System Design for Mechtronics Enigeering

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1 Revision History

Date	Version	Notes
Date 1	1.0	Notes
Date 2	1.1	Notes

2 Reference Material

This section records information for easy reference.

2.1 Abbreviations and Acronyms

symbol	description
Mechtronics Enigeering	Explanation of program name
[... —SS]	[... —SS]

Contents

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3 Purpose

This Document mainly talks about the design of the project, including the behavior, variables and interfaces used in the design. It will also talk about the design of the hardware component of the object, with some electrical components used and some communication protocols in the design.

4 Scope

The system will be designed to track the movement of the object to get the latest location information about it so that the user can always get the desired output. The user will be able to login and start the program through their own username and password. Then the information about the object will be detected through some image processing algorithms and will be stored into certain files. The user can locate desired objects through the searching interface by providing several searching keys.

4.1 Context Diagram

The following pictures shows the design of the context diagram of the project. In this diagram, the user can interact with the SmartVault by logging in and provide key information about the object and SmartVault will output searching results to the user. There will be a camera located in the room that will keep sending images to SmartVault used for image processing. The motor will interact with SmartVault so to change the angular position of the camera. SmartVault will send or update information stored in the database. It will also extract desired information from the database.

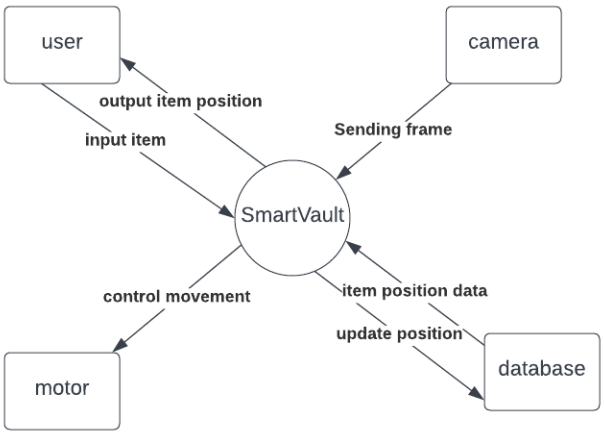


Figure 1: The Picture of Use Case Diagram

5 Project Overview

5.1 Normal Behaviour

5.2 Undesired Event Handling

[How you will approach undesired events —SS]

5.3 Component Diagram

5.4 Connection Between Requirements and Design

[The intention of this section is to document decisions that are made "between" the requirements and the design. To satisfy some requirements, design decisions need to be made. Rather than make these decisions implicit, they are explicitly recorded here. For instance, if a program has security requirements, a specific design decision may be made to satisfy those requirements with a password. —SS]

6 System Variables

[Include this section for Mechatronics projects —SS]

6.1 Monitored Variables

Table 1: Monitored Variables				
Monitor Name	Monitor Type	Range	Units	Comment

6.2 Controlled Variables

Table 2: Controlled Variables				
Controlled Name	Controlled Type	Range	Units	Comment

6.3 Constants Variables

Table 3: Constants Variables

Constant Name	Constant Type	Value	Units	Comment
Angle per step	float	TBD	Degree/step	This is the angle movement stepper motor will move after 1 signal
Height of the Camera	float	TBD	mm	This is the distance between the lens of camera and the bottom of the mount
Angular Velocity	float	TBD	Degree/sec	This is the constant angular velocity of the camera rotation
Resolution	Integer	1920x1080	Pixel	This is the resolution of the camera
Arduino input voltage	float	9.0	V	This is the input voltage of the Arduino board

7 User Interfaces

Two user interfaces will be used for this project, one is for the user to login and the other is used for searching the position information of the desired object. This section will mainly talks about these two interfaces in the following paragraphs.

7.1 Login Interface

7.2 Searching Interface

The Searching Interface is used to help the user to locate the position of the object. The picture shown below describe the FSM of the project. After the program starts, the image processing method will be used to record initial condition of the object detected in the roon through the image taken by the camera. The program will wait for further changes. The motor will rotate the camera if the user detected is not in the certer of the camera or certain percentage of area of the images is blocked. When the movement of an object is detected, if it is moved by human, the program will track the movement of hands and update the information stored in the database. If it is moved by other objects, the program will only update it final state. When the user want to search certain object, the program will allow the user to input some information about the object, also known as the search key. Then a list of pictures meets the information will be provided and wait for the user to choose. If the desired object is within the list and the user has confirmed it, the algorithm will finish.

