Sudan University of Science and Technology

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Electronics Engineering Department

Automatic Colour Level Detection Conveyor System

A Research Submitted in Partial Fulfilment for the Requirements of the Degree of B.Eng. (Honors) in Electronics Engineering

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March 2022

الآيـــة

بسم الله الرحمن الرحيم

قال تعالى:

﴿قَالُوا سُبْحَانَك لَاعِلْمَلَنَا إِلَّا مَاعَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ﴾

صدق الله العظيم

ACKNOWLEDGEMENT

We extend our thanks to all who stood

With us to achieves this research which

It came because of grace of God

And reconcile. We would like to give special thanks

Our supervisor Prof: Ashraf Gasim Elsid Abdalla

For his great help and support.

And our teachers that gave us information and all staff in the University. Finally, yet importantly we dedicate this project for everyone that helped us to be at the place that we are today.

DEDICATION

Dedication to my mother…

Whit warmth and faith...

Dedication to my father…

Whit love and respect …

Dedication to my friends..

Whom we cherish their friendship

Dedication to my special people

Who mean so much to me…

Dedication to all my teachers …

In whom I believe so much …

ABSTRACT

This project aims to design and implement a conveyor control system, capable of classifying colors. The system was built based on Arduino Mega that sense colors through sensors and decide its suitability. Moreover, three servo motors were used to control the conveyer movement, remove unsuitable produce which classified as class I and class II remove. It allows class I to pass through the production line. The system was implemented successfully, with a limitation on product weight and size, and a low-speed movement.

المستخلص

يهدف هذا المشروع إلى تصميم وتنفيذ نظام تحكم في الناقل قادر على تصنيف الألوان ، وقد تم بناء النظام حول Arduino Mega الذي يستشعر الألوان من خلال أجهزة الاستشعار ويقرر ما يصنف المنتج عليه. علاوة على ذلك ، تم استخدام ثلاثة محركات مؤازرة للتحكم في حركة الناقل ، وإزالة المنتجات الخاصة بمنتج الكشف من الفئة الأولى وإزالة المنتج من علبة الناقل ، حيث يصنف Arduino المنتج على أنه فئة II. تم تنفيذ النظام بنجاح ، مع تقييد وزن المنتج وحجمه ، وحركة منخفضة السرعة.

Table of Content

CHAPTER **TITLE** **PAGE**

الآيــــة I
ACKNOWLEDGEMENT II
DEDICATION III
ABSTRACT...IV
المستخلص... V
Table of Content VI
List of Tables... VIII
List of Figures IX
CHAPTER ONE 1
INTRODUCTION... 1
1.1 Background.. 1
1.2 Problem definition.. 3
1.3 Objectives.. 3
1.4 Thesis Layout... 3
CHAPTER TWO 4
LITERATURE REVIEW 4
2.1 Conveyor system.. 4
2.2 Bluetooth Technology 11
2.3 related works.. 12
CHAPTER THREE 16
METHODOLOGY 16
3.1 System Block Diagram.. 16

3.2 Requirements and Components 16
3.4 Programming Environment 27
CHAPTER FOUR 30
RESULTS AND DISCUSSION 30
4.1 Circuit Diagram 30
4.2 Testing Colour Sensor (TCS230 Operation) 31
4.3 Testing Servo Moros 33
4.4 Final Circuit Design 36
CHAPTER FIVE 38
CONCLUSION AND RECOMMENDATION 38
5.1 Conclusion 38
5.2 Recommendations 38
REFERENCE 39
Appendix 41

List of Tables

Table 4. 1: similarly, different types of photodiodes can be chosen by different combinations of s2 and s3. 32
Table 4. 2: Sensor Frequency Scaling. 33

List of Figures

FIGURE NO **TITLE** **PAGE**

Figure 1. 1: automated production line. 2

Figure 2. 1: Automated Conveyor System. 4
Figure 2. 2: Airport Luggage Conveyor. 6
Figure 2. 3: Overview of conveyor system Parts. 8

Figure 3. 1: System Block Diagram. 16
Figure 3. 2: Arduino Mega Sample Board. 18
Figure 3. 3: System Flow Chart. 19
Figure 3. 4: shows a typical single-turn potentiometer. 20
Figure 3. 5: shows a resistor 4 Band. 21
Figure 3. 6: Liquid Crystal Display. 22
Figure 3. 7: Front of Bluetooth Module. 23
Figure 3. 8: Bottom of the Bluetooth Module. 23
Figure 3. 9: Servo Motor Pin-Out. 25
Figure 3. 10: Wiring Liquid Crystal Display. 26
Figure 3. 11: Interfacing Bluetooth Module to Arduino. 26
Figure 3. 12: Interfacing Servo Motor to Arduino. 27
Figure 3. 13: Arduino IDE Sketch. 28
Figure 3. 14: Proteus splash screen. 29

Figure 4. 1: Control System Circuit Diagram. 31
Figure 4. 2: Colour Sensing IC 31
Figure 4. 3: Servo Pulse to Position. 34
Figure 4. 4: powering up servo motor. 35
Figure 4. 5: Top Circuit View. 36
Figure 4. 6: Front View to the Circuit Layout 37

CHAPTER ONE

INTRODUCTION

1.1 Background

A production line is a set of sequential operations established in a factory where components are assembled to make a finished article or where materials are put through a refining process to produce an end-product that is suitable for onward consumption Typically, raw materials such as metal ores or agricultural products such as foodstuffs or textile source plants like cotton and flax require a sequence of treatments to render them useful. For metal, the processes include crushing, smelting and further refining. For plants, the useful material has to be separated from husks or contaminants and then treated for onward sale. In production line conniver is used [1].

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transport of heavy or bulky materials. Conveyor systems allow quick and efficient transport for a wide variety of materials, which make them very popular in the material handling and packaging industries. They also have popular consumer applications, as they are often found in supermarkets and airports, constituting the final leg of item/ bag delivery to customers. Many kinds of conveying systems are available and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys [2].

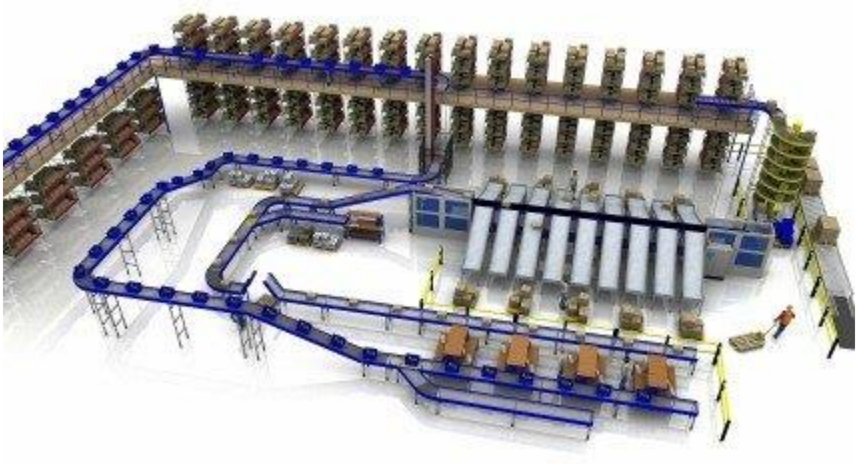

Figure 1. 1: automated production line.

Conveyor systems are commonly used in many industries, including the Mining, automotive, agricultural, computer, electronic, foodprocessing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand. Some individual areas that are helpful to consider are the required conveyor operations, such as transport, accumulation and sorting, the material sizes, weights and shapes and where the loading and pickup points need to be [3].

1.2 Problem definition

When it comes to automation in industries, a problem occurs while detecting 2^{nd} and 3^{rd} quality in Conveyor, in this project the quality for the products are classified through the colour, so eye detection may not be the efficient way to control the quality in production line.

1.3 Objectives

- To design and implement a Conveyor system capable of detecting colour codes for the products and classify it in 2^{nd} and 3^{rd} quality.
- To use colour code sensor to classify products.
- To design a Conveyor system and control it through Arduino and servo motors.

