SENTRY GUN

A MINOR PROJECT REPORT

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Certified that this minor project report titled **AUTONOMUS SENTRY GUN"** is the bonafide work of "**ARUN KUMAR",** who carried out the minor project work under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on these or any other candidate.

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ABSTRACT

Autonomus sentry gun

A sentry gun is a weapon that automatically aims and fires at the targets .it uses camera to feed in the data required it compares frame by frame and shoots the moving objects these complex image comparisons are done by a computer and the information is fed to a microcontroller such as Arduino and the x axis and y axis servos are moved to the appropriate locations and the gun starts firing until threat is eliminated. It can also be used in manual mode and using a controller

I have used a laptop to capture images and process it and give signals to a Arduino which will process the information given to the servos and moves the x axis and y axis servos to the appropriate position and fires the gun

A finger print sensor is used to prevent unauthorized use of the sentry gun

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1 INTRODUCTION

A sentry gun is mostly used in military ships and military instalations as line control and a close range defence system against incoming missiles

As of now most of the international borders are maned by humans, it is impossible to keep a soldier on entire line of actual control on the border 24/7 because of this both the soldiers life and the internal security of the country is at stake . Automating the border is a better ways to deal with counter insurgency and counter terrorism.

it is also used for security purposes around the world in high value vaults ,secret governmental fascilities to keep the intruders out at the bay it reduces human loss at the operators side during the operation

1.1 PROBLEM STATEMENT

- The sentry gun models available on the internet at the present time are not easily disassembled and assembled
- The guns are fixed to the sentry gun in a complex manner
- The whole system is costly and too space consuming
- The system is with less security
- And its big for easy transportation by a single soldier
- Existing models are costly

1.2 OBJECTIVES

For the sentry turret, the following aspects need to be covered:

- To develop a model sentry gun which can detect movements and fire

- A physical frame that can holster a paintball gun needs to be designed and constructed
- Electronics to control the gun should be integrated into the frame
- To reduce cost as much as possible
- To improve the security of existing sentry gone modes available on the internet
- To make the sentry gun universal to make changing between different type of guns
- To make it simple to build and disassemble the sentry gun
- To make it as a kit so that it can be disassembled and carried anywhere in a suitecase

2.1 LITERATURE REVIEW

2.1 Sentry Turrets

A Sentry Turret or Sentry Gun is a weapon that automatically aims and _res at targets that are detected with sensors. Where Sentry means to guard, and Turret means tower, i.e. a guard tower.

Many sentry gun models are available on the internet which are complex to use and not easily portable and has a fixed gun in which the whole y axis components has to be changed

In the following sections we will see the available or existing sentry gun models

2.1.1 Project Sentry Gun:

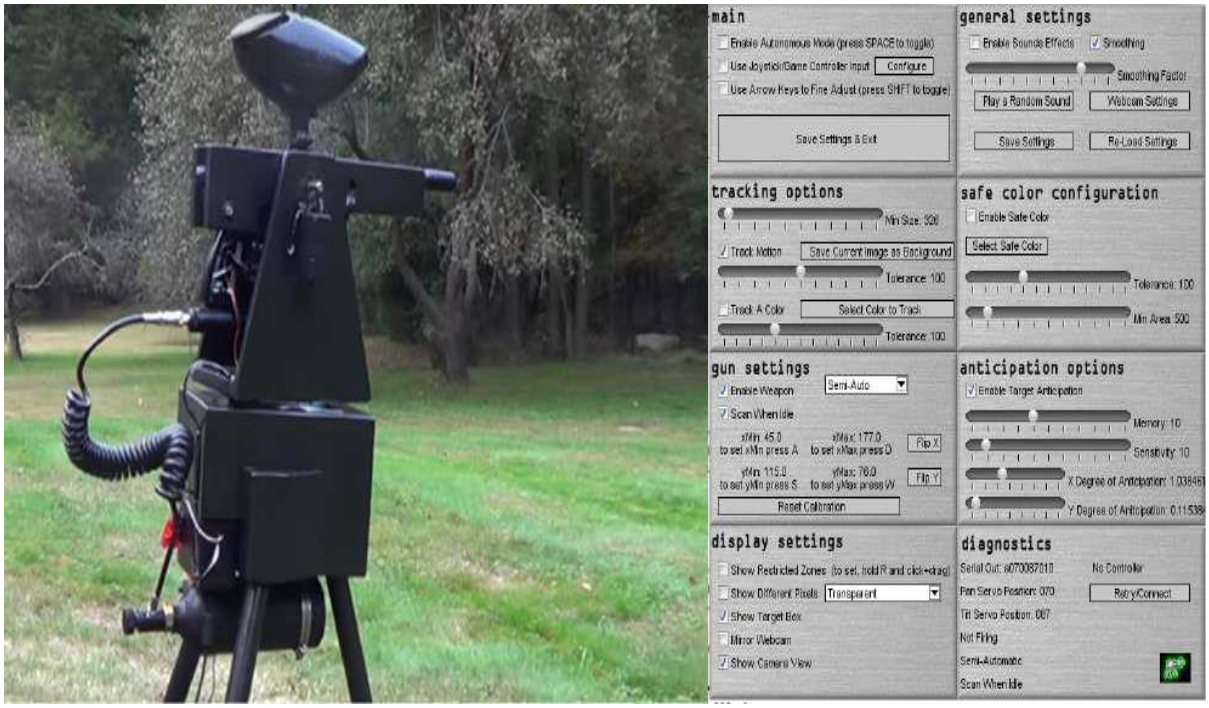

Figure 2.1: Example of Gladiator 2

Project Sentry Gun is probably one of the most popular sentry guns on the internet today due to its open source code. The Gladiator 2 (Figure 2.1) uses a dedicated PC controlling an Arduino, along with a webcam as visual input. The software consists of two parts: The Computer Vision code and the Microcontroller code.

The Computer Vision code (GUI) is written in Processing and is a JAVA based application that sends commands to the Arduino via a serial interface. The GUI comes with extensive features including anticipation and smoothing, as well a colour tracking and calibration.

2.1.2 Low-Cost 2-DOF Sentry Gun

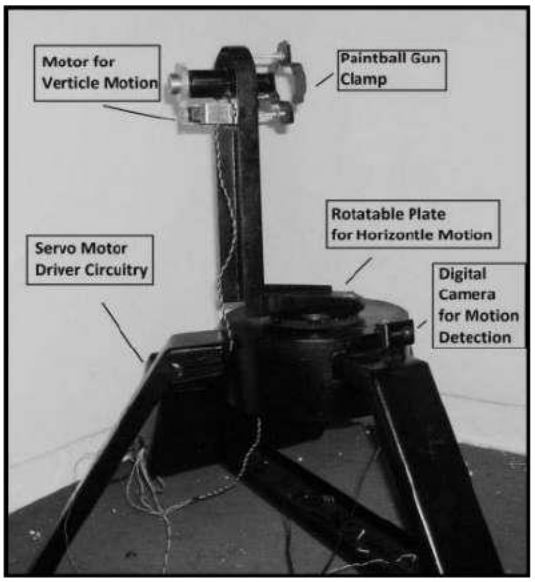

Figure 2.2: Example of 2-DOF Sentry Gun

Figure 2.2 above proposed a low-cost solution to a sentry turret that is not military grade. The system tracks motion using an embedded microcontroller and MATLAB interface. Motion is detected using periodic background estimation subtraction.

2.1.3 Hybrid Defence System

Figure 2.3: Example of Hybrid Defence System

Figure 2.3 above has excellent software and electronic features. Not only does it have motion detection, but also face detection and recognition. They had two versions, one with a Raspberry Pi 2 and one with a mini ATX desktop. The two versions are to enable the software to run on an SBC and high-end computer. The Arduino Uno was used as the microcontroller to move the servos.Their hardware included a Nerf gun that could be used semi-automatic. They had the very innovative idea of current induction which transfers power so that they do not have cables limiting the rotation.They also used the Asus Xtion Pro Live, which has a 3D sensor, which takes stereoscopic images. This incorporates distance into the motion tracking.They used is the OpenCVMOG2 algorithm [10]. They also had a web interface that alerted users if there are intruders.

