
**An-Najah National University**

Faculty of Engineering & Information Technology

Department of Computer Engineering

**Hardware Graduation Project:**


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Presented in partial fulfilment of the requirements for

**Bachelor Degree in Computer Engineering**

# Contents

# 1 Disclaimer

This graduation project report was written by Mohammad Halaweh and Haytham Saleh from the Department of Computer Engineering at Najah National University, this graduation project is a requirement for Bachelor degree completion.

A disclaimer for this report is that it is worth noting that it might contain human errors.

An Najah National University does not bear or is responsible for any of this.

# 2 Acknowledgment

Before we begin, we must thank Allah for everything we have accomplished as without his blessing we would not be able to achieve anything neither the project nor anything in our journey in life, so it is a priority for us to always thank God.

We would like to take this opportunity to sincerely thank our Instructor Dr. Sulaiman Abu Kharmah for providing us the guidance we needed and for giving us the confidence and courage to complete the project and to give it all we got, which led us to overcome the difficulties we faced and achieved our goal in finishing a project that we gave our heart in.

And finally, our deepest gratitude to our families and friends who played an important part in being supportive and helpful in every step of the way, so we could accomplish a project that was just an idea and now is a real thing.

# 3 Abstract

In light of today's technological development and as we have experienced from the quarantine of Coronavirus we should be aware of any other crisis that would happen in the future that would cause the same affects on any factory that would require the employees to be in quarantine, and we certainly don't want the factory to stop working because of that.

It has become necessary to use machines to reduce the number of workers in factories, for this reason we decided to work on a machine that helps factories sort goods. From our point of view, this project will help the factories to sort the goods easier and in less time without the need for a large number of workers to do this task.

One of the most important objectives of the project: facilitating the task of sorting goods at the lowest costs and the least number of workers by doing this automatically. The project consists of a conveyor belt for the goods and it's controlled by a DC motor that would move the products to the gates that would fill the containers with their products using servo motors with arm connecting to it, to close the path of the box so that it can fall to their containers using the beston and if none of the products match the description of the containers that would be filled by them it will fall in a container that would be for unspecified products, and these description of the boxes that will be placed in the container that match their description is provided from a web page interface and the user or worker provide exactly for how he wants the system to act, to place specific boxes in specific containers and be able to see how many boxes are in each container and to stop and to start the machine.

# 4 Introduction

Smart Belt is a belt that would implement on a small hardware project what could be a potential implementation on industries that would sort products and boxes and place them in large containers, it simply does the sorting of products and place them in containers and puts the burden on the machine instead of human-hands, and the duty of the workers are now about the information that is on the web page and to check are the containers filled correctly.

Since that machines are required to do the simple and obvious tasks without any errors and misses, a factory can provide much more efficient performances and

use the human-hands for more important tasks instead of simple moving boxes and waste time for tasks that a machine can do easily and precisely.

It is also important to mention that we can't just simply rely on a machine to just handle everything without the human knowledge, so we made the machine give us feedback for every action it makes and to tell the user/employee on a web page on their computer on what is currently happening in the sorting of products, and the user can change how the machine should act regarding the products as it does not behave statically which means that the user can provide it with specific details on how it should function.

# 5 Methodology

The human worker would use a web page to insert what the container should be filled with and it would give the web page the exact amount of products inside the containers, the products are all placed in a large container (stack) and it would put products on the belt individually and by using the belt it would move the box on the belt and depending on which container it should be placed in.

When a product arrives at the beginning of the belt there would be a sensor to detect if there is a product on the now moving belt, once it detects that it arrives the belt stops and there would be a color sensor to check the type of the product and depending on what the container is defined to be filled with on the web page it will decide on which gate it would stop at and be filled on the container next to it, so the moving product on the belt is now defined and it is known on which container it should be filled in and which gate it should stop at.

Now what happens is that at each gate there is a servo motor that would close the path of the product moving on the belt and a beston would push the product to fall in the container next to it, once it falls the servo motor will go to its initial place and we can expect another product to come in.

So in our project, we have 3 containers and 3 gates so if the user enters the values in the web page red, yellow, blue. The products will be placed in these containers, however what if there was a product with the color black?

What happens is that at the end of the belt there would be a container for unspecified items which means none of the gates accepted this color to fill in their container so it would reach the end of the belt and be placed in the unspecified container.