1.4 Thesis Layout

This thesis consists of five chapters, in chapter two the literature review was included, while chapter three includes the methodology of the project, in chapter four the results and discussion, while chapter five includes the conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conveyor system

A conveyor system is a fast and efficient mechanical handling apparatus for automatically transporting loads and materials within an area. This system minimizes human error, lowers workplace risks and reduces labour costs among other benefits. They are useful in helping to move bulky or heavy items from one point to another. A conveyor system may use a belt, wheels, rollers, or a chain to transport objects [4].

Figure 2. 1: Automated Conveyor System.

Typically, conveyor systems consist of a belt stretched across two or more pulleys. The belt forms a closed loop around the pulleys so it can continually rotate. One pulley, known as the drive pulley, drives or tows the belt, moving items from one location to another. The most common conveyor system designs use a rotor to power the drive pulley and belt. The belt remains attached to the rotor through the friction between the two surfaces. For the belt to move effectively, both the drive pulley and idler must run in the same direction, either clockwise or counter clockwise. While conventional conveyor systems such as moving walkways and grocery store conveyors are straight, sometimes, the unit needs to turn to deliver the items to the proper location. For the turns, there are unique cone-shaped wheels or rotors which allow the belt to follow a bend or twist without getting tangled [5].

2.1.1 Benefits of Conveyor Systems

The main purpose of a conveyor system is to move objects from one location to another. The design allows for movement of objects that are too heavy or too bulky for humans to carry by hand. Conveyor systems save time when transporting items from one location to another. As they can be inclined to span multiple levels, they make it simpler to move items up and down floors, a task that, when performed manually by humans, causes physical strain. Inclined belts can automatically unload material, eliminating the need for someone to be on the opposite end to receive pieces [6].

Figure 2. 2: Airport Luggage Conveyor.

It can be probably imagine a large warehouse filled with conveyors using belts and rollers to move boxes and other heavy equipment, but this is just one of several types of conveyor systems. You'll also find conveyor systems in airports, where they're used to transport luggage. Other examples include escalators and ski lifts. These apparatuses still use a belt or chain and pulleys to move heavy items from one point to another [7].

There are many types of conveyor systems, including:

- Belt
- Roller
- Slat/apron
- Ball transfer
- Overhead
- Pneumatic
- Bucket
- Chute
- Magnetic

- Vertical
- Wheel
- Walking beam
- Vibrating
- Screw/auger
- Chain

Each type of conveyor serves a specific purpose. For example, a slat conveyor, made from slats or plates instead of a belt, is designed for moving heavy materials. The materials conveyed by a slat system are typically too large or heavy for traditional belt movement. An escalator is an example of a chain-driven conveyor system. Instead of having a pulley system that pulls items along, the chain conveyor uses a towing system that pulls the steps in an upward or downward motion. Ski lifts are an example of an overhead conveyor. These units use an electric track inclined to pull the chairs up or down the mountainside. Like an escalator, these systems use a chain-driven towing system [8].

2.1.2 Essential Parts of a conveyor System

There are three main parts of a conveyor system: the belt support, the pulley and the drive unit. Each component plays an essential role in the conveyor unit's operation. While all conveyor systems contain these parts, designs vary in the construction materials and where each component is located. Belt support is the component that ensures the belt moves smoothly [9].

Figure 2. 3: Overview of conveyor system Parts.

If the support unit is not firm, the belt sags when workers place a heavy object on top, and the sagging causes the belt not to move smoothly or swiftly as it should. The use of a firm support unit keeps the belt taut and running efficiently. The pulley system is an external component used to control the belt movement. Each unit has at least two pulleys, one that operates under power and an idle one. More complex conveyor systems may have additional rotors throughout the frame.

The drive unit allows the system to move. The unit contains a counter bearing that keeps the parts moving efficiently. This unit also allows for the belt to move in reverse and manage the repeated adjustments in direction for some systems. Some conveyor systems are manually operated. These systems still use a drive unit; however, it is not motorized [10].

2.1.3 Choosing the right Conveyor System

A conveyor more or less acts as a central nervous system for operations that receive, handle, store, distribute, manufacture or ship products. Selecting the right conveyor system can be challenging for warehouse managers and other stakeholders due to the several conveyor types and hundreds of possible configurations to choose from. Also, there are several factors to consider when trying to identify and purchase the ideal conveyor system for your warehousing or distribution facility. You should simultaneously consider both product and process requirements [11].

A) First off, an ideal conveyor system must be:

- Operationally safe
- Energy efficient
- Reliable (parts and components engineered to last)
- Adaptable to changing needs
- Cost-effective (in terms of TCO, or total cost of ownership)

Installing the wrong conveyor system will quickly undermine a warehouse's operational efficiency, leading to higher cost and lower customer satisfaction, eventually stripping the business of its competitive advantage. Without further ado, let's explore factors to consider when evaluating and selecting the right conveyor system for your operation [10].

B) Process requirements

Process requirements cover factors governing how the conveyor should move and the unique conditions of the operating environment. These considerations include:

- The distance items need to move between functional areas
- The pathway through which it moves — are there stops, elevation changes, curves or diversions?
- Product orientation — must items be positioned in a particular way (for easy scanning of barcodes, transfer, etc.)?
- Transfer speed — short, rapid movement or slow, steady movement?
- Ambient environment
- Available space

- **Flow rate**

Conveyor system should be able to handle your facility's average transfer rate as well as periods of peak demand due to seasonal fluctuations. The number of products you need to transport per hour (or per minute) will determine conveyor length and speed. Also, certain kinds of conveyors are ideal for certain products. A large plastic chain conveyor is best used for transferring plastic-footed pallets, while a chain-driven roller conveyor is best suited for wooden pallets. Also, the former is best used for moving smaller boxes or totes than the latter.

- **Transfer requirements**

The point where items are transferred to and from the conveyor is a critical one. Most conveyors use side to side transfers, powered transfers, dead plates, gravity rollers, etc. to facilitate this. Products with a smaller footprint may require a powered transfer, while larger and longer products may need gravity rollers.

2.2 Bluetooth Technology

Bluetooth is a short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances using UHF radio waves in the ISM bands, from 2.402 to 2.48 GHz, and building personal area networks (PANs).[3] It is mainly used as an alternative to wire connections, to exchange files between nearby portable devices and connect cell phones and music players with wireless headphones. In the most widely used mode, transmission power is limited to 2.5 milliwatts, giving it a very short range of up to 10 meters (33 ft.). Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device. A network of patents applies to the technology, which are licensed to individual qualifying devices. As of 2009, Bluetooth integrated circuit chips ship approximately 920 million units annually. By 2017, there were 3.6 billion Bluetooth devices shipping annually and the shipments were expected to continue increasing at about 12% a year [11].

2.2.1 Bluetooth Applications

- Wireless control and communication between a mobile phone and a hands-free headset. This was one of the earliest applications to become popular.
- Wireless control of and communication between a mobile phone and a Bluetooth compatible car stereo system (and sometimes between the SIM card and the car phone).
- Wireless communication between a smartphone and a smart lock for unlocking doors.
- Wireless control of and communication with iOS and Android device phones, tablets and portable wireless speakers.
- Wireless Bluetooth headset and intercom. Idiomatically, a headset is sometimes called "a Bluetooth".
- Wireless streaming of audio to headphones with or without communication capabilities.
- Wireless streaming of data collected by Bluetooth-enabled fitness devices to phone or PC.

2.3 related works

The authors in [12] discuss that Transmission lines are prone to a wide variety of faults due to transmission lines conditions. Diagnosing the fault is difficult and entire cable should be replaced. This project is intended to detect the location of fault in transmission line cable lines from the base station in km using a microcontroller. In case of fault, the voltage across series resistors changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed. It further displays fault location in distance. Using GPS, location can be tracked. The fault occurring distance, phase, and time is displayed on a 16X2 LCD interfaced with the microcontroller. IOT is used to display the information over Internet using the Wi-Fi module. A webpage is created using HTML coding and the information about occurrence of fault is displayed in a webpage.

