DESIGN OF A COIL GUN WITH TRACKING SYSTEM

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Abstract: Having strong armed forces and the need to protect the people against various threats is important. Our objective is to design and develop a weapon which is more accurate, reliable and safe to use. In this perspective, a coil gun is designed which has capability to accelerate a ferromagnetic projectile to high velocity in shortest time possible, added with a target tracking system to shoot down the target with high speed and accuracy. Coil guns use a strong magnetic field to accelerate ferromagnetic projectiles. Tracking system is used to enhance its application and it is achieved by image processing using machine vision camera. The whole setup can be mounted on a portable vehicle and controlled with a remote. This weapon is capable of achieving high velocities than conventional systems and propellant less firing that is capable of firing moving targets and also can be remotely controlled.All the safety measures are ensured while doing this project.

Key words: coil gun, ferromagnetic projectile, machine vision camera.

I. INTRODUCTION

A lot of electromagnetic guns have been proposed for various applications since the early 1900's, but they have not yet been developed into a practical application. They have been suggested as a means of transporting payloads into space, however this technology has not yet been developed.Electromagnetic guns come in two main types: coil guns and rail guns. Both have been shown to reach supersonic speeds, however this coil gun was not designed to exceed velocities of a few meters per second for safety reasons.The coil gun we created in this project was integrated with a target tracking system in order to ensure accurate firing. The coil gun accelerates the projectile by running a strong impulse of current through a coil of wire with many turns, creating a strong magnetic field that accelerates the projectile.A large DC capacitor provides the impulse by rapidly releasing current through the coil of wire. The pulse of current should be fired as the projectile approaches the coil, but should not last longer than the time that it takes for the object to reach the center. Image processing is used to track the target. The target is tracked, and the coordinates are continuously passed on to the microcontroller to which the servos are connected, which control the motion of the coil gun.An entire setup can be mounted on a portable vehicle and controlled remotely.

II.Construction of Prototype Model:

II.1 Components used
1. Arduino Uno
2. MG995 Servo Motors
3. B10k Potentiometers

4. SG90 Servo Motors
5. Boost Converter
6. Webcam
7. Push Button
8. Multimeter
9. Capacitors
10.Bread Board
11.Pan and Tilt clips

II.2 Softwares used
1. Spyder IDE
2. Arduino IDE

III.Design Considerations

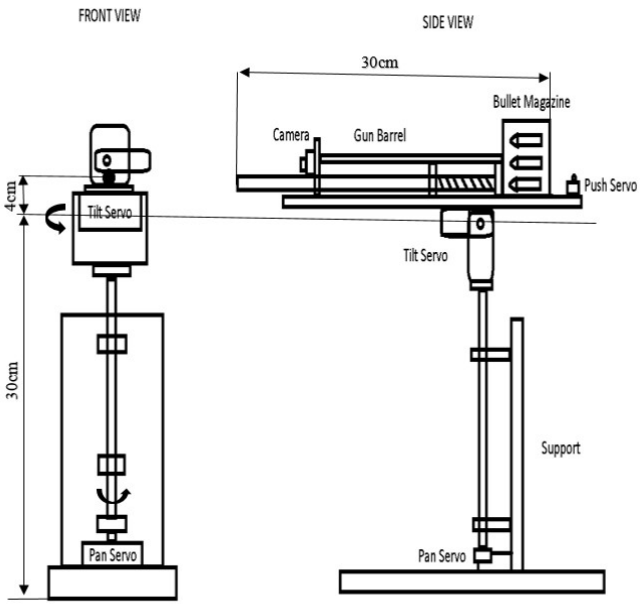

Fig 1: Design Considerations

IV.Circuit:

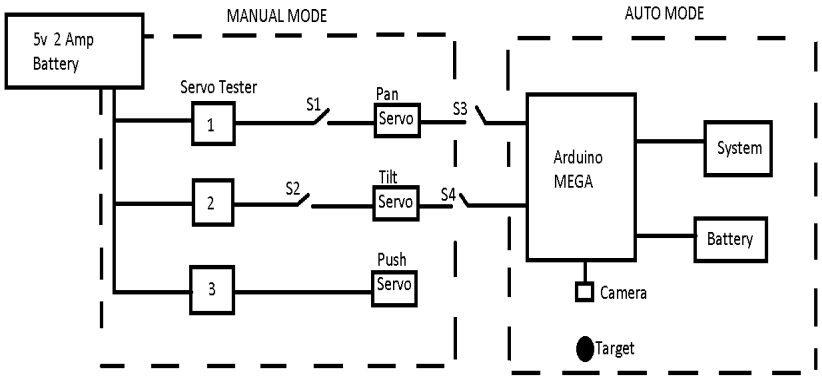

Fig 2: Servo control system

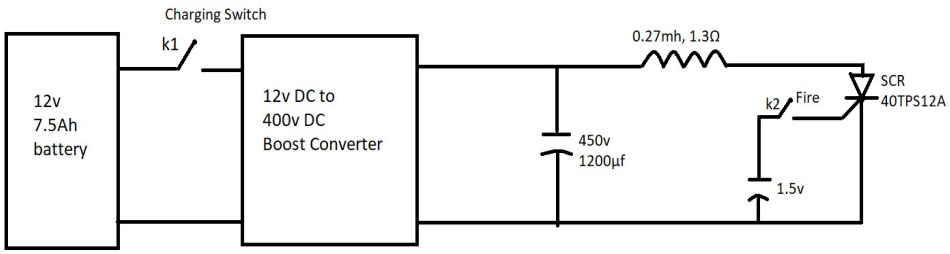

Fig 3: Firing Circuit

V.Selection of Materials

V.1 Coil Gun

Name of the material	Description
Hollow copper tube	Length=30cm
Copper wire	24AWG 7x50=350 turns
Wood	For outer part of gun for stability
SG servomotors	For loading of bullets
Boost converter	Converts 8-12vDC to high voltages upto 450vDC
Capacitor	870µf 450v for storing the high voltage
Iron bullets	6mm dia and 2.5cm long
Switches	For firing the bullet and for charging the capacitor

Table 1: coil gun materials

V.2 Tracking System

Name of the material	Description
Arduino	Controls all the sensors and actuators i.e the servomotors
Webcam	Helps in automatic tracking
Pan and Tilt mechanism clips	Helps in holding the MG995Servomotors and gives pan and tilt movement to the gun
Potentiometer	Controls the loading of bullets
Servotester	Controls the pan and tilt movement of gun manually

Table 2: Tracking system materials

VI.Working Principle:

1. As we can track the objects manually and automatically we have two working methods.
2. The points below from 3 to 9 helps us to know about working of coil gun with automatic tracking of objects. 3. Before going to the actual process we have to install all the packages regarding opencvin spyder IDE so that the tracking takes place.
4. In our project we are tracking a ball and faces of trained persons, we have to select which is to be tracked first and then run the program.
5. If there is any problem regarding running of program please remove the cable of arduino and insert again.
6. If you select ball tracking then an icon can be seen in the taskbar which has frame and mask windows click on them. If you place ball or round shaped object in front of web cam then you can see the object is tracked in the frame and the amount of which object is tracked is seen in mask.
7. If you select ball tracking, then an icon can be seen in the taskbar which has frame and you can see faces which are trained are tracked and at a time only one face is tracked.
8. From here the information of location of object is transferred serially from our program to arduino andarduino controls the movement of servomotors in the direction of object.
9. When we want to fire the target we have to press the pushbutton, when we press the pushbutton the servomotors beside the switches will be operated at some delay so that the maximum voltage is stored in the capacitor with the help of boost converter and then after the full charge of capacitor another servomotor will switch on and allows the energy stored in capacitor to flow through the coil and because of that magnetic field is created and due to Lorentz force when a ferromagnetic material is placed in magnetic field.it experiences force and because of that force created by field the bullet gains large acceleration and comes out of the barrel and may hit the target.
10. After some delay a servomotor will reload the bullets from the back meanwhile the tracking of the object will be taking place.
11. The points below will help us to know working of coil gun with manual tracking of objects.
12. With the help of knob of potentiometers we can adjust the movement of pan-tilt servomotors which are connected with arduino and the code helps in controlling the movement of servomotors.
13. When we want to fire the target we have to press the pushbutton, when we press the pushbutton the servomotors beside the switches will be operated at some delay so that the maximum voltage is stored in the capacitor and then after the full charge of capacitor another servomotor will switch on and allows the energy stored in capacitor to flow through the coil and because of that magnetic field is created and due to Lorentz force when a ferromagnetic material is placed in magnetic field it experiences force and because of that force created by field the bullet gains large acceleration and comes out of the barrel and may hit the target.
14. After some delay a servomotor will reload the bullets from the back.