2.1.4 Sentry Turret with Dlib

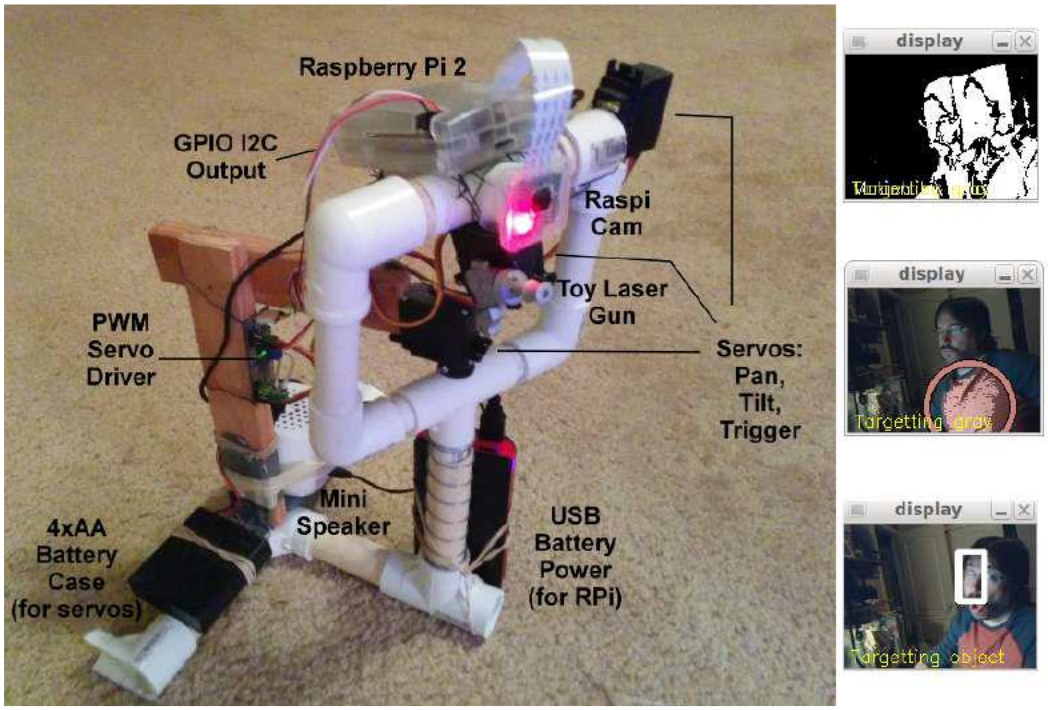

Figure 2.4: Example of Sentry Turret with Dlib

Figure 2.4 is another great example of a sentry turret with open source code. It uses a Raspberry Pi, OpenCV, Python and Dlib. Dlib is an additional library that includes pre-trained neural models for facial recognition and motion tracking for humans.

2.2 Software

The software is responsible for locating a moving target with some visual/sensing input and then issue the right commands to aim the paintball marker in the direction of movement. The software is the largest contributing factor to the effiency of the turret. This is due to the time it takes processing these large chunks of data and then calculating where the gun should move to and then compensate for the time lost.

The software we use to control the sentry gun is an open source software called as “project sentry gun”

3. SYSTEM DESIGN

Systems design is the process of defining the architecture, product design, modules, interfaces, and data for a system to satisfy specified requirements.

3.1PRELIMNARY DESIGN

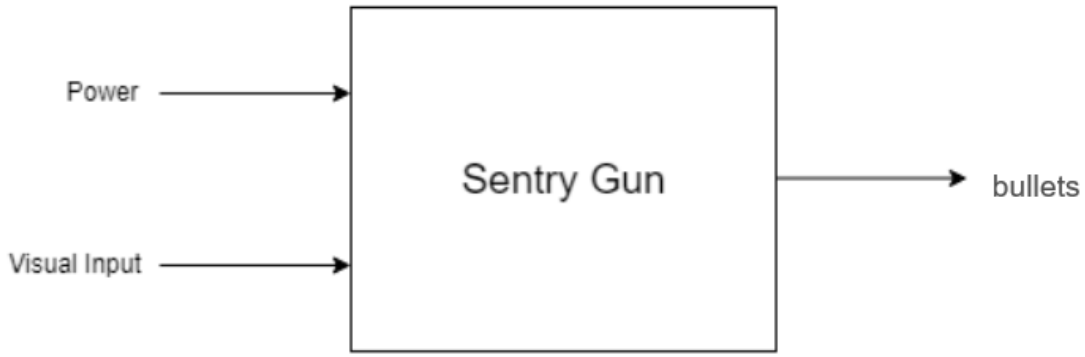

figure 3.1.1 basic system architecture

prelimnary system architecture shows the most basic input and output of the system as seen in Figure 3.1.1 Power is given to the system, motion is detected and bullets leave the system..The intruder was left out of this level of the architecture.

3.2FINAL DESIGN

3.2.1 DESIGN OF UNIT 0

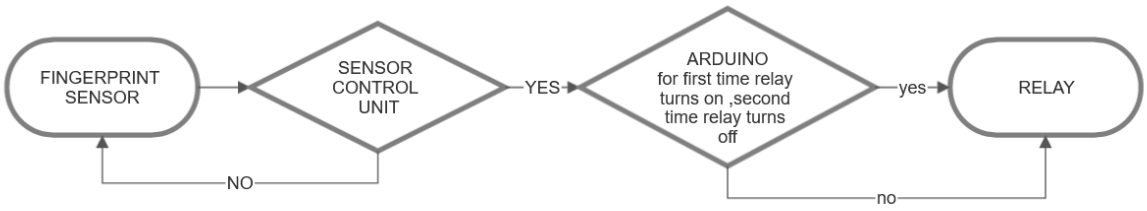

Figure 3.2.1 Flow chart of the fingerprint unit

As seen in Figure 3.2 at first the finger print sensor reads the fingerprint and sends the signal to control unit if the control unit authenticates the fingerprint it gives a positive 5v signal to the Arduino if not it gives a 0v signal and shuts down

When Arduino receives a 5 v signal from the control unit it triggers the relay which will power the entire sentry gun

Now turn off the sentry gun the sensor has to be authenticated again and the sensor gives 5v signal to the Arduino which turns the relay shutting down the system