The authors in [13] discuss that Arduino.cc created the Arduino Nano, an 8-bit open-source microcontroller board. The board has a number of digital and analog input/output pins that can be used to connect to other circuits. A visitor counter is a device that measures visitor traffic entering and exiting institutions, recreational centers, malls, etc with the incorporation of an energy-saving lighting system in a bid to maximize energy consumption whilst providing crowd control and crowd traffic information. This thesis is based on the design of an Arduino Nano bi-directional visitor counter using Baze University as a case study. With the emergence of the Covid-19 pandemic and the need to enforce social distancing guild lines the importance of the digital counter increases daily. The primary idea behind this project is to calculate and show the number of people entering any environment, such as a lecture hall, a conference room. The LCD monitor located outside the room shows the number of individuals in the room. This counter is said to be bi-directional since if a person enters the room, the counter will be increased and decreased if a person exits the room. The counter is fitted with two ultrasonic sensors each at the exit and entrance of the enclosed room that generates a 40 kHz sound wave which when obstructed reads as an individual entering or leaving the environment. In various enclosed settings, such as seminar halls, where space capacity is limited and should not be exceeded, implementations of these systems are important. The device will show the exact number of people inside the room and potential system upgrades include adding a voice warning system to signify when the room limit is exceeded and people can no longer enter inside compared to the buzzer already included. The counter is fitted with a relay system which powers the lighting system. The counters system project achieved crowd control to enable social distancing whilst implementing small-scale energy conservation.

The authors in [14] discuss that the experimental implementation of optically powered wireless sensor nodes based on the power-over-fiber (PoF) technology, aiming at Industrial Internet of Things (IIoT) applications. This technique employs optical fibers to transmit power and is proposed as a solution to address the hazardous industrial environment challenges, e.g., electromagnetic interference and extreme temperatures. The proposed approach enables two different IIoT scenarios, in which wireless transmitter (TX) and receiver (RX) nodes are powered by a PoF system, enabling local and remote temperature data monitoring, with the purpose of achieving an intelligent and reliable process management in industrial production lines. In addition, the system performance is investigated as a function of the delivered electrical power and power transmission efficiency (PTE), which is the primary performance metric of a PoF system. We report 1.4 W electrical power deliver with PTE = 24%. Furthermore, we carry out a voltage stability analysis, demonstrating that the PoF system is capable of delivering stable voltage to a wide range of applications. Finally, we present a comparison of temperature measurements between the proposed approach and a conventional industrial programmable logic controller (PLC). The obtained results demonstrate that PoF might be considered as a potential technology to power and enhance the energy efficiency of IIoT sensing systems.

The authors in [15] discuss that Software reuse has potential for educational purposes since it uses decomposition and abstraction, two necessary skills to learn programming. Software reuse techniques require abstractions that are not obvious to students or even to professionals. Taking advantage of these techniques, students can learn computer programming in a productive and organized way. This paper proposes to use the Software Product Line (SPL) reuse technique as a strategy for learning to program industrial robots with the Arduino platform. First, the paper explains SPL construction and application with first-year university students. The SPL proposes abstractions close to the industrial robots domain with a simplified variability. The paper uses the case study method to show the feasibility of using the SPL approach in a learning environment. In this evaluation, students reused 38% to 43% of the total code needed to program the robot. It represents an improvement in the time it takes students to program industrial robotics solutions facilitating their learning. In addition, the paper unveils some limitations related to usability, specific knowledge, and some exploitable technologies.

CHAPTER THREE

METHODOLOGY

3.1 System Block Diagram

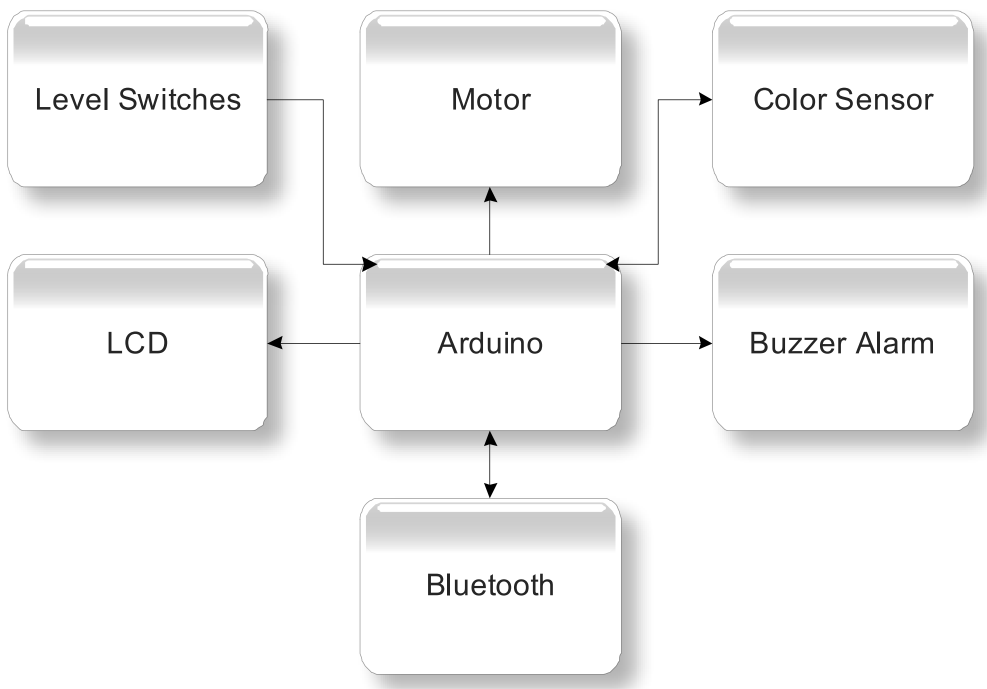

Figure 3. 1: System Block Diagram.

3.2 Requirements and Components

There are ten main component which are :

3.2.1 Arduino Development Board

Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

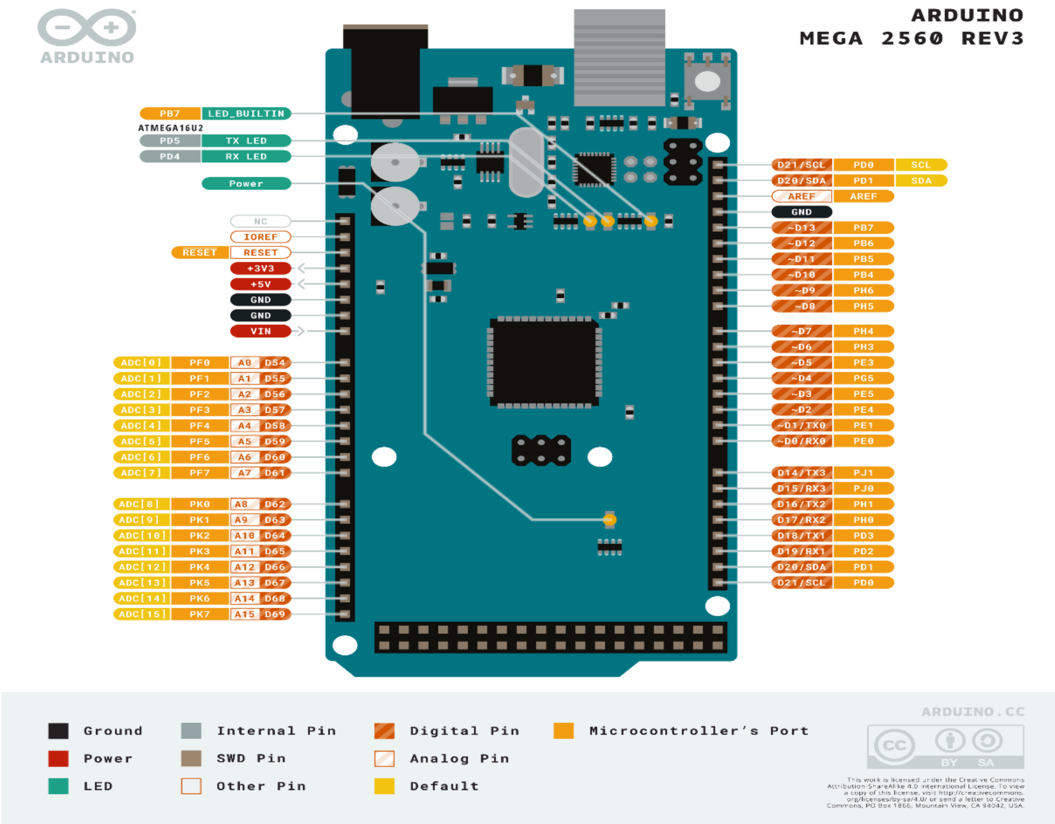

Figure 3. 2: Arduino Mega Sample Board.

