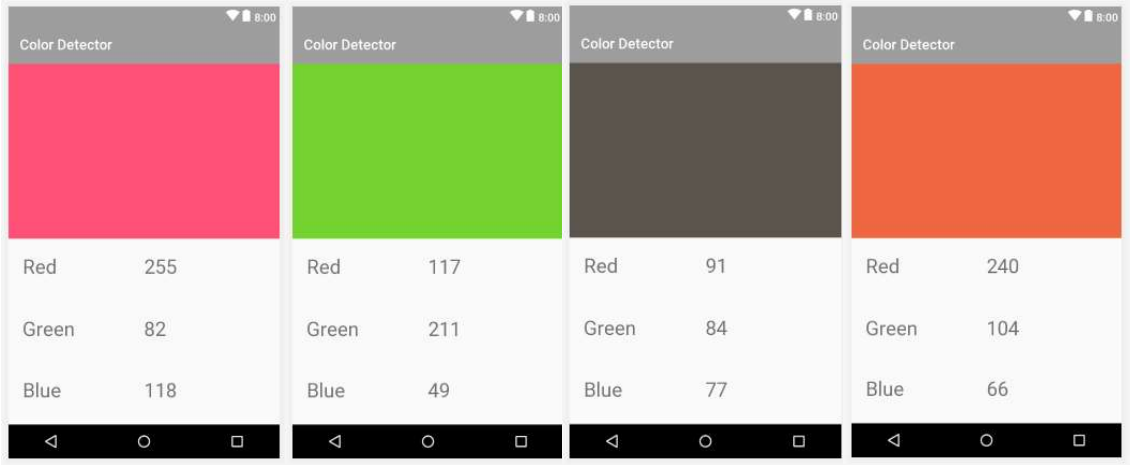


Fig. 6.5 Screenshots

CHAPTER 7: TESTING

7.1 TESTING PLAN

Testing is a vital step to follow before readying of any project. Testing helps find error within the project and determination them. Testing ensures that the project developed is of course and prepared to deploy.

We also made some check cases to see them to make sure that app is functioning evidently. As we included the hardware part in project, so to make it work efficiently, we have to test our product as well.

7.2 TEST CASES

- Function Testing
  It includes checking of functionality that is promised to work. Here in functionality testing, we found that the infrared signals and the Bluetooth connection to smartphone are affecting the color detector and hence it reads the faulty measures. So we applied a black cover around the sensor to prevent it from surrounding infrared signals.
  Our app crashed several times after running for more than 7-8 color detection. So, that was also solved. Bluetooth background connection was previously kept on but it is irritating when we want to close it. So that is also solved by keeping Bluetooth to be closed when user comes outside from that activity.

- Android UI Testing
  The UI we provided, is very simple to use. There are only 2 main activities that user needs to interact. So that, this portion of testing UI has been processed easily.

- Compatibility Testing
  Our application supports on minimum API 22 on android that is Android 5.1 Lolipop. The target android version is 27 that is Android 8.1, Oreo.

- Security Testing

  As mentioned before, the app can only be accessible for a single user at a time. Now the data passing through Bluetooth is not highly secured as there is not any reason behind high security because the user uses only to detect the colors. However, we tried to make our application secured with pro-guard rules and minify to obfuscate the code.

7.2.1 Purpose

By creating and running unit tests against our code, we can easily verify that the logic of individual units is correct. Running unit tests after every build helps you to quickly catch and fix software regressions introduced by code changes to our app. This helps to create our product more efficient, reliable and secured and easy to use.

7.2.2 Required Input

Required inputs were different for different tests. Main inputs are to pass the color detected from Arduino to android.

7.2.3 Expected Result

We have ensured that there is no unexpected result in any cases. Product is working properly for these much of testing case. However, any unexpected result will be tried to resolve as soon as possible.

CHAPTER 8: Limitation and Future Enhancement

Here we implemented the stepper motor with some basic concepts. For industries to work with this product, they need more control over the stepper motor and application. For example, they need the motor to be like of tray where any object is placed the color is given as output or they need the stepper motor to be having more stops and having different direction according to preference. So in future enhancement, that kind of improvement or addition can be done.

Android app is having less control for Bluetooth connections. It is not possible now to connect to other Bluetooth module that is detecting color. So the manual setting can be added to the application to make it more controllable

To enhance the user flexibility, we can add a more thing to understand the user activity in future versions. We can store the detected data to android application and then to the server to manage and see the day to day data collection from sensor with application and website.

Now the Arduino based product is working fine but one can make it small by programming the current requirement with one small IC and that reduces the size of product.

CHAPTER 9: CONCLUSION

We have tried to provide the solution to the people of society having visionary impairment to understand the colors of objects in life. Hopefully, this can solve their problems with sensing colors as smartphone is now a part of life and getting the result there makes it easy to process. The other use we have focused is on industry to define object colors with low cost compared to other techniques. There are much future enhancements in this topic but as of now this can serve the basics to them.

References

[1] M.Anil Kumar, Dr. S. A. K. Jilani, Mr. U.Sreenivasulu, Mr. S. Javeed Hussain *"Automated Color Recognition System for Visually Challenged and Achromatopsia People using Arduino and Mobile App"* (IJARECE) Volume 4, Issue 8, August 2015

[2] TAOS Inc 2003, 'TCS230 Programmable Color Light-to-Frequency Converter', Product Datasheet TAOS046 – February 2003.

[3] HC-05 Bluetooth Module Datasheet

[4] 28BYJ-48 Stepper Motor and ULN2003 Driver

[5] Color Sensor calibration: www.43oh.com

[6] Arduino tutorials: www.arduino.cc

[7] Other websites like howtomechatronics.com, www.hackster.io, www.youtube.com, www.stackoverflow.com, etc.

[8] www.dronebotworkshop.com/stepper-motors-with-arduino/