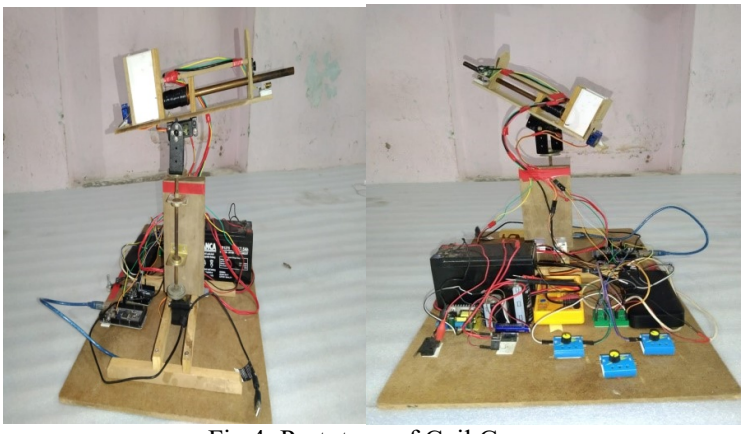

Fig 4: Prototype of Coil Gun

VII. Results and Discussion

The firing of ferromagnetic projectile and tracking of the target is successfully achieved. The object can be detected and tracked up to 2m and successfully tracked. The firing range of the gun is nearly 15m. According to the observations made, the bullet velocity is approximately 3 m/s which is not as high as to penetrate through a wall. The velocity of bullet can be considerably increased by using capacitor banks of capacity and changing no. of turns of coil. The velocity is also affected by size and shape of bullet. The design of coil gun can be improvised by adding multiple coils to increase the velocity of projectile. The object tracking can be improvised and make easier by replacing webcam with machine vision cameras like PIXY2, Husky Lens etc. Coil gun with image tracking technology can be used as military weapon which have high precision and accuracy. It can replace conventional guns because it eliminates consumable propellant (gun powder) for firing and is capable of breaking thick shells compared to conventional systems and also can achieve higher muzzle velocities.

VIII. Conclusion

The Coilgun is a gun that launches projectiles made of ferromagnetic material. This project has military, civilian, and scientific applications and uses. These include defence, electromagnetic rail travel, and magnetic field generation. The project goals include high velocity and accuracy. These goals are achieved through the utilization of the concepts of magnetic fields, electronic circuitry, and microcontroller programming. The Coilgun is a gun that is capable of accelerating ferromagnetic projectiles to high velocities. The project features a boost converter, capacitor bank, custom firing circuit. The Coilgun with object tracking system was chosen because it provided design and implementation challenges for both Electrical and Computer engineering disciplines. The Coilgun with object tracking system also required knowledge of power electronics, electromagnetic field theory, software development, computer programming, and embedded systems. This project provided challenges to each group member that required direct application of knowledge gained through each group member's engineering coursework. This project also provided each group member with a foundation of experience in group work and working on a team to complete a project, which can be directly applied to a chosen career path

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