If the object is not found, the initial pictures will be pulled out and let the user to choose. The object is marked "Taken out" if the object is still not found.

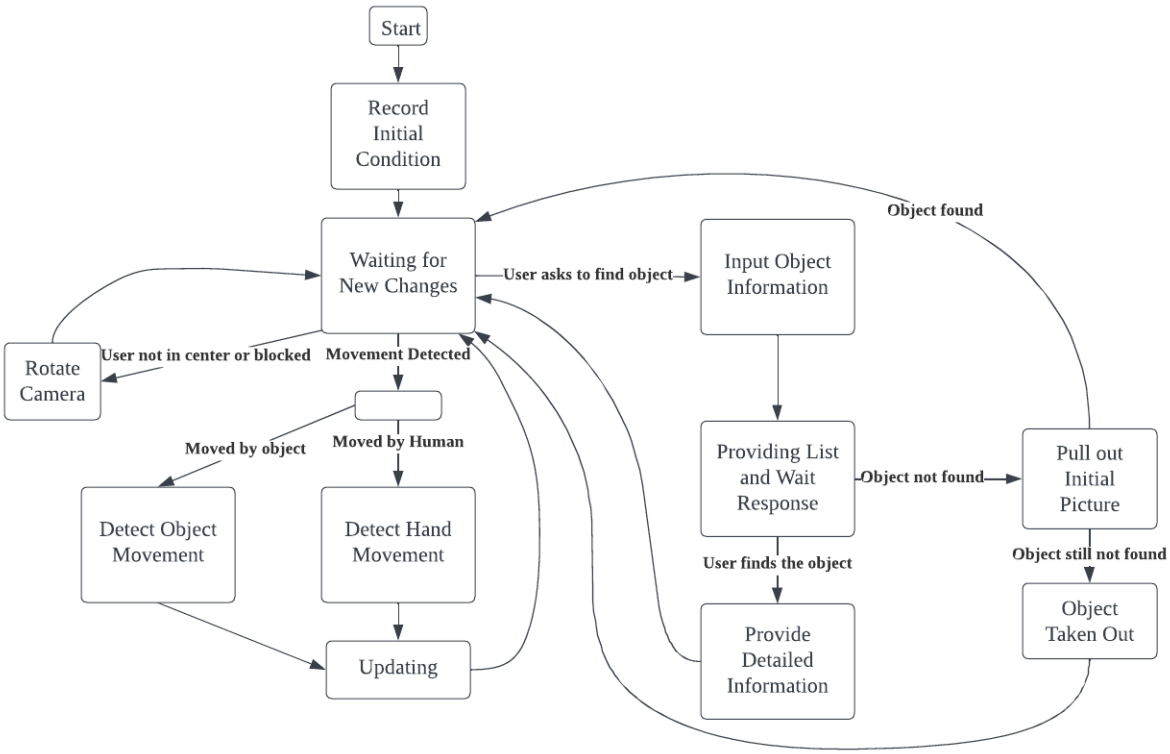


Figure 2: The Finite State Machine of the Project

For the searching interface of this project, the window will come up after the use has successfully logging into the system. A simple design of that interface is shown in the figure below. On the left hand side the images talen by the camera will be shown. On the right hand side, the object-searching algorithm will be used. If the user want to search for one desired object, the system will ask the user to input several informations about that object. After user has finished entered the information and press search, a new window will appear. It will provide several pictures that meets the input information. After the user has confirmed the final result, the result window will come up with the information that the user needs about the object.