3.1.2.2 DESIGN OF UNIT 1,2,3

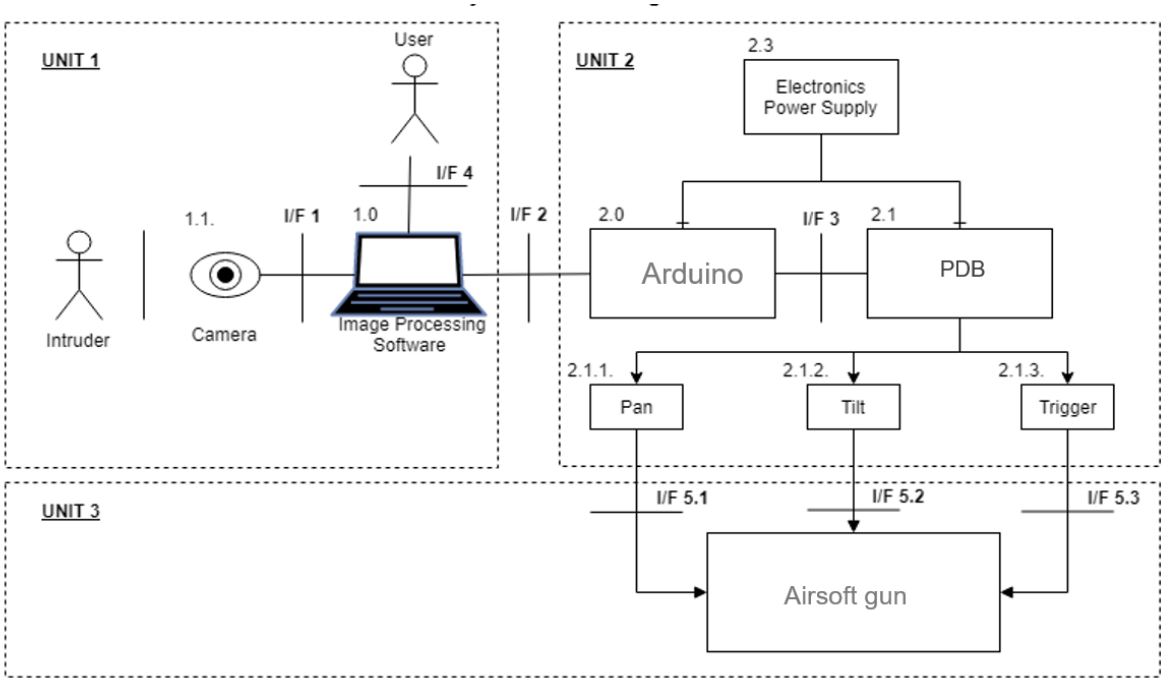

Figure 3.3: Final System Architecture

Functional Units (F/U)

1. Software

1.1. processing software and Arduino ide

1.2. Camera for visual input.

2. Arduino

2.1. Pdb

2.2. Motor Controller

2.3. Power Supply

Hardware (unit 3):

3.1.base structure

3.2.pan structure

3.3tilt structure 3.3.1gun holster

Interfaces (I/F)

1. Camera to PC interface: Universal Serial Bus (USB)

2. PC to SBC interface: Serial cable

3. Arduino to servo: From GPIO pins to pdb

5. Servo to structure

5.1. Pan servo to pan motion structure: Gears

5.2. Tilt servo to tilt motion structure: Gears

5.3. Trigger relay to gun

- UNIT 1:program gets visual data from the web cam (1.2) through IF.1 and compare it with previous image to locate the moving object and sends the position of the object to arduino ide
- UNIT 2:Arduino Ide(1.1) received data from system1 is processed and sent to system2
- UNIT 3:the received data from system 1is sent as pwm signals to x axis and y axis servos by system 2
- Then the servos move the gun to exact position and the triger command is given by system 1 which is relayed to system 3 through system 2
- And it activates the trigger relay and shoots the gun

- when there is no possible moving objects inside the frame it servo position are maintained at the center

4.PARTS USED

4.1 ELECTRONIC COMPONENTS

4.1.1 SERVO ACTUATORS

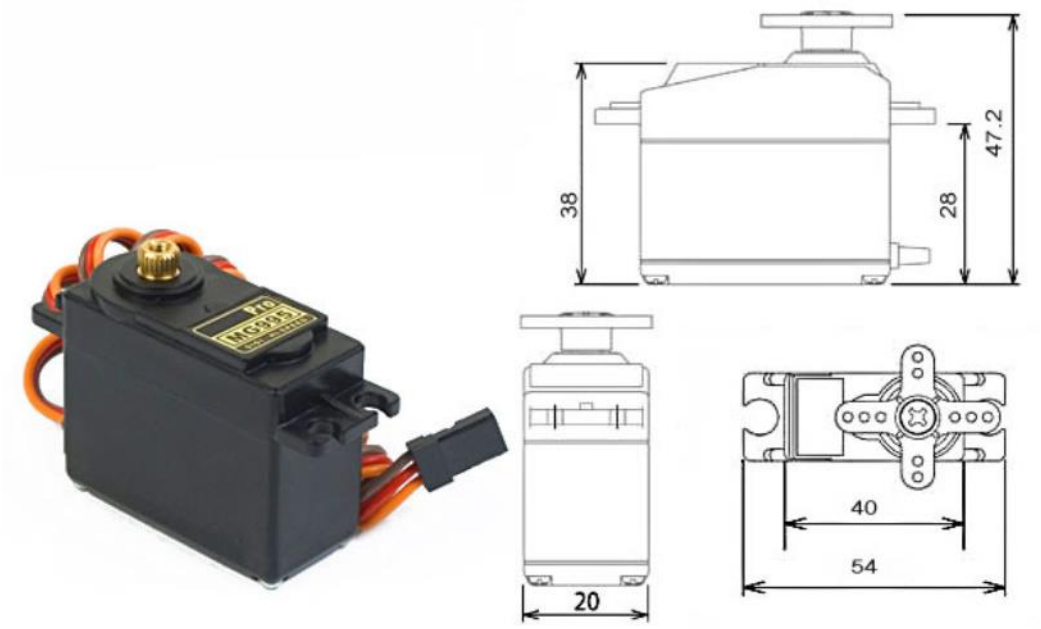

Figure4.1.1 MG995 High Speed Servo Actuator

Specifications

- Weight: 55 g
- Dimension: 40.7 x 19.7 x 42.9 mm approx.
- Stall torque: 8.5 kgf·cm (4.8 V), 10 kgf·cm (6 V)
- Rotation Angle: 120deg. (+- 60 from center)
- Operating speed: 0.2 s/60º (4.8 V), 0.16 s/60º (6 V)
- Operating voltage: 4.8 V to 7.2 V
- Dead band width: 5 µs
- Stable and shock proof double ball bearing design
- Metal Gears for longer life
- Temperature range: 0 ºC – 55 ºC

4.1.2 ARDUINO UNO R3(microcontroler)

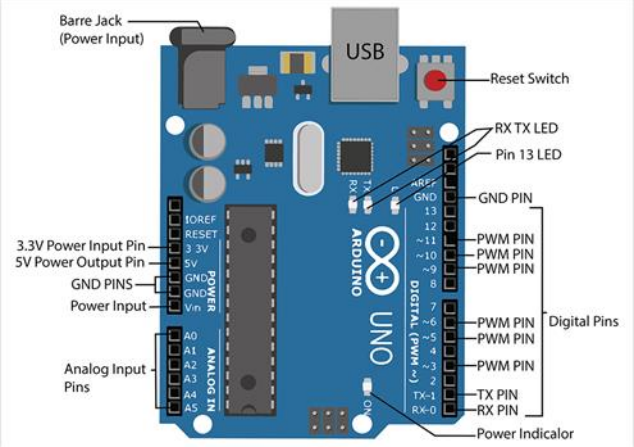

Figure4.1.2

Figure4.1.3

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

We are using Arduino uno r3 micro controller for our sentry gun as it is cheap and effective