1) 38g S3003 Standard Servo Motor 180 Degree

*Figure 1: Servo Motor*

There are 4 servo motors:

- the first servo motor job is to push boxes into the belt from the stack that contains all different types of boxes, so when it pushes the box into the belt another box will take its place for the second turn when the first box is done and it is sorted in its container.
- The other 3 servo motor are placed at each gate to block the path at the gate of the container using an arm attached to it so the container next to it will be filled, and when they are done the servo motor will move its arm back to its place (will not block the path).

2) 16 Channel 12 Bit PWM Servo Driver I2C Interface PCA9685

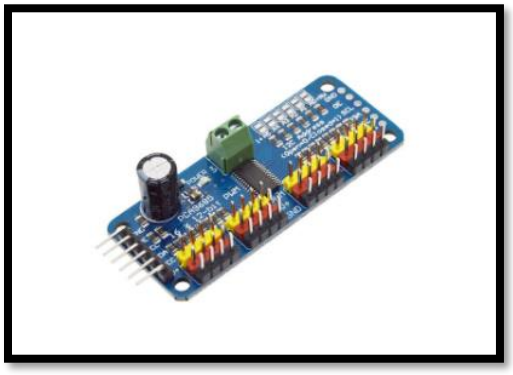


*Figure 2: Servo Driver*

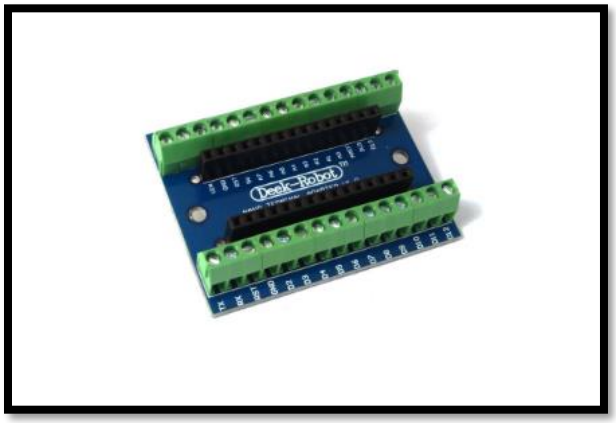
- This device will connect all the 4 servo motors, it can connect up to 16 servo motors.
- It will be connected with the esp32 and it will be connected as I2C through SCL,SDA

3) ESP32-Development-Board-ESP-WROOM-32 38pin

*Figure 3: ESP32*

- ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth.
- It is used as the main device to control the project, we connect it with the color sensor , servo motors' driver and the LCD screen

4) Terminal Adapter Shield Expansion Board For Arduino Nano V3.0 Small Screw Terminal



- It is used as a shield for the esp32 and we fix it on this device using screws

5) CJMCU-29125 ISL29125 RGB Color Sensor Module

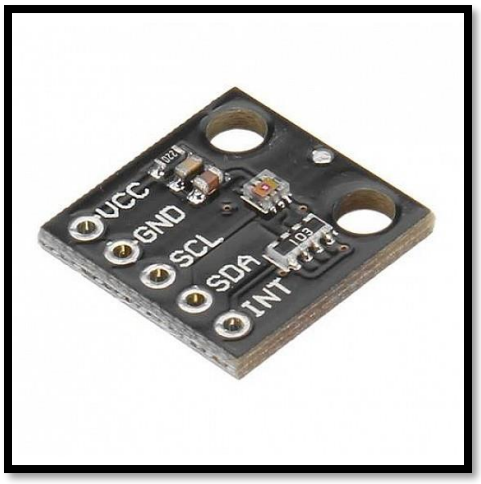



*Figure 5: RGB Color Sensor*

- It is connected with the esp32, and it is used to analyze the color of the box so we can use that value to determine if it belongs on one of the containers or not.

6) I2C LCD Module 20X4 2004


*Figure 6: I2C LCD module*

- It is used to display the number of products in each containers.

7) IR Infrared Adjustable Proximity Sensor 3-80cm E18-D80NK 5V

*Figure 7: IR Sensor*

- It is used to determine if there is a box on the belt or not, if there is the belt will start moving so it can be sorted in the container it belongs into, if not it still awaits a box from the stack that holds all the boxes.