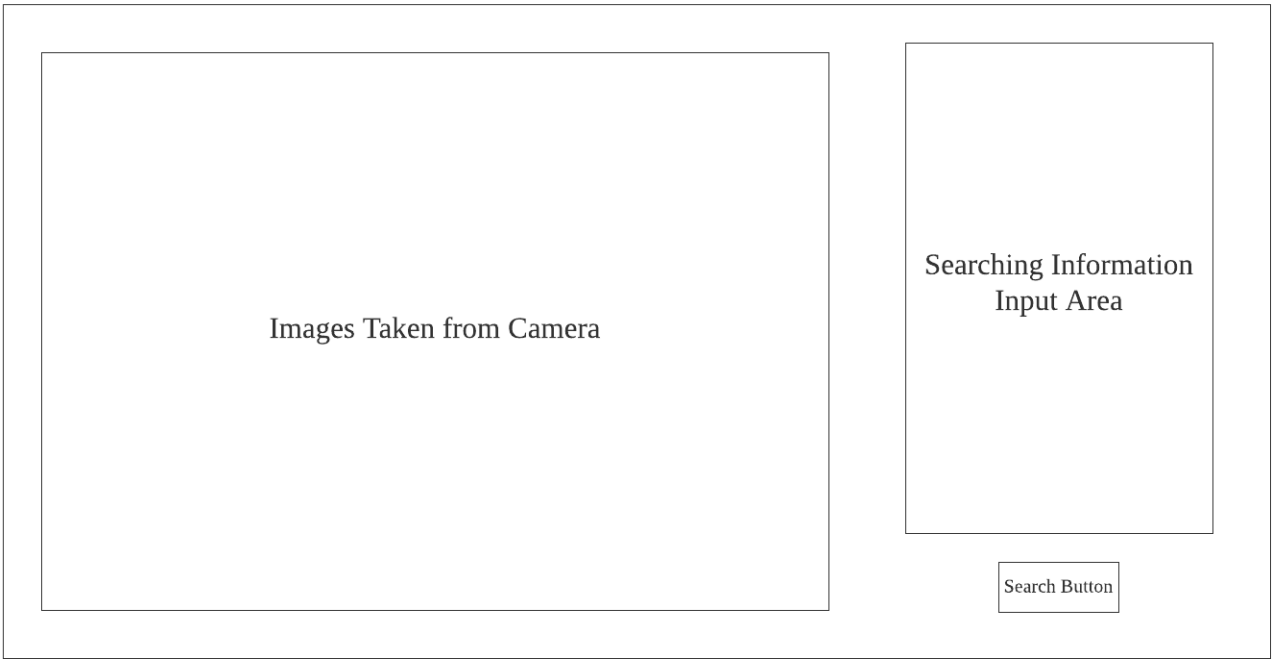


Figure 3: The Design of Searching Window

8 Design of Hardware

The hardware part consists of motor, Arduino contoller board, camera and mount.Arduino controller board is used to communicate with PC and driven by the functionality input by the user. Two stepper motors will be used for horizontal motion and vertical motion respectively. Camera is directly connected to PC to display the video in the user interface. Mount is designed to meet the requirement which can fix both the camera and the motors and capable of three-dimension movement. Further details will be described in below subsections.

8.1 Stepper Motors

Stepper motors are directly connected to the Arduino controller board to receive corresponding signal and rotate to the assigned position. In this section, its physical dimensions will be mainly described. The dimension figure is shown below.

Figure 4: Motor figure

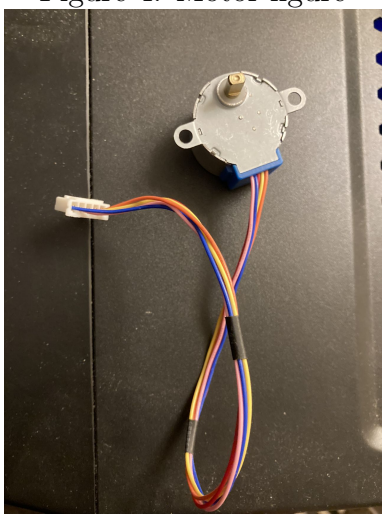
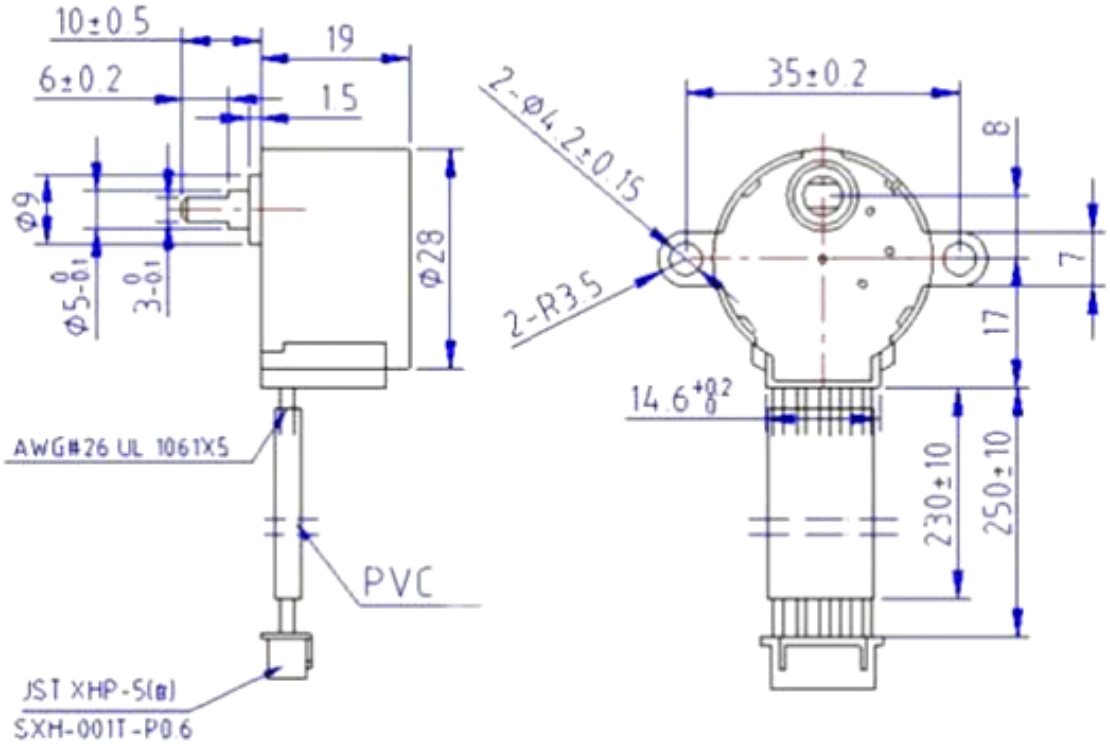