4.1.3BUCK CONVERTER

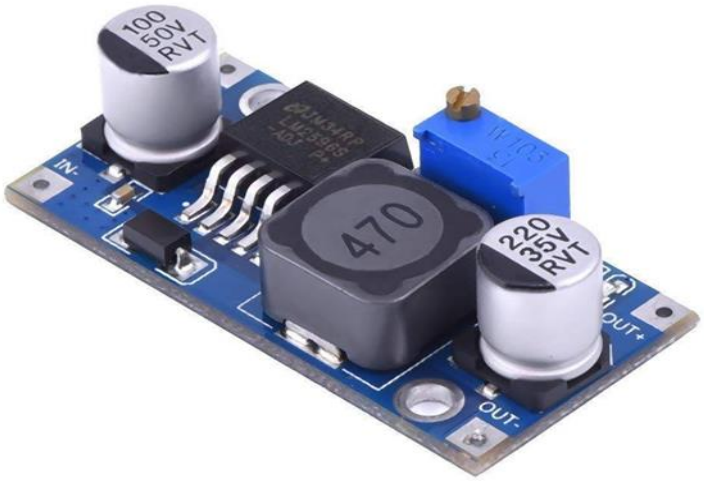

Figure 4.1.4 buck converter

LM2596 DC-DC Buck Converter Adjustable Step Down Power Supply Module

Specifications

Input Voltage - 3.2V - 40V DC

Output Voltage - 1.25V - 35V DC

Size - 43mm x 20mm x 15mm

Output Current - 2A, Max 3A

4.1.4 POWER DISTRIBUTION BOARD

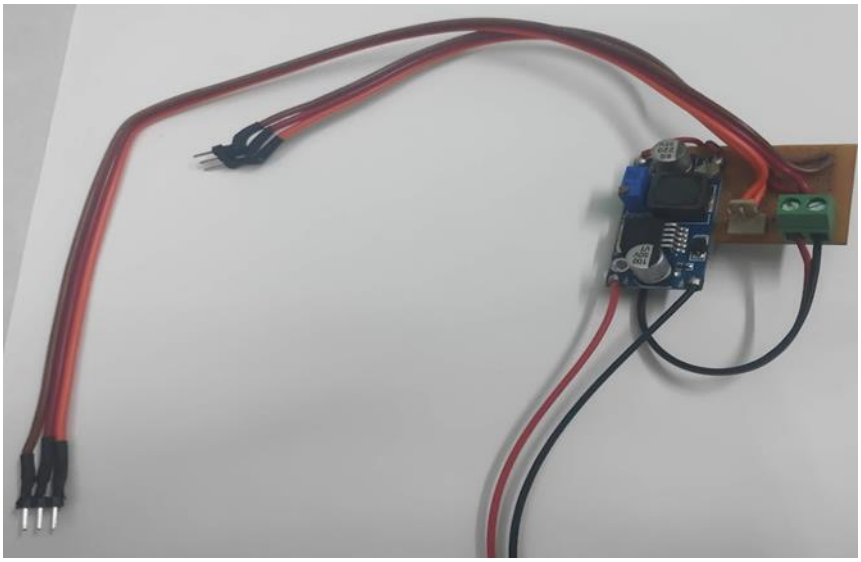

Figure 4.1.5 Power distribution board (top view)

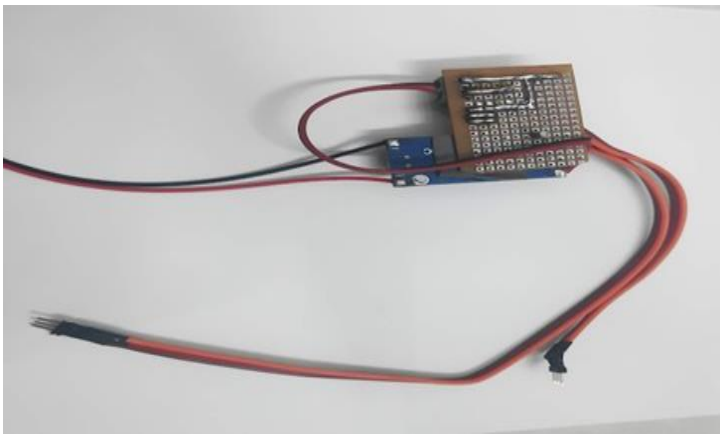

Figure 4.1.6 Power distribution board (bottom view)

- We are using a power distribution board to keep the model net and for fast deployement
- And reduces lots of confusions as its simple to use with easy plug and use connectors

4.1.5 PWM SPEED CONTROLLER

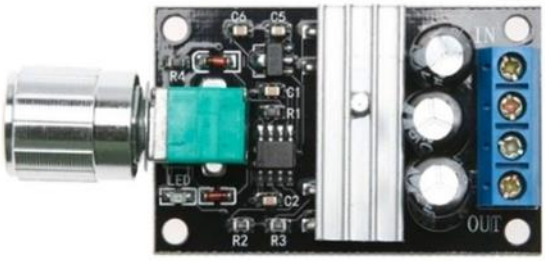

Figure 4.1.7 Pwm speed controller

We are using a speed controller to maintain the correct shooting speed of the gun as too much shooting speed causes the bullets to break inside the gu itself so it is necessary to set appropriate speed of the gun for smooth operation

4.1.6 POWER SUPPLY

Figure4.1.8 Volt DC Power Supply

Figure 4.1.8 depicts the most general AC to DC converters. It takes 220V AC to 12V DC and is generally rated at 10A.

4.1.7 WEB CAMERA

Figure 4.1.9 web camera

We are using the camera(Figure 4.1.9) it has a

Max Resolution: 720p/30fps

Camera mega pixel: 0.9 Diagonal field of view (dFoV): 55°

4.1.8 FINGERPRINT CONTROL UNIT

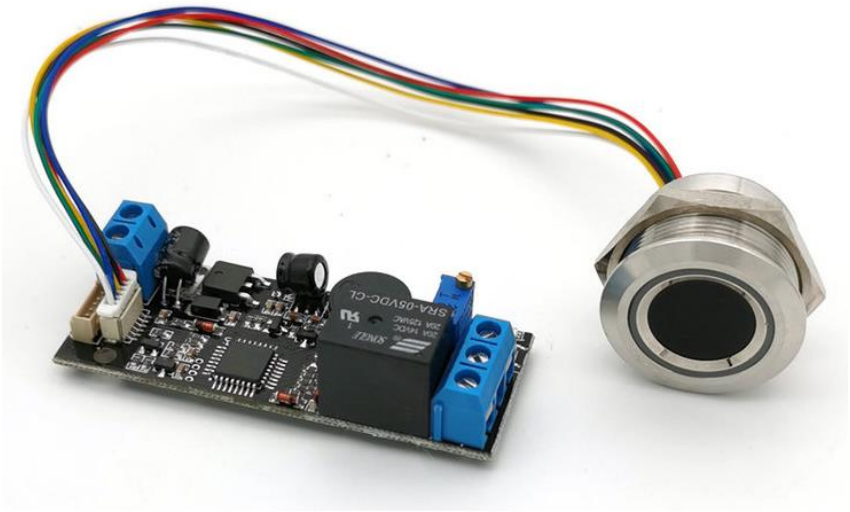

Figure 4.1.10 Grow K202 finger print system

- The finger print sensor and control board(Figure 4.1.10) when correct finger print is detected the relay triggers for 0- 30 seconds which can be controlled using a potentiometer
- so it wont be useful if we directly power the whole sentry gun system through this relay
- so we need to code an Arduino to triger another rela and hold it when it gets a 5 v signal from the fingerprint control board and the Arduino should open the relay when it receives another 5 v signal

4.2 HARDWARE USED

4.2.1 Castor wheel

Figure 4.2.1

Specifications

- Base plate diameter : 38.2mm

- Wheel height : 23mm
- Mounting hole - Three, 120 Degree apart, 3.4mm diameter
- castor wheel is used to reduce the friction and to support the pan assembly

4.2.2 SPUR GEAR

Figure 4.2.2

- No. of Teeths =25.
- Diameter=40 mm.
- Center Shaft Diameter=6 mm.
- Teeth Face Width=12.5 mm.

we are using a spur gears to reduce inertia and for smooth movement

4.2.3 BEARING

Figure 4.2.3

bearing is used to reduce friction

5 Experimental Investigation

Mostly the model was tested then and there during the building process for stability and smooth operation and necessary changes were made