Figure (3.3) represent the system flow chart used for programming the Arduino.

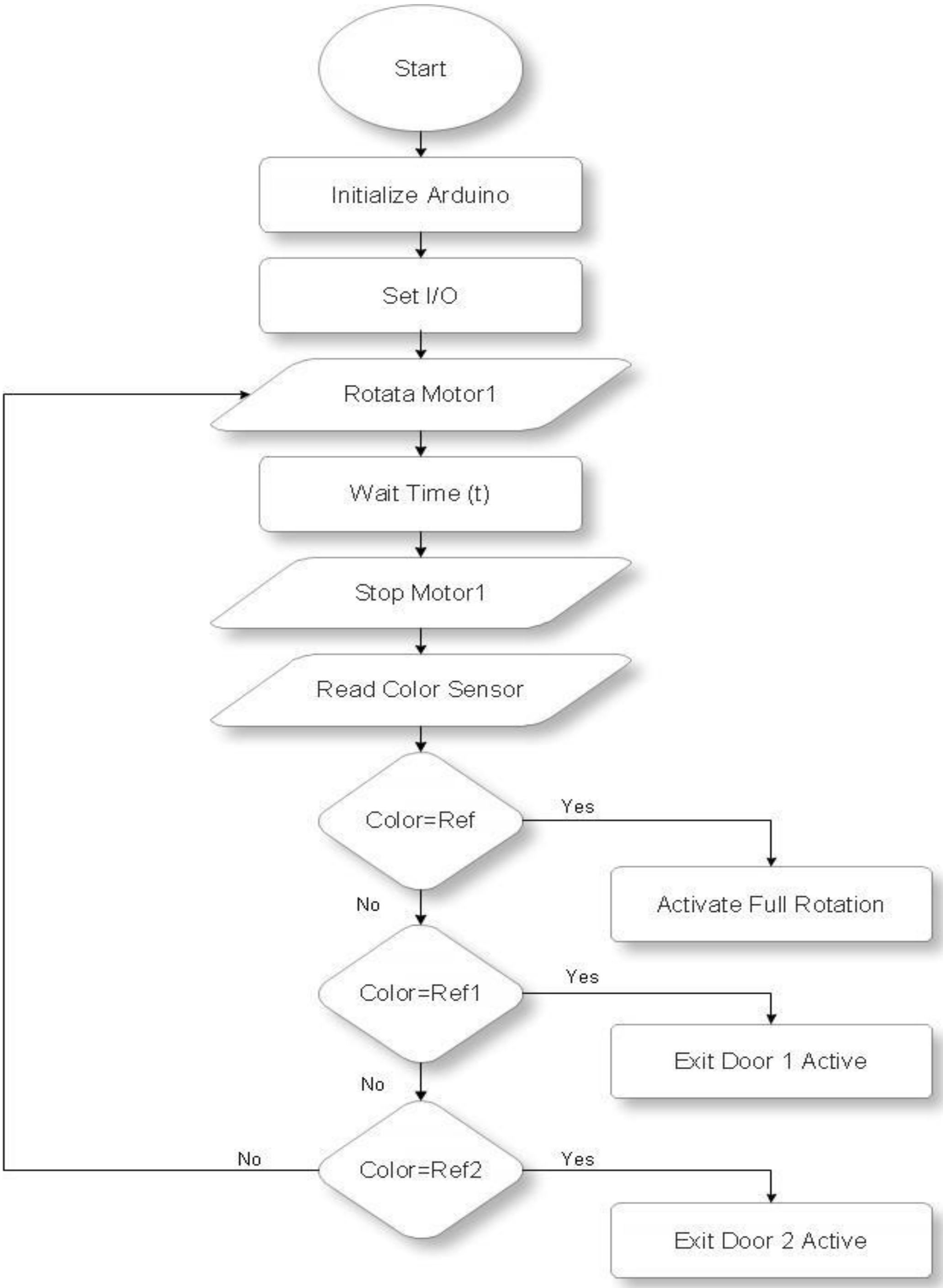

Figure 3. 3: System Flow Chart.

3.3.2 Potentiometer

A potentiometer measuring instrument is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

Figure 3. 4: shows a typical single-turn potentiometer.

Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.

3.3.3 Coloured Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. Thus, the ratio of the voltage applied across a resistor's terminals to the intensity of current through the circuit is called resistance. This relation is represented by Ohm's law:[16].

$$\mathbf{I} = \frac{\mathbf{V}}{\mathbf{R}} \qquad (3.2)$$

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analogy devices, and can also be integrated into hybrid and printed circuits.

Figure 3. 5: shows a resistor 4 Band.

3.3.5 Liquid Crystal Display

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome.

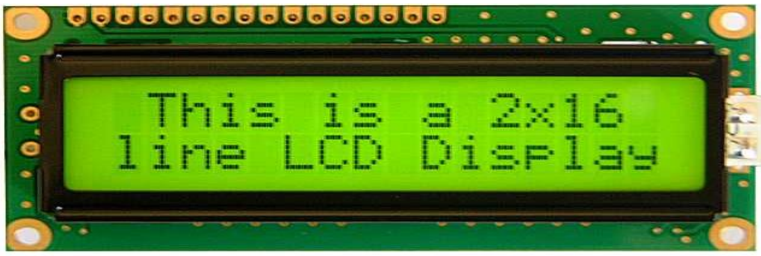

Figure 3. 6: Liquid Crystal Display.

3.3.6 HC-05 Bluetooth Module

- It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications.
- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

- HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.

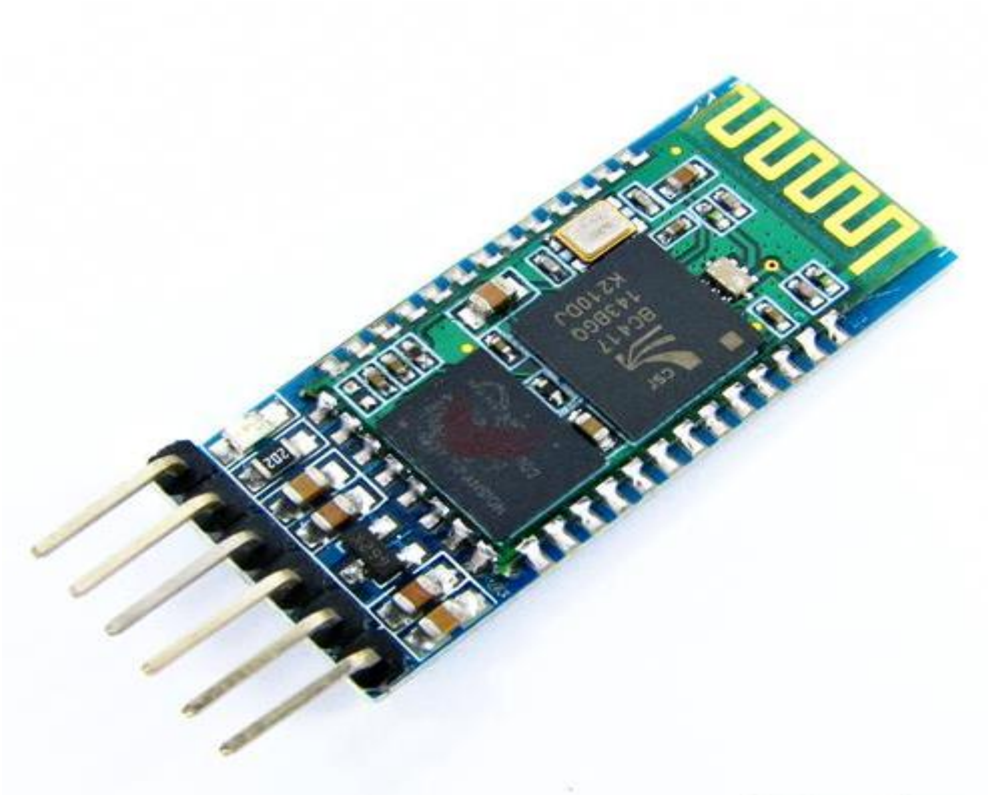

Figure 3. 7: Front of Bluetooth Module.