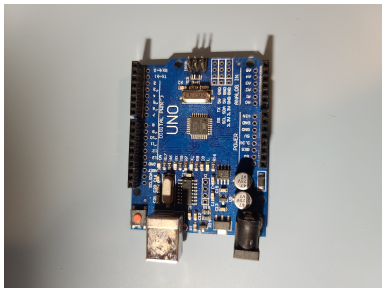
Figure 5: Motor dimension



8.2 Arduino controller board

Arduino controller board is connected to PC and the stepper motors.It is responsible for sending signals to the stepper motors in order to move the camera to desired angle. The board is shown below. As it is not in the moving part of the hardware system, its dimensions are not taken into consideration for initial design.

Figure 6: Arduino controller board



8.3 Camera

Camera is connected to the PC for video display and fixed to mounting bracket in order to be driven by the stepper motors. The camera is shown below. Under our design and cost consideration, the protruding camera part's radius is taken into consideration.

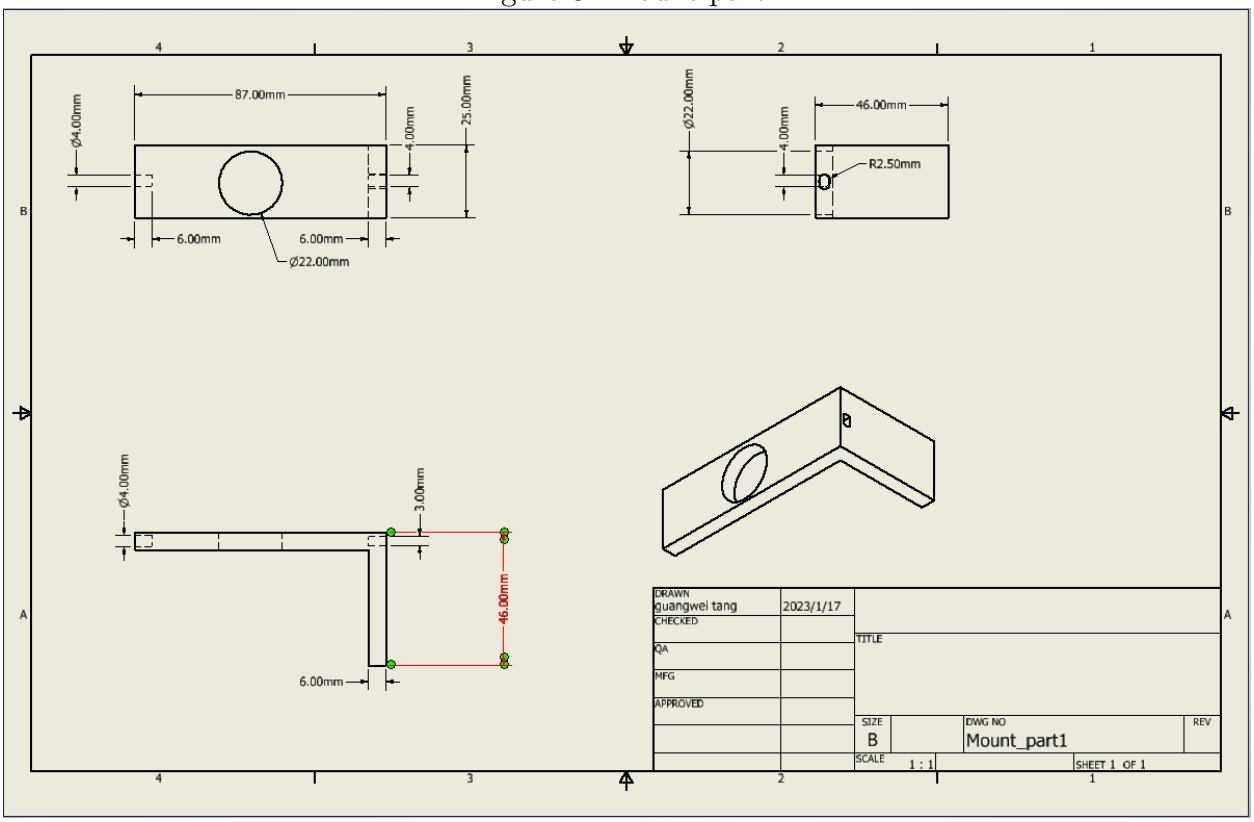
Figure 7: Camera

8.4 Mounting bracket

The mounting bracket is designed to meet the design requirement. It consists of two parts. First part is used to fix the camera and allow vertical motion. One hole is constructed on

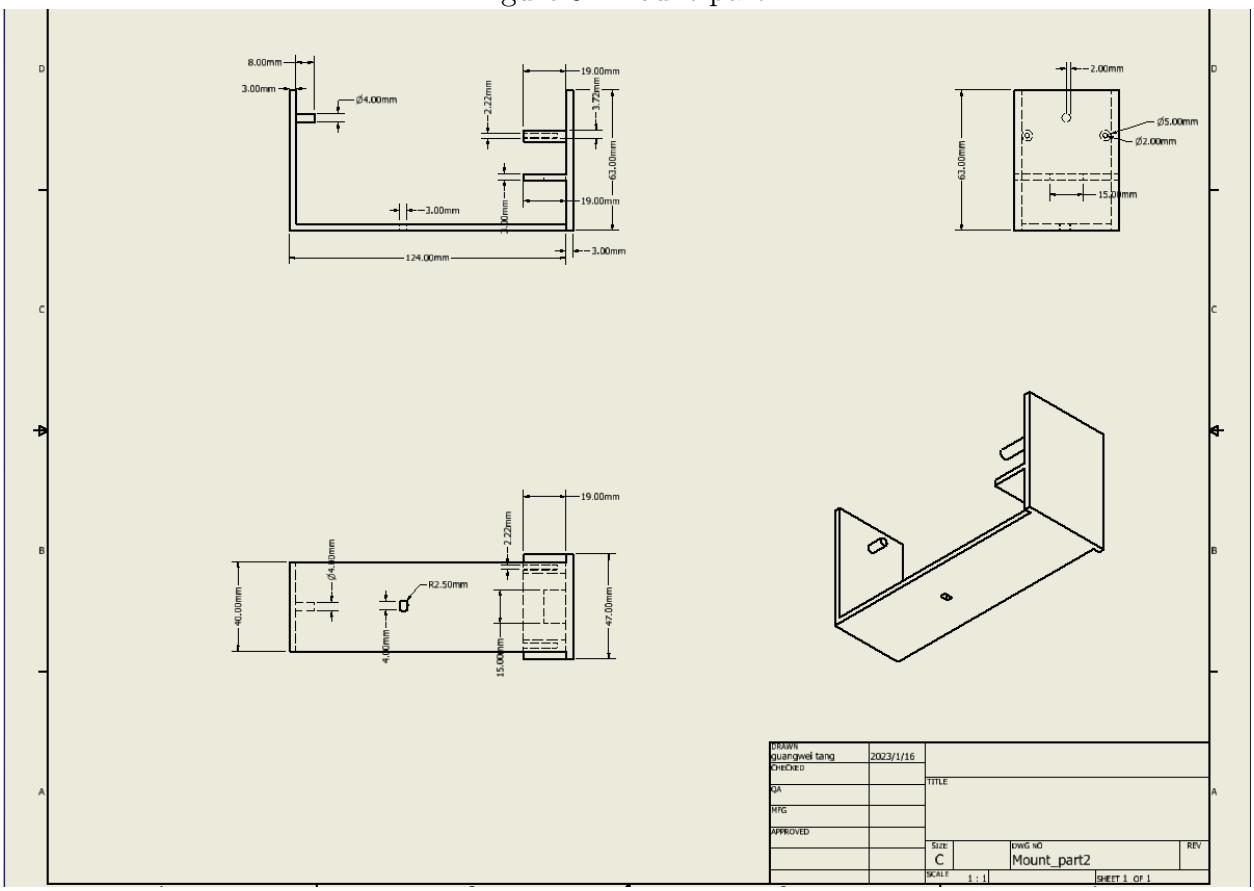
one side of the wall to fit the stepper motor's actuator. The dimensions can be found in the figure below.