5.1 PROTOTYPES

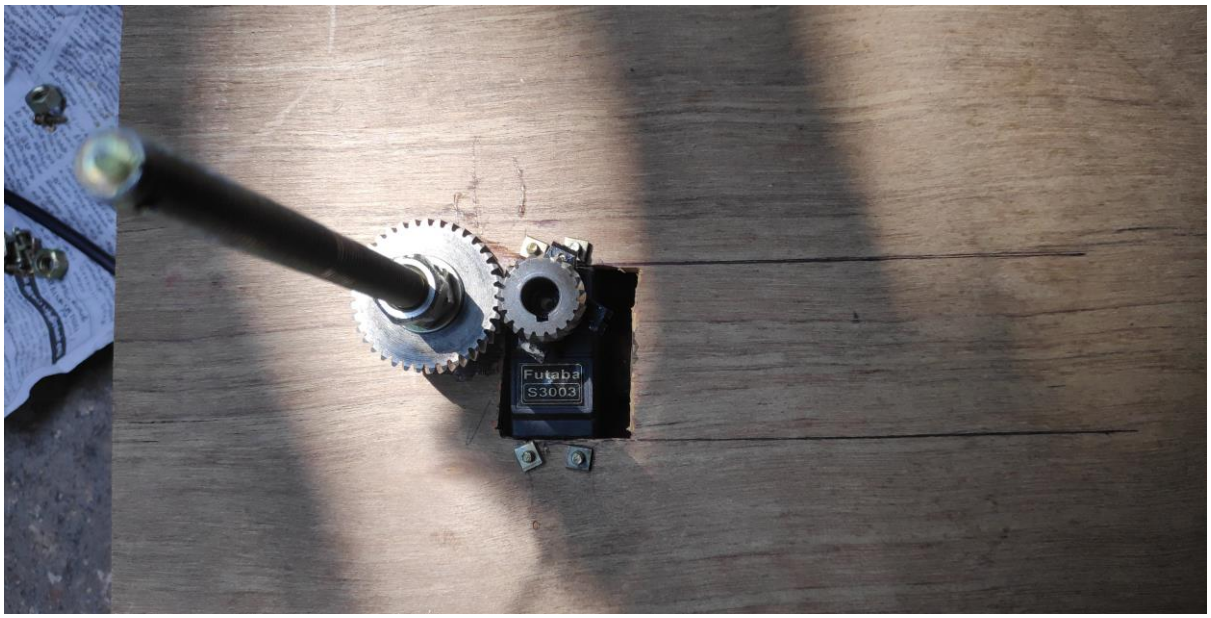

Figure 5.1.1Gear assembly using helical gear(top view)

Figure 5.1.2 Helical gear assembly(side view)

- during the initial phase of the project helical gears (figure 5.1.2,5.1.2)were used in the model
- instead of spur gear as those gears had more back lash or slipping rate than the spur ger it was discarded and more stable spur gear was used

Figure 5.1.3 pan disc directly mounted on the servo

- 6 castor wheels were nused and the inner diameter of the pan disc dosent coincide with the base circle
- and the idea was totally discarded and instead a square shaped base was used to mount all the components of the sentry gun within it

Figure 5.1.4 servo control arm mounted on the pan disc

- At first I tried to fix the pan assembly directly to the servo with multiple supporting castor wheels (Figure 5.1.3,5.1.3)to support the weight but it caused more stress on the servo so the idea was dropped.
- And a fiber geared servo where also used but it was not able to handle that much load and the gears broke so I switched to metal servos.

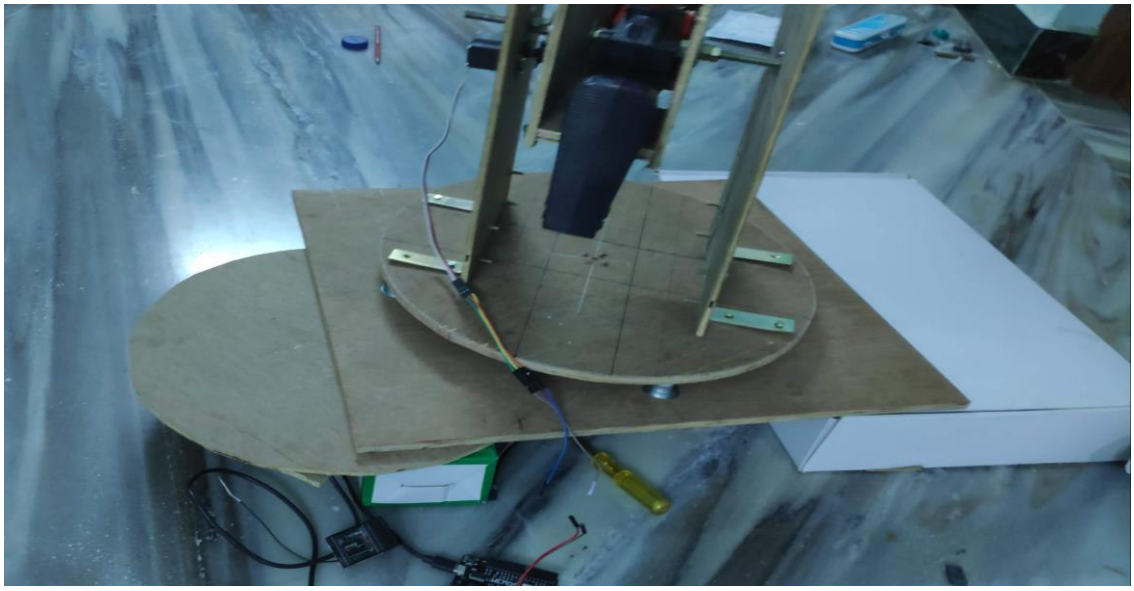

Figure 5.1.5 L Clamps(1^{ST} prototype)

The L clamps (Figure5.1.5) used were not sturdy enough as there was two much vibration and swinging motion

Figure 5.1.6 L clamp

I used this l clamp(Figure 5.1.6) for sturdiness and stability even but even with this when the tilt motion was happening this whole vertical structure would move right and left so i used another alternative

6TESTING

Figure 6.1 pan disc gear assembly

The gears are placed very closely to avoid slippage and backlash and to prevent overload from servos

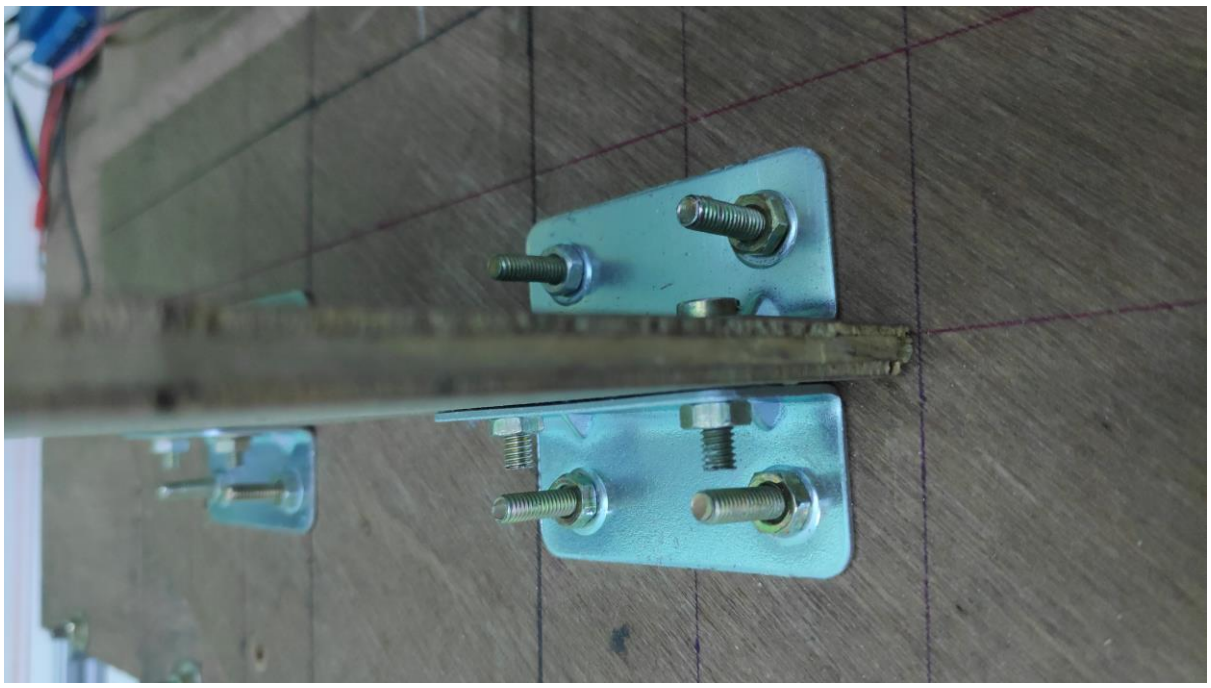

Figure 6.2 The new l clamps used

These stronger l clamps (Figure 6.2) are used on both the side of the vertical structure to restrict any motion during operation of the tilt motion .