Figure 3. 8: Bottom of the Bluetooth Module.

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

1. **Key/EN:** It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

2. **Data mode:** Exchange of data between devices.
3. **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.
4. **VCC:** Connect 5 V or 3.3 V to this Pin.
5. **GND:** Ground Pin of module.
6. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)
7. **RXD:** Receive data serially (received data will be transmitted wirelessly by Bluetooth module).
8. **State:** It tells whether module is connected or not.

3.3.7 Servomotor

A servomotor (or servo motor) is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery, and automated manufacturing.

Figure 3. 9: Servo Motor Pin-Out.

3.3.8 Interfacing LCD to Arduino Mega

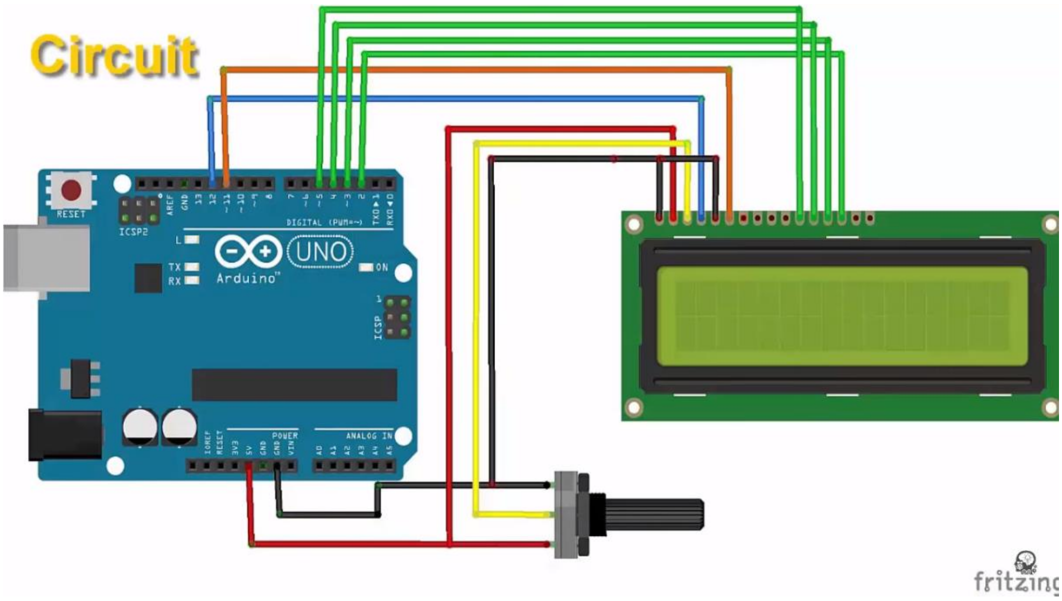

Figure 3. 10: Wiring Liquid Crystal Display.

3.3.9 Bluetooth wiring

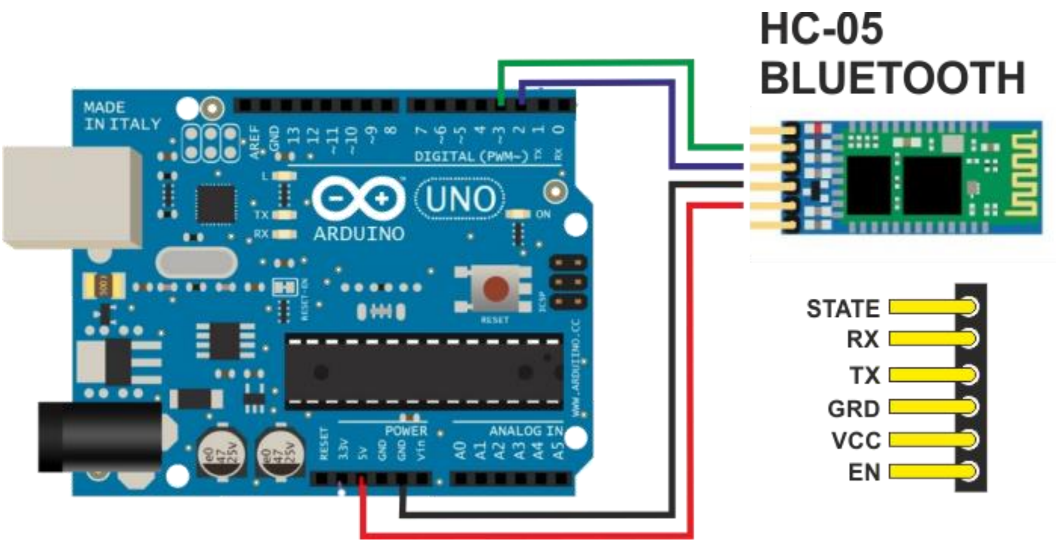

Figure 3. 11: Interfacing Bluetooth Module to Arduino.

3.3.10 Interfacing Servo motor

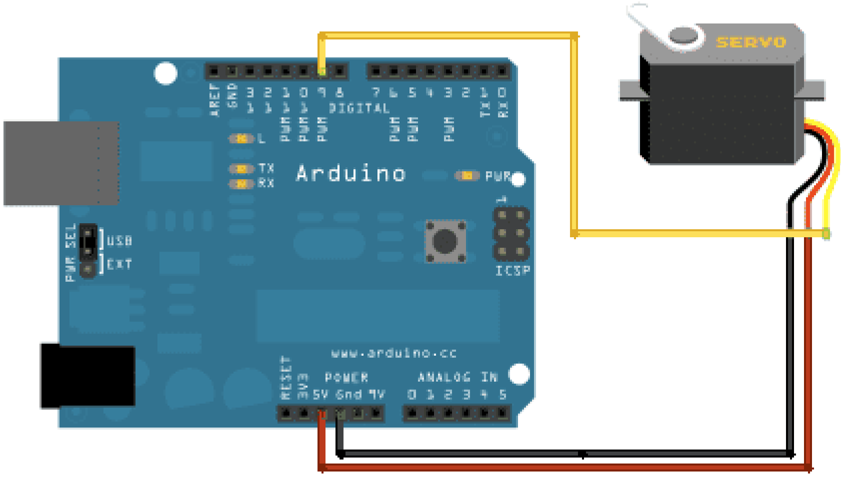

Figure 3. 12: Interfacing Servo Motor to Arduino.

3.4 Programming Environment

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone.

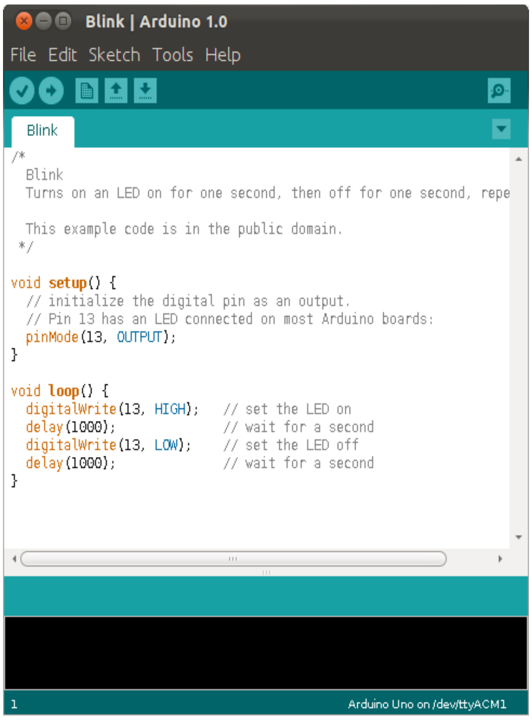

Figure 3. 13: Arduino IDE Sketch.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project. The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy,[2] aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors. The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

3.4.1 Proteus Design Suite

The Proteus Design Suite is an Electronic Design Automation (EDA) tool including schematic capture, simulation and PCB Layout modules. It is developed in Yorkshire, England by Lab center Electronics Ltd with offices in North America and several overseas sales channels. The software runs on the Windows operating system and is available in English, French, Spanish and Chinese languages.