8) 12V 5A Power Supply

*Figure 8: Power Supply*

- It is used to provide power for all the components it will give a large voltage, although our devices need lower voltage other devices will regulate the voltage we'll discuss them below

9) L298N Dual H-Bridge Motor Drive Module Board

*Figure 9: H-Bridge Drive module*

- It is a bridge used to be able to use the DC motors, we can stop and move the direction of the DC motor depending on the values it will be given to it from the esp32.

10) 25GA-370 12V 60RPM 25mm DC Gear Motor 25GA370

*Figure 10: DC motor*

- It is connected to the H-Bridge and from it the roller connected to it will start moving and belt that is attached to it

11) LM2596 Adjustable Step Down Buck Converter Module 3.2-35V To 1.25-30V 2A

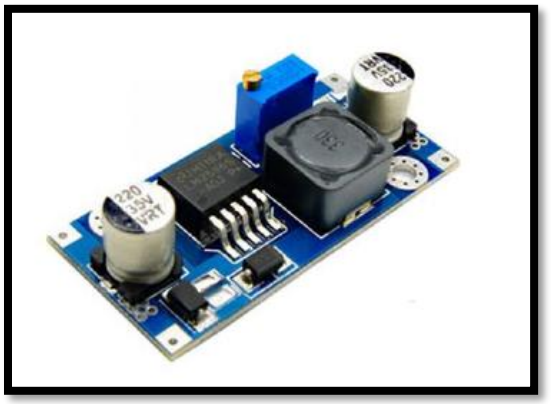


*Figure 11: LM2596 module*

- It is used to regulate voltages into voltages suitable for the devices that require it.

12) 4 Pin Connector Terminal PCT-214 Spring Lever Push In 250V/600V 32A 0.08-4.0mm2

*Figure 12: Connector Terminal*

- It is a device used to give multiple output values, so if we have a 5 voltage coming out from wire instead of having 1 output we use this device to get multiple 5 voltage outputs.

13) Coupler

*Figure 13: Coupler*

- It is connected from the DC motor to the roller so that it can protect the roller from any friction with the belt.

14) Roller for conveyor belt

*Figure 14: Conveyor Belt*

- The belt is put around it and it is connected with the DC motor so that it can move the objects put on the belt.

15) conveyor belt


*Figure 15: Conveyor Belt*

- The material that would be put around the roller and boxes are placed on it.

16) wires

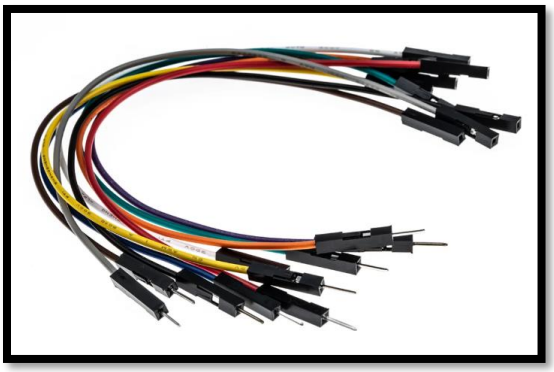


*Figure 16: Wires*

- Used to connect between the devices and components.

17) Web Interface


*Figure 17: Web Interface*

- The web page that we can provide the esp32 with the information it needs so that the project works based on it, what colors should each container should accept, numbers of boxes filled in these containers, starting the machine and stopping it.

## 6 Results and Discussions

After analyzing our project, we have found that not only does it work efficiently but it is also practical, it fills the container with products that a human would specify what should be filled in and it would provide exactly how many products were filled in each container and if there are unknown objects they would be filled in the unknown container so the worker could check them out. And also our color sorting machine is dynamic so if the factory decides to repleace a products with a different color the can do this easily from the web page so they don't have to buy a new machine to fit there needs.

## 7 Conclusion and Future Work

In conclusion, this project is suitable and efficient for an industrial company, it would save time and energy what could be done in a lot of time and effort the machine would simply handle it in the most efficient way.

This project can be developed so that not only it is sorted by colors it could be improved to handle projects based on images using image processing.

So if we imagine this project on a larger scale with thousands of products and it would fill each of these products in the containers specified to them it would have a large impact on how much easier it would be for factories to get their jobs done and it is one of the things it would bring an evolution for how factories work in the future.

## 8 References

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