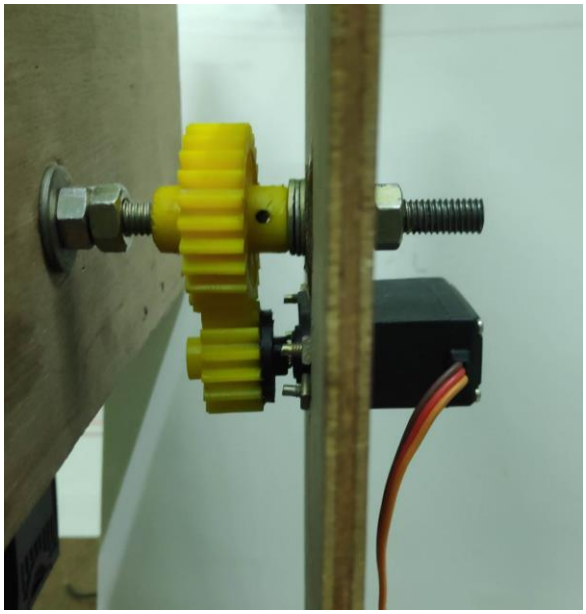

Figure 6.3 Tilt gear assembly

This is the tilt gear assembly (figure 6.3)where the shaft of the gun holster is mounted on the bearings and the gear of the shaft is coupled with the gear of the servo

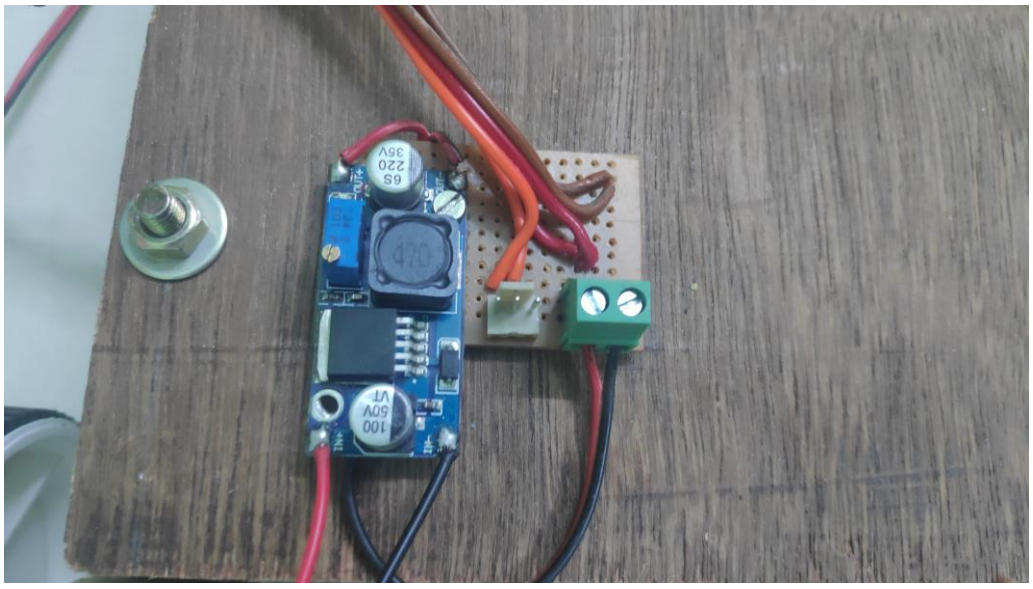

Figure 6.4 power distribution board

- Ass seen in (Figure 6.4))The main purpose of using this is to make the process of assembling easier
- Normally 6 wires from servo 3 wires from the arduino and two wires for the power supply will be used and will be connected with jumper wires or directly to the Arduino .
- As the sentry will always move in x axis and y axis the wires should move along with it that's the reason we have used this board in the sentry gun as a buffer the movement in no way break the pins in ardino and this is easy to connect this board has a three pin connector which is not reversible .

6.1 BOTTOM VIEW OF BASE STRUCTURE

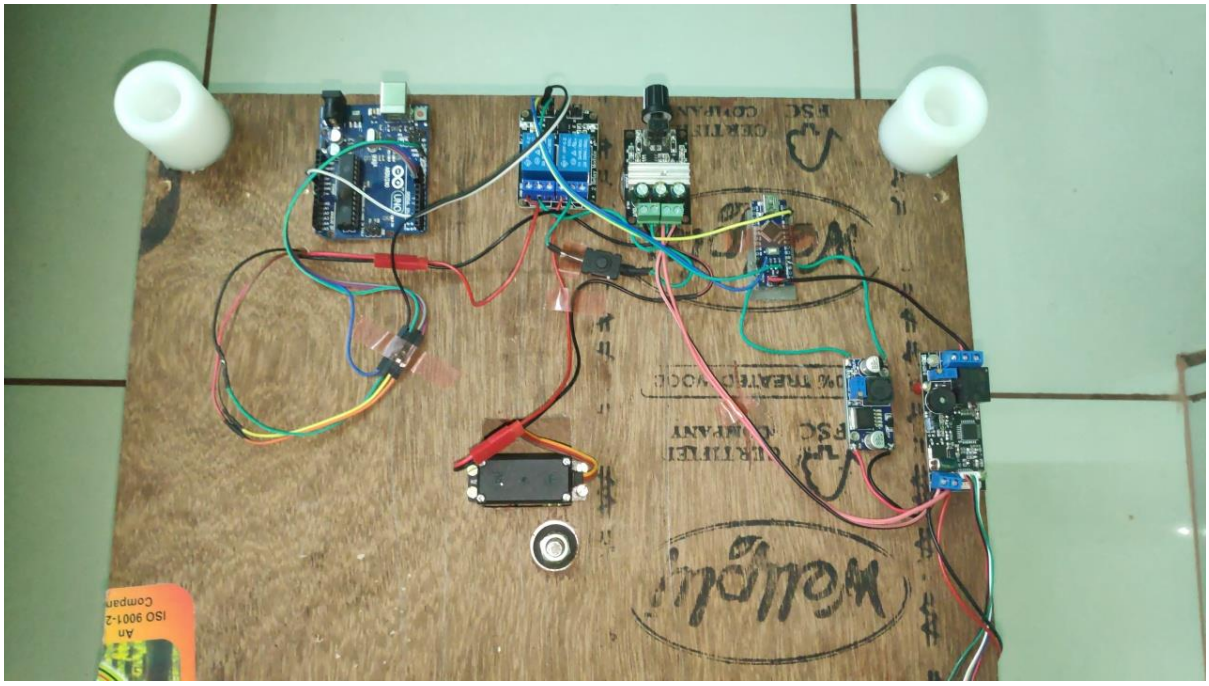

Figure 6.1.1 bottom view of the sentry gun

- this bottom base houses all the electronic components required for the operation of the sentry gun

- The Arduino used here works as a detent witch ie .when a 5v signal comes from the fingerprint control board it triggers the relay powering the whole system and holds it until another 5 v signal comes

Figure 6.1.2 the gun holster shaft mounted on a bearing

The bearings (Figure 6.1.1) are fixed in the plywood with compression and epoxy so that it wont easily fall off and the shaft (Figure 6.1.2) is inserted and secured with bolts to reduce further horizontal movement