Figure 8: Mount-part1



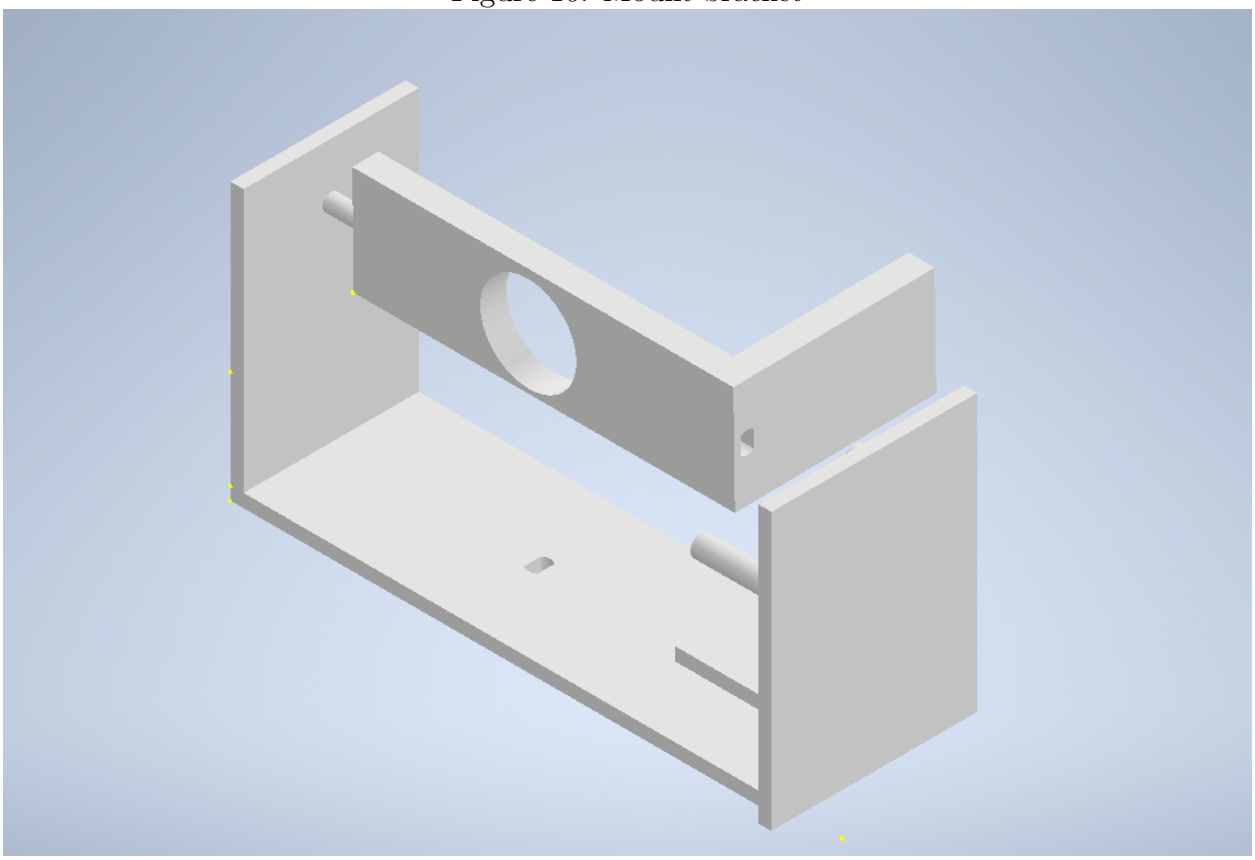
Second part is used to fix the first part and driven by the second stepper motor to allow horizontal motion.One hole is constructed at the bottom to fit the stepper motor's actuator. The dimensions can be found in the figure below.