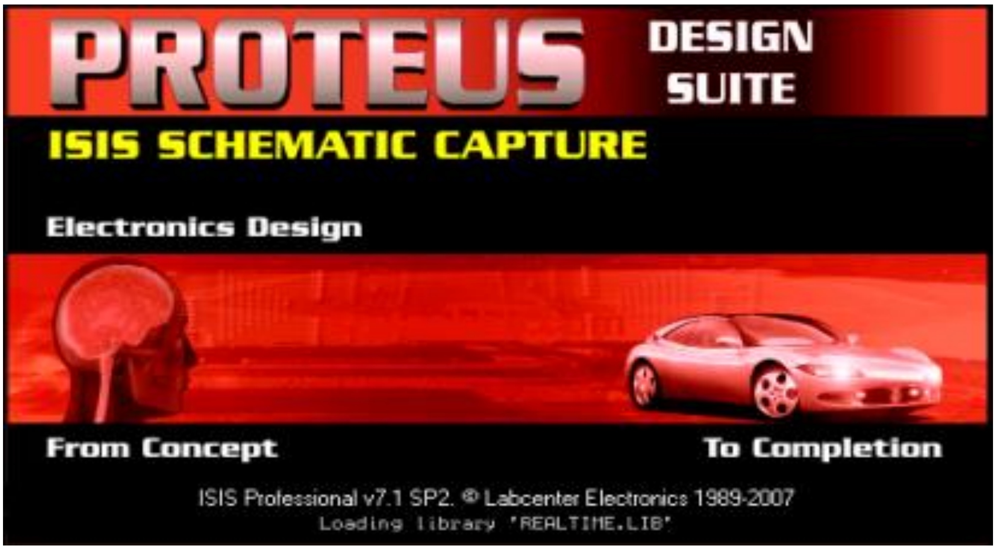

Figure 3. 14: Proteus splash screen.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Circuit Diagram

The following chapter represent the, results and discussion for the circuit diagram, colour sensor and servo motors. Figure 4.1 represent the system circuit diagram; the LCD was attached to the Arduino in order to view sensor colour, a Bluetooth module was attached through the TX and RX and it was used to send the situation of the circuit, servo motors attached in order to move conveyer, push products class I and Class II out of the conveyor, the colour sensor used for sensing colours and differentiate between them, and three limited switches was used to verify the position of the product in conveyer.

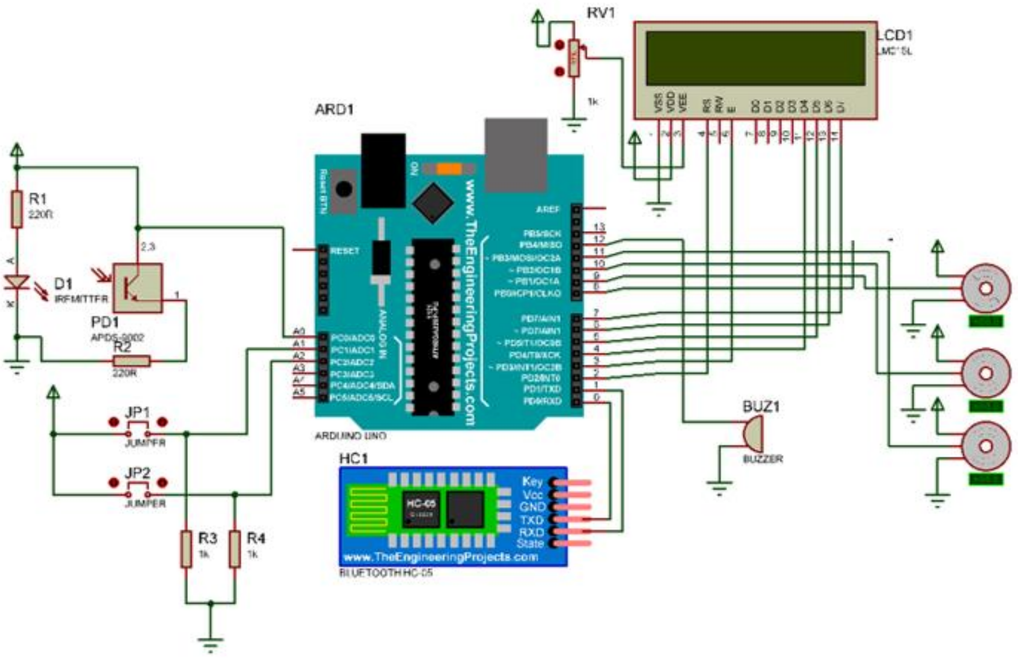

Figure 4. 1: Control System Circuit Diagram.

4.2 Testing Colour Sensor (TCS230 Operation)

The TCS230 detects colour with the help of an 8 x 8 array of photodiodes, of which sixteen photodiodes have red filters, 16 photodiodes have green filters, 16 photodiodes have blue filters, and remaining 16 photodiodes are clear with no filters.

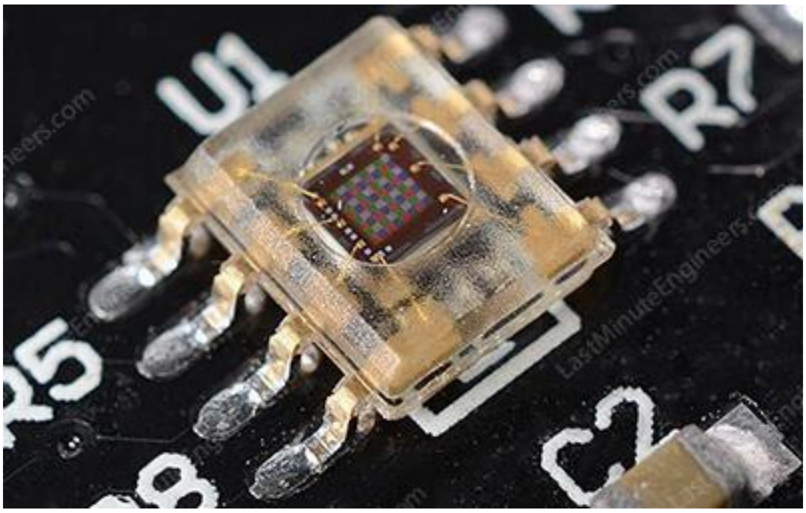

Figure 4. 2: Colour Sensing IC.

Each 16 photodiodes are connected in parallel, so using two control pins S2 and S3 user can choose which of them to read. So for example, if user want to detect only red colour, you can select 16 red-filtered photodiodes by setting the two pins to LOW according to the table.

Table 4. 1: similarly, different types of photodiodes can be chosen by different combinations of s2 and s3.

S2	S3	Photodiode type
LOW	LOW	Red
LOW	HIGH	Blue
HIGH	LOW	Clear (No filter)
HIGH	HIGH	Green

An internal current-to-frequency converter converts readings from photodiodes into a square wave whose frequency is proportional to the intensity of the chosen colour. The range of the typical output frequency is 2HZ~500KHZ.

The sensor has two more control pins, S0 and S1, which are used for scaling the output frequency. The frequency can be scaled to three different present values of 2%, 20% or 100%. This frequency-scaling function allows the sensor to be used with a variety of microcontrollers and other devices.

Table 4. 2: Sensor Frequency Scaling.

S0	S1	Output frequency scaling
LOW	LOW	Power down
LOW	HIGH	2%
HIGH	LOW	20%
HIGH	HIGH	100%

Different scaling can be obtained by different combinations of S0 and S1. For the Arduino most applications use the 20% scaling.

4.3 Testing Servo Moros

The third pin of the servo connector carries the control signal, used to tell the motor where to go. This control signal is a specific type of pulse train. The pulses occur at a 20 mSec (50 Hz) interval, and vary between 1 and 2 mSec in width. The Pulse Width Modulation hardware available on a microcontroller is a great way to generate servo control signals.

Common servos rotate over a range of 90° as the pulses vary between 1 and 2 mSec -- they should be at the center of their mechanical range when the pulse is 1.5 mSec.