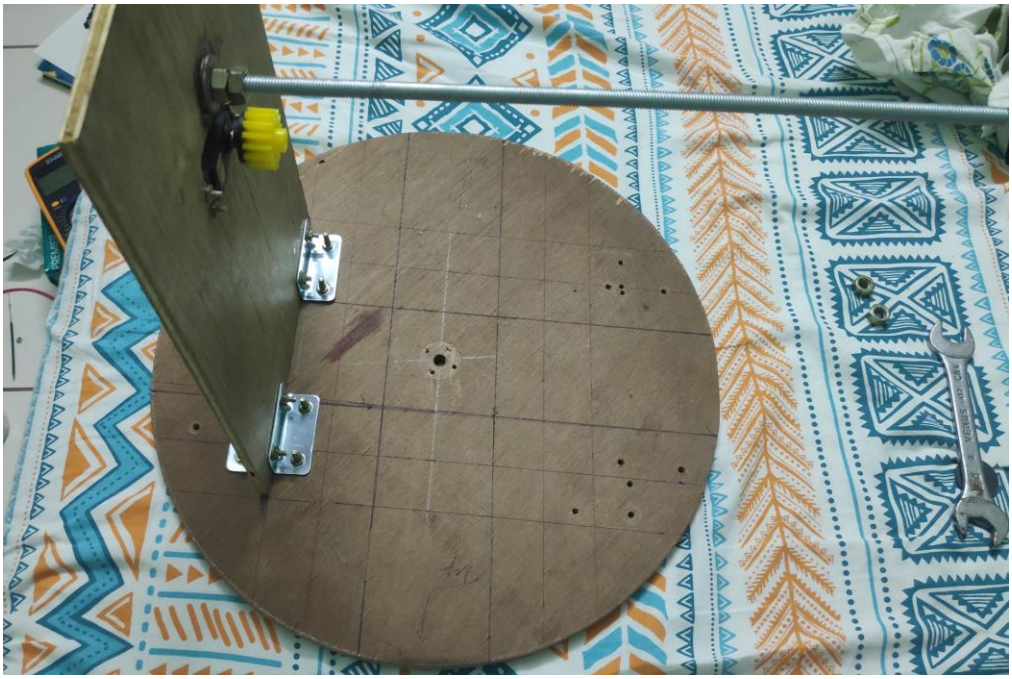

Figure 6.7 the shaft is inserted and secured with bolts

6.2 COMPLETED SENTRY GUN

In figure 6.2.1 you can see the fully completed sentry gun

The relevant videos and photos are uploaded in the submission portal

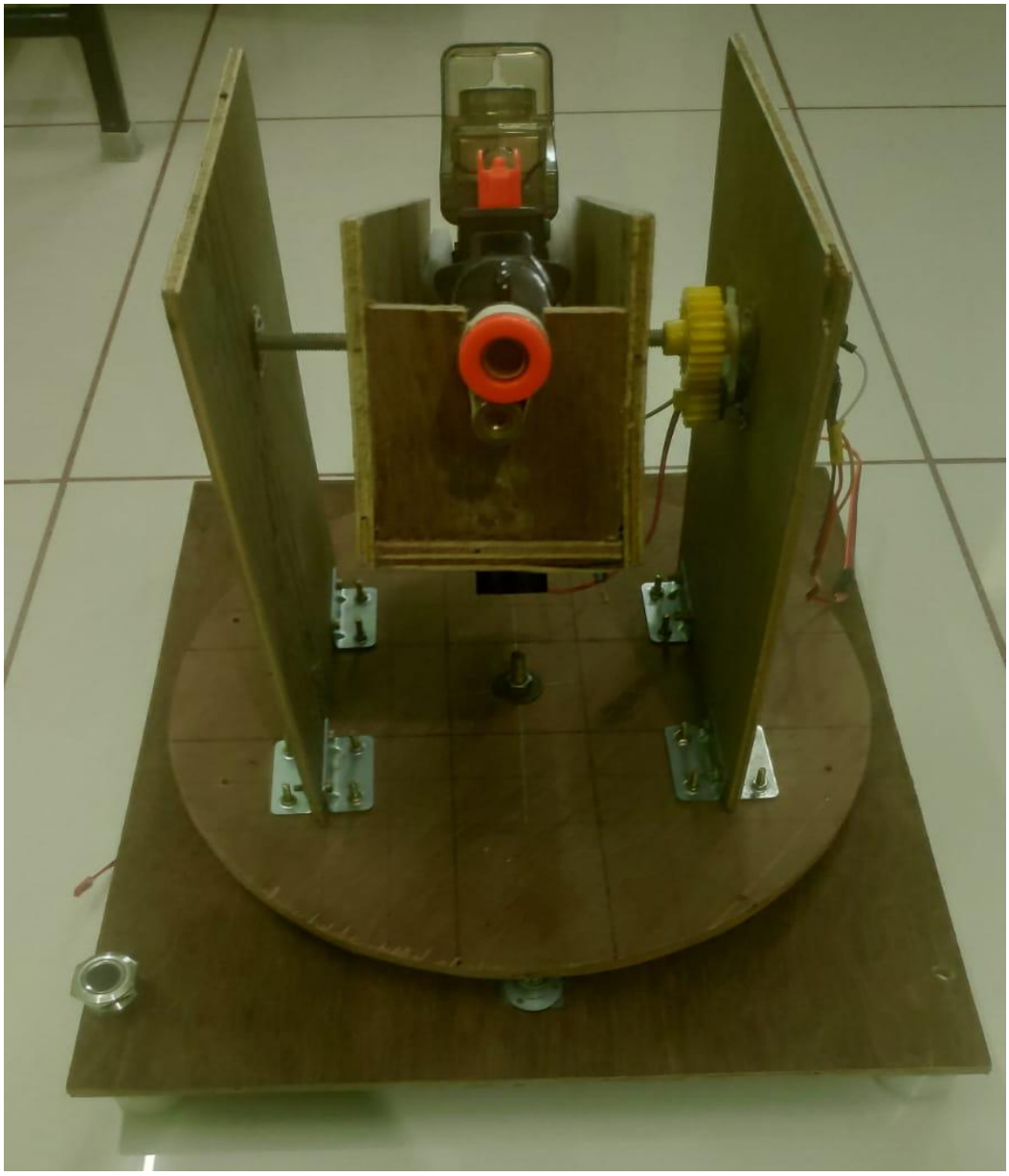

Figure 6.2.1 completed sentry gun

7 Result

The project has been implemented in a model successfully and the project has met its proposed objectives and obtained our desired result.

8 CONCLUSION

- we have successfully completed making the sentry gun and it works stable and operates smoothly
- We have achieved the objective of making the gun simple and remove all the complex aspects and making the gun as simple as possible
- The gun can be easily carried anywhere by a single soldier
- The fingerprint sensor enchance the security of the sentry gun
- as this is is a never ending platform as it can be added with tons of features and upgraded to new hardware we will continue to work on it for future enchancement

9 FUTURE ENHANCEMENT

Figure9.1 Frame structure of the proposed rover

This minor project is going to be upgraded as major

Figure 9.1 is a glimpse of the major project

- As the sentry gun will be mounted on a rover with four wheels powered by a brushless motor
- It can be controlled wirelessly upto a range of 2 km equipped with a fpv camera for better situational awareness
- And sthe structure will be made from a light weight stron material and
- Even the major will be mainly focused on ease of disassembly and reassembly
- It will have smoke screen to hide itself from the enemy ,unguided rockets
- and a self destruct button to protect the sentry gun from falling into enemy hands

10 REFERENCES

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APPENDIX

1 **ARDUINO CODE:**

```
//fingerprint sensor code


int pbuttonPin = 13;// connect output to push button
int relayPin = 10;// Connected to relay (LED)
int val = 0; // push value from pin 2
int lightON = 0;//light status
int pushed = 0;//push status
void setup() {
  Serial.begin(9600);
  pinMode(pbuttonPin, INPUT_PULLUP);
  pinMode(relayPin, OUTPUT);
 digitalWrite(relayPin, HIGH);// keep the load OFF at the begining. If you wanted to be ON, change the HIGH to LOW
}
void loop() {
  val = digitalRead(pbuttonPin);// read the push button value
  if(val == HIGH && lightON == LOW){
    pushed = 1-pushed;
```

```
    delay(100);
  }
  lightON = val;
     if(pushed == HIGH){
       Serial.println("Light ON");
       digitalWrite(relayPin, LOW);
     }else{
       Serial.println("Light OFF");
       digitalWrite(relayPin, HIGH);
     }
  delay(100);
}
```