Figure 9: Mount-part2



The whole configuration of the mounting bracket is shown below.

Figure 10: Mount bracket



9 Design of Electrical Components

The electrical components of the system include the Arduino controller board,stepper motor driver board, camera and stepper motors. The electrical schema is shown below:

Figure 11: Board-motor connection

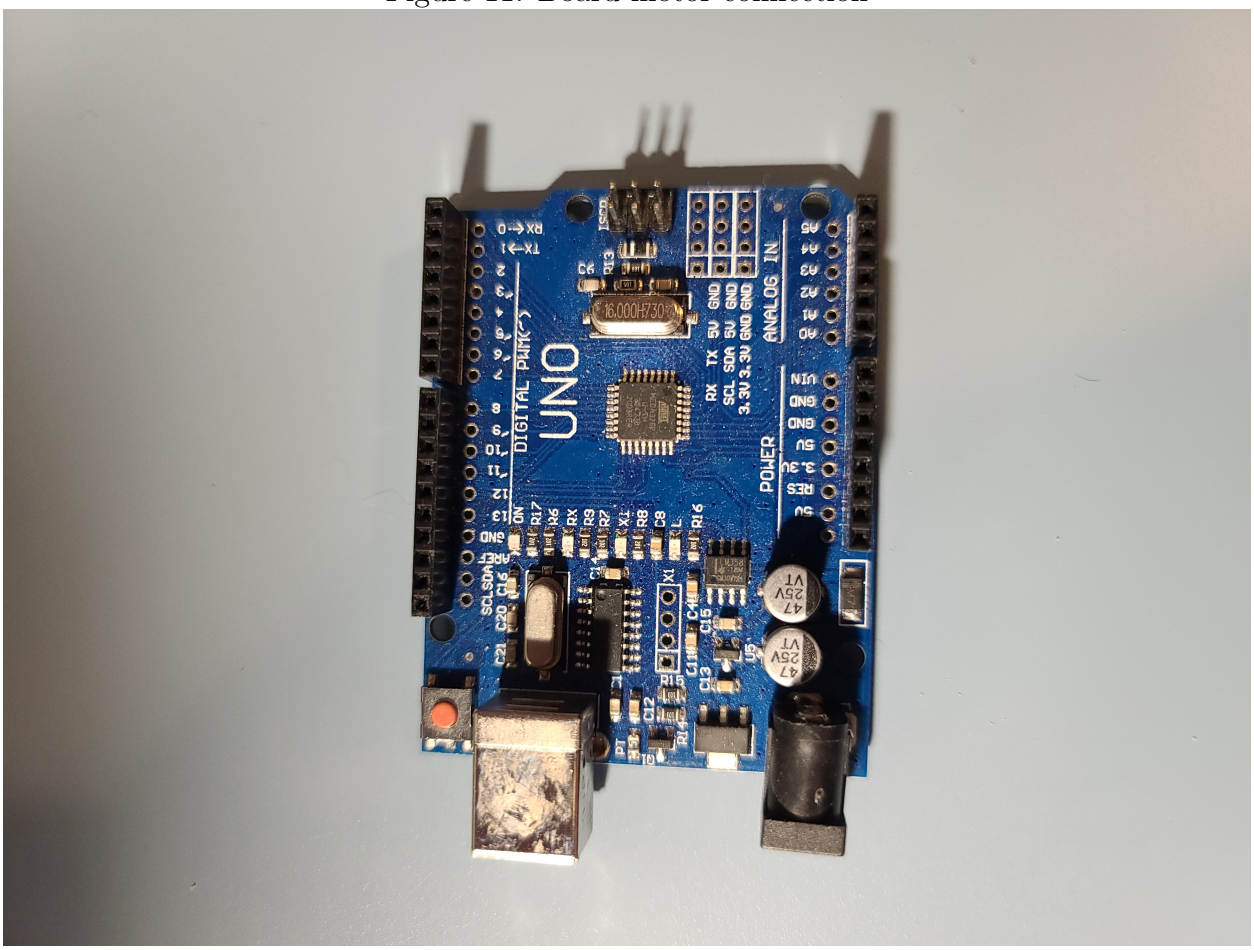
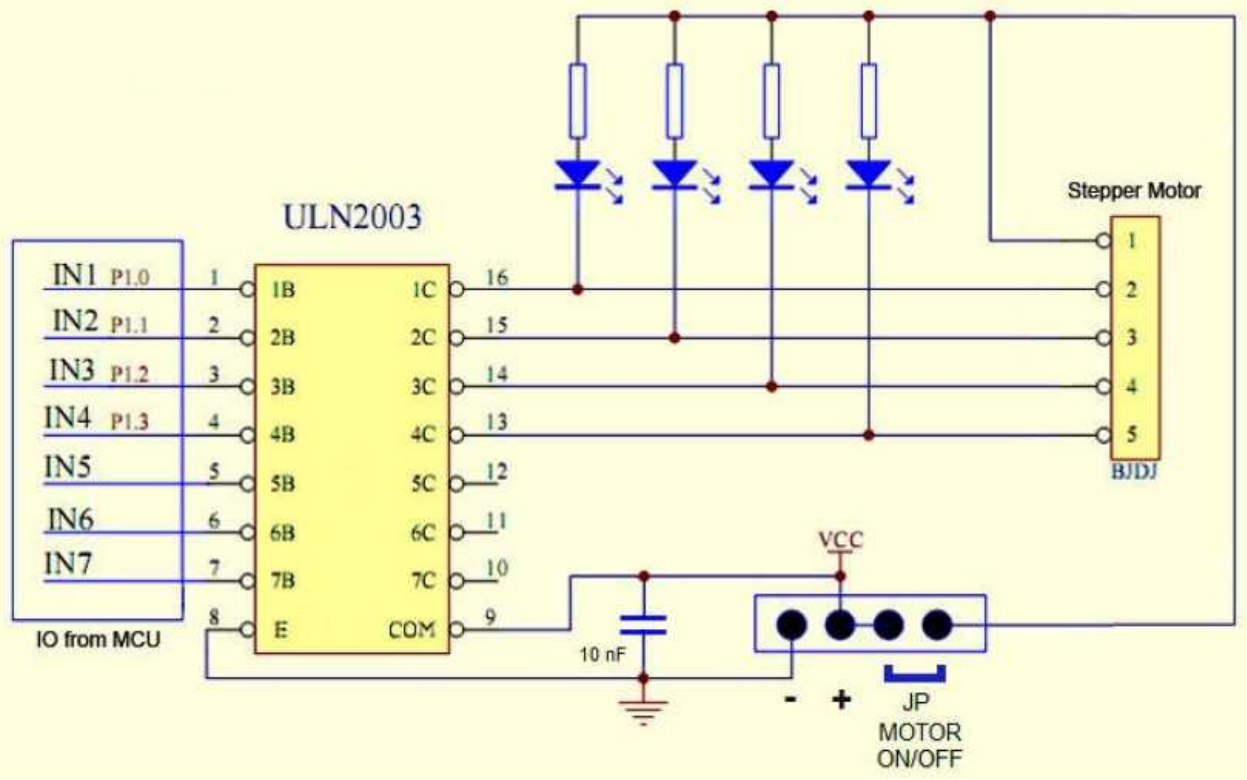


Figure 12: Stepper motor driver board schematic



10 Design of Communication Protocols

The communication protocol between the hardware and software is serial communication protocol. The software system acts as the master and the hardware acts as slave. The communication is a one direction communication, the software system sends the serial command to the Arduino controller board, and the board control the stepper following the serial commands.

11 Timeline

[Schedule of tasks and who is responsible —SS]

A Interface

[Include additional information related to the appearance of, and interaction with, the user interface —SS]

B Mechanical Hardware

C Electrical Components

The electrical components include 1 Arduino board, 2 stepper motors, 2 ULN2003 drivers and 1 camera. The motor driver simplify the control process of the stepper motor and save the physical space of the hardware. The Arduino board send signal to control the stepper motor.

D Communication Protocols

The serial communication protocol in the project guarantee the communication between software and hardware. The project uses python serial library to send the serial signal to the Arduino board. The communication is one-way direction which means the Arduino only receive the signal from software system but not send any signal back to the system.

E Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design. Please answer the following questions:

1. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO_ProbSolutions)

2. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select documented design? (LO_Explores)