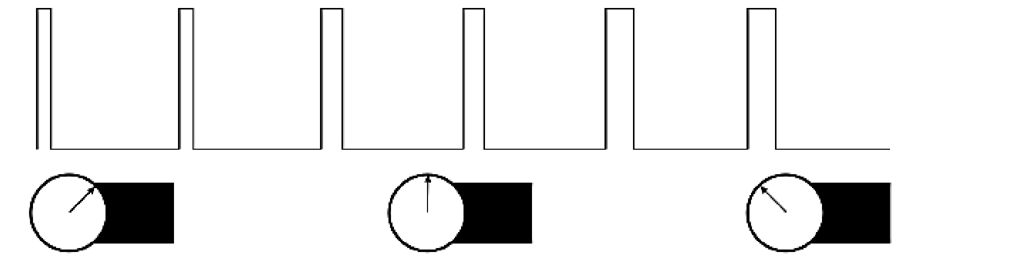

Figure 4. 3: Servo Pulse to Position.

4.3.1 Powering Servos

In RC vehicles, the nominal battery voltage is 4.8V. It will be somewhat higher after a charge, and it will droop as the batteries discharge. As the voltage drops, the available torque also drops -- if you've driven RC vehicles, you're no doubt familiar with the loss of control that occurs as the batteries get weaker. It starts to feel sluggish just before it dies.

If you're not using batteries, the 5VDC available from a garden variety power supply is a good option. If you're using an Arduino or other microcontroller (such as the SparkFun Servo Trigger) to control your motor, the absolute maximum supply voltage that should be applied is 5.5 VDC.

Regardless of how you're powering them, it's worth noting that the current consumed by the motor increases as the mechanical loading increases. A small servo with nothing attached to the shaft might draw 10 mA, while a large one turning a heavy lever might draw an Ampere or more! If your power supply isn't up to the task, a straining or stalled servo can cause the supply to sag, which may have other unpredictable repercussions, such as causing microcontrollers to reset.

Additionally, if you've got multiple servos, or in applications where the motors are moving non-trivial loads, it's best to use heavy gauge wires and give each servo a direct connection to the power supply, rather than daisy-chaining power from one to the next. This configuration is commonly known as "star power." If one servo causes the power rail to droop, it's less likely to effect the others when each has a direct connection.

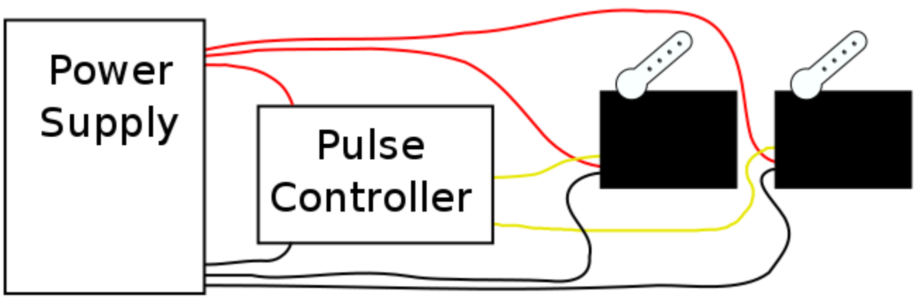

Figure 4. 4: powering up servo motor.

4.3.2 Star Power.

When in doubt, grab a mustimeter, measure the current consumed, and check whether VCC sags when the servos are turning.

4.4 Final Circuit Design

A) TOP view of circuit layout

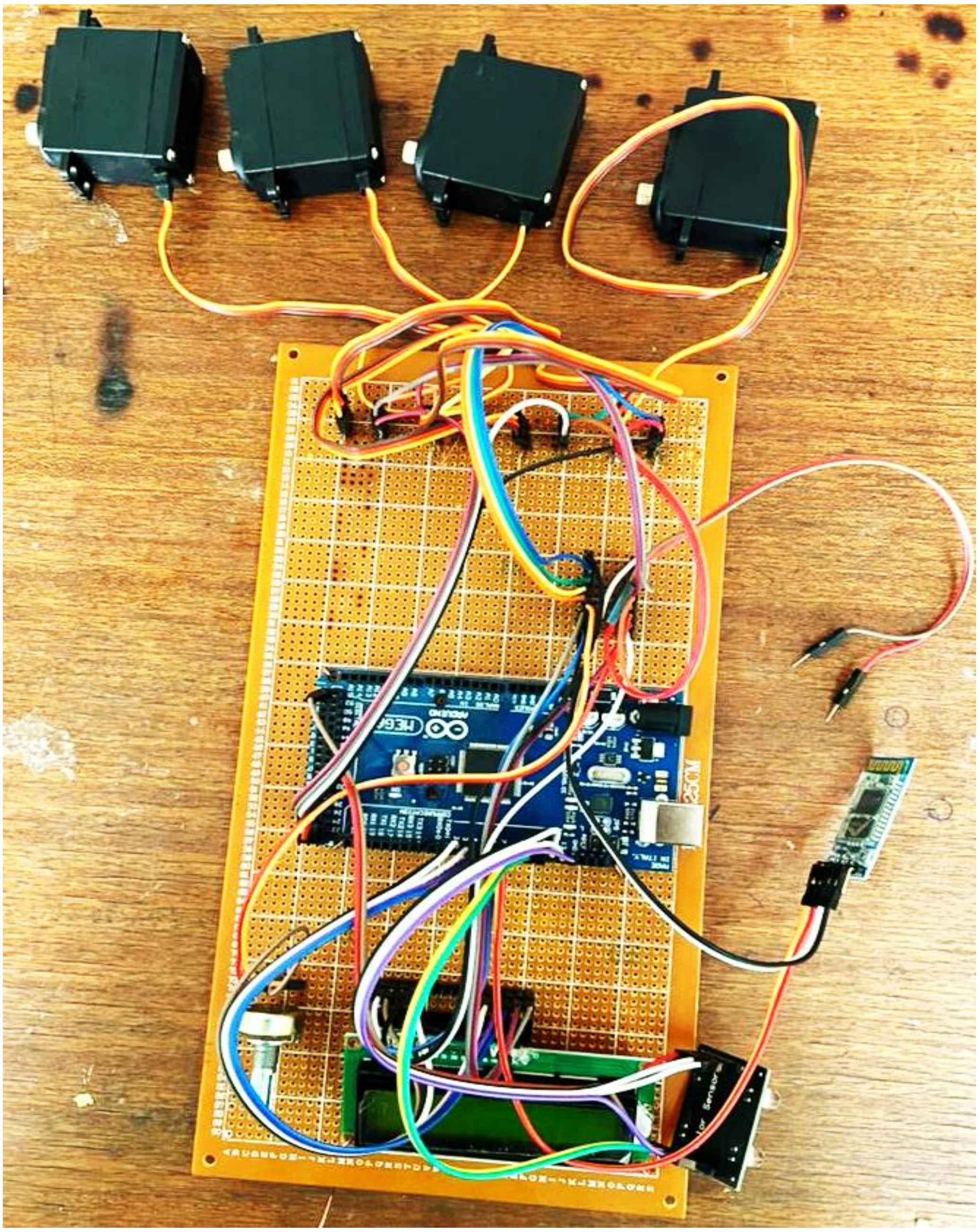

Figure 4. 5: Top Circuit View.