CAD MODEL:

I have used solid works to make a virtual model of the sentry gun

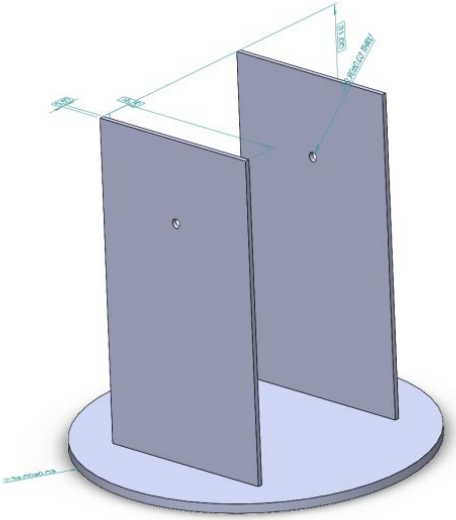

Figure 2.1 pan structure

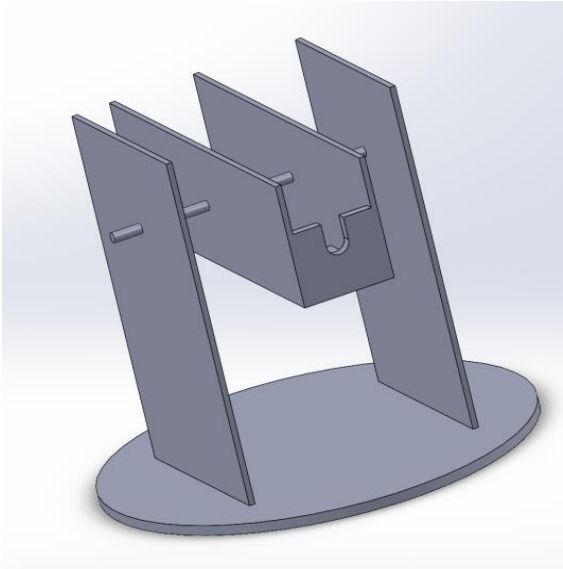

Figure 2.2 tilt structure and holster and pan structure
assembled together

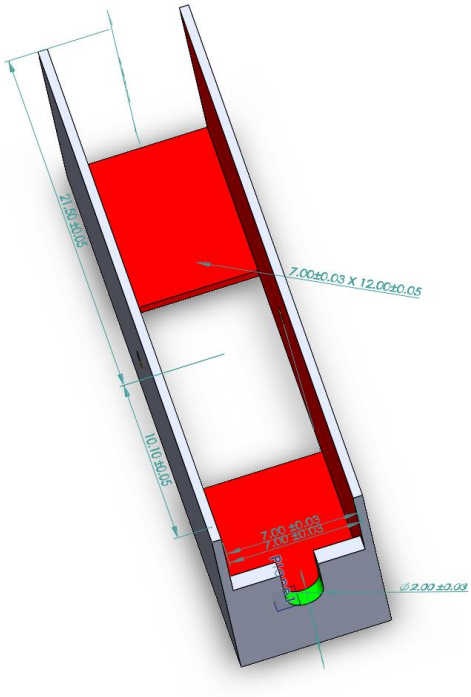

Figure 2.3 gun holster

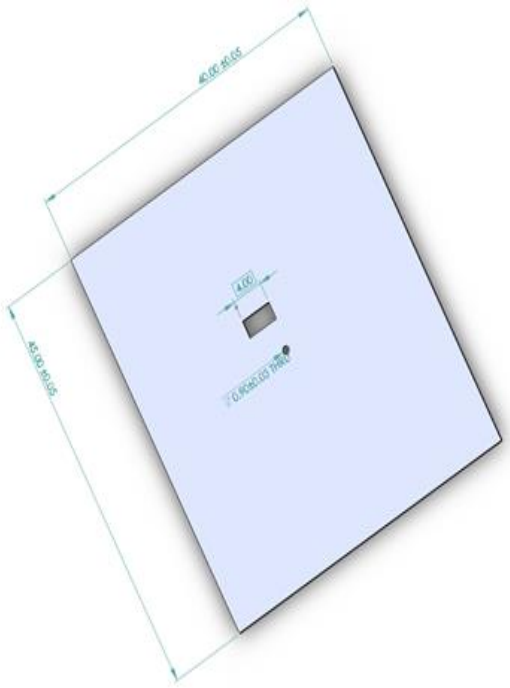

Figure 2.4 base structure

Program Outcomes mapping

S.No	Program Outcomes (POs)	Relation to the Project
PO01	**Engineering Knowledge** ***In this project:*** Highlight the knowledge of science and engineering fundamentals used	Engineering fundamentals like friction gear transmission balancing ,torque have been studied and used. The model has been using solidworks
PO02	**Problem solving and analysis** ***In this project:*** Highlight how did you identify, formulate, analyse the problem undertaken.	Problem solving was applied throughout the entire project. The whole project designed to address the issue of existing complex sentry gun model . During the building process, other shortcomings also needed to be solved for the turret to be functional like stability isues with the vertical supports to reduce the inertia of the seros and power supply problems.
PO03	**Design & developing solutions** ***In this project:*** Highlight the design (mechanical, electronics, mechatronics, algorithmic, control etc.) and techniques used.	A customised systems engineering design approach was taken which included preliminary and detail design of the mechanical, electronics . and software aspects of the turret. Available resources were used to implement the solution.
PO04	**Research-based investigation of systems:** ***In this project:*** Highlight the literature review that was conducted and how was research-based knowledge gained.	Investigations were conducted to provide feasible solutions during the literature study, preliminary and detail design. Data was acquired from testing and the results were analyzed.
PO05	**Modern tool usage** ***In this project:*** Highlight the engineering tools or software for design, analysis, analysis, that was/were used to create, select and apply appropriate techniques	Computer aided design software like Solidworks was used to visualize viable solutions.
PO06	**Engineers and society** ***In this project:*** Highlight whether your project take into consider public health & safety, cultural, legal, ethical and global consequences and their relations to the responsibilities of a professional engineer	This sentry gun is made to serve the military and this will ensure the safety of the country and its ethical to deploy a sentry gun in the border instead of our soldiers lives being lost

PO07	**Environment and sustainability** ***In this project:*** Highlight the components of your project demonstrate knowledge of and need for sustainable development and understand the social and environmental impacts of engineering solutions	This project has social impact of saving the lives of soldiers during border patrol Instead they can sit in their command room and monitor through the gun
PO08	**Professional ethics:** ***In this project:*** Highlight how did you apply, follow and practice commit to professional ethics and responsibilities and norms of engineering practice.	Having submitting regular progress for feedback and communication with the guide were addressed professionally. Presentations were also given professionally during the course.
PO09	**Communication** ***In this project:*** Highlight how did you manage and/or coordinate communication: (between project members, guide, subject-coordinator, outside community, etc. and also with the community at large	This was a solo project so the only communication was between me ,my project guide and the subject coordinator I shared images of my project development and review files through the means of WhatsApp and asked for her opinion and got my project to success
P10	**Individual and team work** ***In this project:*** Highlight how did you function effectively as an individual, and in multi-disciplinary and multi-cultural teams	As I did my project alone I was quiet good in achieving all the targets of the project by myself
PO11	**Lifelong learning** ***In this project:*** Highlight the opportunity that you gained or to be gained for the need for independent and lifelong learning, and possess the capacity to do so	As I did the project by myself I learned to work with plywood and mounting bearings to wood and sort out malfunctions in the electrical components and to integrate all electrical mechanical electronics and the software components together
PO12	**Project management and finance** ***In this project:*** Highlight how was the engineering project-management was done and along with financial and resources and supply constraints.	Due to covid 19 lockdowns there was a supply constrains but was overcame by first making the parts of sentry gun from locally available resources while the gear and servo components came in courier And the utilized budget is far below the estimate

Thank you