B) Front view of circuit layout

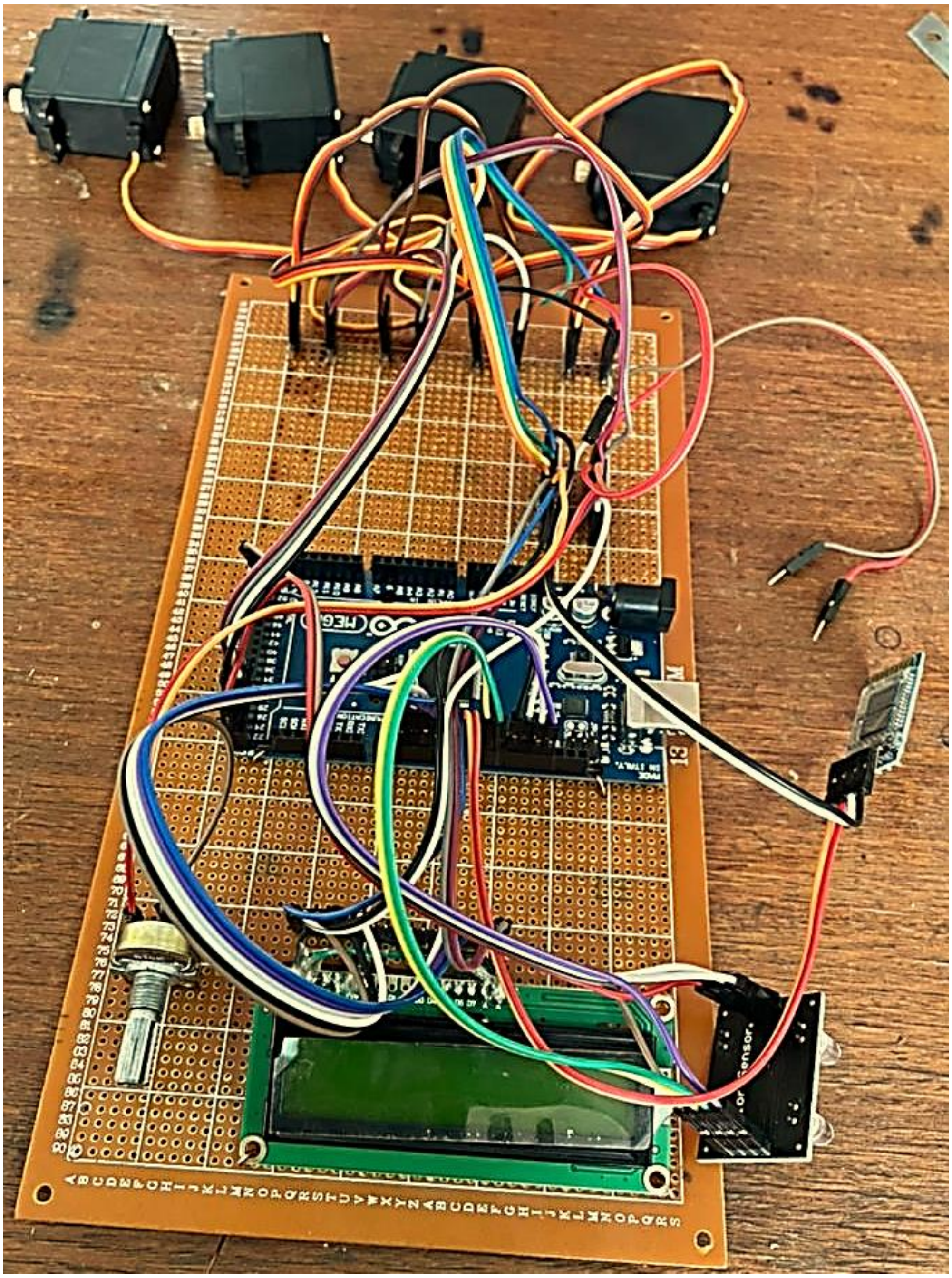

Figure 4. 6: Front View to the Circuit Layout.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The system was successfully implemented and tested for three colours, the classification was done through sensor and the control based on arduino MEGA, thus the aim of the project was done by a design and implement a conveyor control system, capable of classifying colors, the system was built around Arduino Mega that sense colors through sensors and decide what the product is classified to. Moreover, three servo motors were used to control the conveyer movement, remove produce for class I detection product and remove the product from conveyer case the Arduino classify the product as class II. The system was implemented successfully, with a limitation on product weight and size, and a low-speed movement.

5.2 Recommendations

After finishing the design and implementation of the project a recommendation was written for future development

1- Use high torque motors that can handle more weight.

2- Use IR sensor to detect product position and replace limit switches.

3- Replace LCD with a bigger one to show all of the sensor and other components status.

REFERENCE

[1] R. J. R. Corday, April, "The evolution of assembly lines: A brief history," vol. 24, 2014.

[2] H. Ford, *Today and Tomorrow: Commemorative Edition of Ford's 1926 Classic*. Routledge, 2019.

[3] K. J. S. Boozer, Technology, and S. A. S.-L. Exploration, "The Assembly Line," 2020.

[4] I. A. Daniyan, A. Adeodu, O. J. j. o. a. i. e. Dada, and technology, "Design of a material handling equipment: Belt conveyor system for crushed limestone using 3 roll idlers," vol. 1, no. 1, pp. 2348-2931, 2014.

[5] K. ÖZSOY, B. AKSOY, and M. J. E. Ü. F. B. E. D. YÜCEL, "Design and manufacture of continuous automatic 3D printing device with conveyor system by image processing technology," vol. 13, no. 2, pp. 392-403, 2020.

[6] J. Kildal, M. Martín, I. Ipiña, and I. J. P. C. Maurtua, "Empowering assembly workers with cognitive disabilities by working with collaborative robots: a study to capture design requirements," vol. 81, pp. 797-802, 2019.

[7] P. J. O. Watt, "Ford's metaphysics: On the Transcendental origins of Henry Ford's Fordism," vol. 28, no. 4, pp. 577-603, 2021.

[8] A. Scholl and C. J. E. J. o. O. R. Becker, "State-of-the-art exact and heuristic solution procedures for simple assembly line balancing," vol. 168, no. 3, pp. 666-693, 2006.

[9] N. Slack, S. Chambers, and R. Johnston, *Operations management*. Pearson education, 2010.

[10] T. Gutowski, "Introduction to manufacturing systems," ed: MIT: Cambridge, USA, 2010.

[11] D. O. N. OBIKWELU, "An Inaugural Lecture of the."

[12] S. Suresh *et al.*, "Transmission line fault monitoring and identification system by using Internet of Things," vol. 4, no. 4, p. 237112, 2017.

[13] S. Gupta, A. Talwariya, and P. Singh, "Development of arduino-based compact heart pulse and body temperature monitoring embedded system for better performance," in *Performance Management of Integrated Systems and its Applications in Software Engineering*: Springer, 2020, pp. 189-197.

[14] L. C. Souza, E. R. Neto, E. S. Lima, and A. C. S. J. S. Junior, "Optically-Powered Wireless Sensor Nodes towards Industrial Internet of Things," vol. 22, no. 1, p. 57, 2022.
[15] A. F. Solis Pino, P. H. Ruiz, and J. A. J. E. Hurtado Alegria, "A Software Products Line as Educational Tool to Learn Industrial Robots Programming with Arduino," vol. 11, no. 5, p. 769, 2022.

APPENDIX

```
#include <Servo.h>


#include <SoftwareSerial.h>

#include <LiquidCrystal.h>

/*The circuit:

 * LCD RS pin to digital pin 12

 * LCD Enable pin to digital pin 11

 * LCD D4 pin to digital pin 10

 * LCD D5 pin to digital pin 9

 * LCD D6 pin to digital pin 8

 * LCD D7 pin to digital pin 7

 * LCD R/W pin to ground

 * LCD VSS pin to ground

 * LCD VCC pin to 5V

 * 10K resistor:

 * ends to +5V and ground

 * wiper to LCD VO pin (pin 3)

*/

// initialize the library with the numbers of the interface pins
```

```
LiquidCrystal lcd(2, 3, 4, 5, 6, 7);


SoftwareSerial BT(8,9);

Servo myservo;  // create servo object to control a servo

// twelve servo objects can be created on most boards


int pos = 0;    // variable to store the servo position


void setup() {

  // put your setup code here, to run once:

Serial.begin (9600);

  BT.begin(9600);

myservo.attach(36);  // attaches the servo on pin 9 to the servo object

  delay(100);

// put your setup code here, to run once:

// set up the LCD's number of columns and rows:

  lcd.begin(16, 2);

  // Print a message to the LCD.

  lcd.print("Color Detection ");

  delay(1500);

}
```

```
void loop() {


  for (pos = 0; pos <= 360; pos += 1) { // goes from 0 degrees to 180
degrees
  // in steps of 1 degree
  myservo.write(pos);              // tell servo to go to position in variable
'pos'
  delay(15);                       // waits 15ms for the servo to reach the position
 }



}
```