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# Development of Gun Turret Drive StabilizationSystemWith a MicrocontrollerandImplementation on a Model Tank

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**Abstract.** Nowadays and in the future, high mobility combat troops will be needed instead of the steady troops in the battlefields. The mobility of troops improves the effect of incursion and prevents troops from becoming an easy target. Mobile gun systems move and vibrate easily because of rough land. Thus, shooting the target and the likelihood of hitting target successfully becomes more difficult for tank gunners. In order to improve thelike hood of hitting target and shoot straight, the gun barrel on the turret of a mobile tank has to be stable in the target region.

## Introduction

The barrel of a mobile gun system needs to be stable on the target area so that it can shoot straight and it is more likely to hit the target. To do so, the location of the gun system needs to be determined and the barrel needs to be made stable on the target area by moving the barrel in the opposite direction and finding out the changes in the location within the past time.

In this study, the changes in the location of a gun system will be identified through the use of gyroscope and accelerometer. Through the engines directing/leading the barrel, the change identified in the location will make the barrel move in the opposite direction.

Furthermore, by making the barrel stable on the target area, block diagrams will be formed by benefiting from/using automatic control algorithm in order to develop systems in which mobile gun systems can shoot robust and are more likely to hit the target.

## Literature Review

### Introduction to tanks

Tank,whose main function is to attack enemy forces by using firepower directly, is a military vehicle used in wars. The most important features of a tank which differentiate it from other combat vehicles are having heavy armour, high firepower, undercarriage designed in such a way that it can move fast on any kind of land. Although it is expensive and difficult to be supported logistically, it is an indispensable element of the modern armies thanks to its ability to demotivate infantryman and attack targets on land [1].

There are there main features of a tank which determines the effectiveness of a tank: firepower, mobility and protection.

In a tank design, the main purpose is to use these three features efficiently, in a way that they coordinate and support each other. As a result, the tank will have good armour; have increased mobility with heavy armour. In addition to this increased mobility, the tank will be designed in such a way that it can shoot straight and effectively. Tanks can have the ability to shoot while moving at high speed on different and rough land at remote targets thanks to barrel stabilization system [1-3].

Stabilization, originated from French, literally means consistency, balance and immobilization. Stabilization is used in various areas such as automotive, informatics, marine, and defense technology. To exemplify, it is commonly used in various areas such as vehicles detecting roadways, electronic stabilization program, camera systems supported by movement sensors, unmanned air vehicle, autopilot applications, continental missile systems, satellite systems, mobile weapon platforms[2,3].

## Materials and Method

### Design of tank barrel gun stabilization system

Actually, tank barrel gun stabilization system is a closed cycle control system. After the tank gunner move the barrel gun towards the target area, because of changes in the direction of the tank body and rough land conditions, there are deviations in the barrel from the target area. By using automatic control system, it is possible to deal with these deviations. Automatic control system detects the location of the tank body which is signaled by the sensors. These signals are transmitted to the systems directing the barrel gun and by moving in the opposite of the deviations, the barrel is made stable on the target area. What needs to be taken into consideration at this point is that automatic control system takes the tank body as a basis. In other words, stabilization system is not a target tracking system, but it is system which makes the barrel gun focused on target area, helps the tank gunner to shoot straight and efficiently by being least affected from the land conditions[4-9].

In the study, in the closed cycle automatic control system MPU-6050 is used as a location detector, Arduino Uno is used as a processor and GT9 servo engines are used as actuator.Thanks to the accelerometer and gyroscope that MPU-6050 sensor includes, MPU-6050 detects the angular changes made on x,y and z axis based on the defined reference points. Whether the stabilization system works or now is checked by the microprocessor and if the system is activated by a tank gunner, the angular values of y and z axis is defined as $y_0$ and $z_0$. The data obtained is sent to Arduino Uno microprocessor card, which is used a tool to compare and control, by using$I^2C$ communication protocol. Arduino Uno microprocessor card, which uses ATmega328 processor, evaluates the obtained data in line with the software algorithm which is defined earlier, and sends the necessary signals to actuatorsso as to redirect the barrel gun to the reference point. GT9 servo engines which are used as actuator take their new positions based on the signals coming frommicroprocessor card and direct the barrel gun on the defined reference point. In short, what automatic control system does is to move the GT9 engines in the proportion and in the opposite direction to the angular changes determined with the MPU-6050 sensor. The block diagram of this automatic control system is illustrated below (Figure 1) [10-17].

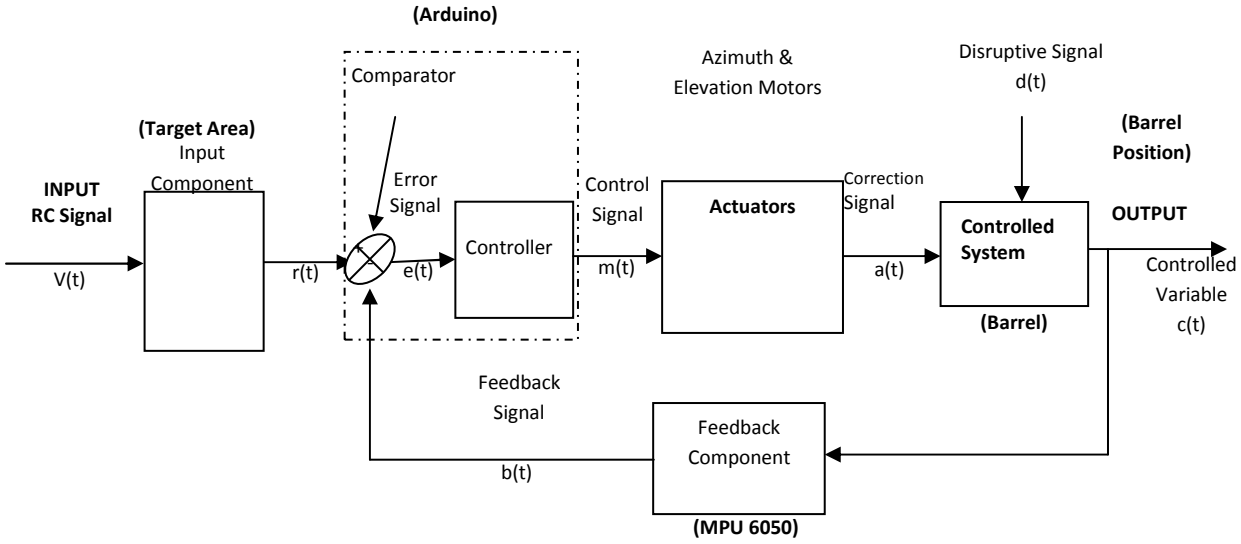


Figure 1: The block diagram of tank barrel gun stabilization system

### Modeling of tank barrel gun stabilization system

The electronic connections of the closed cycle automatic control system which is designed using Arduino Uno processor, MPU-6050 sensor detecting the location and actuator GT9 servo engines are as in figure 2.

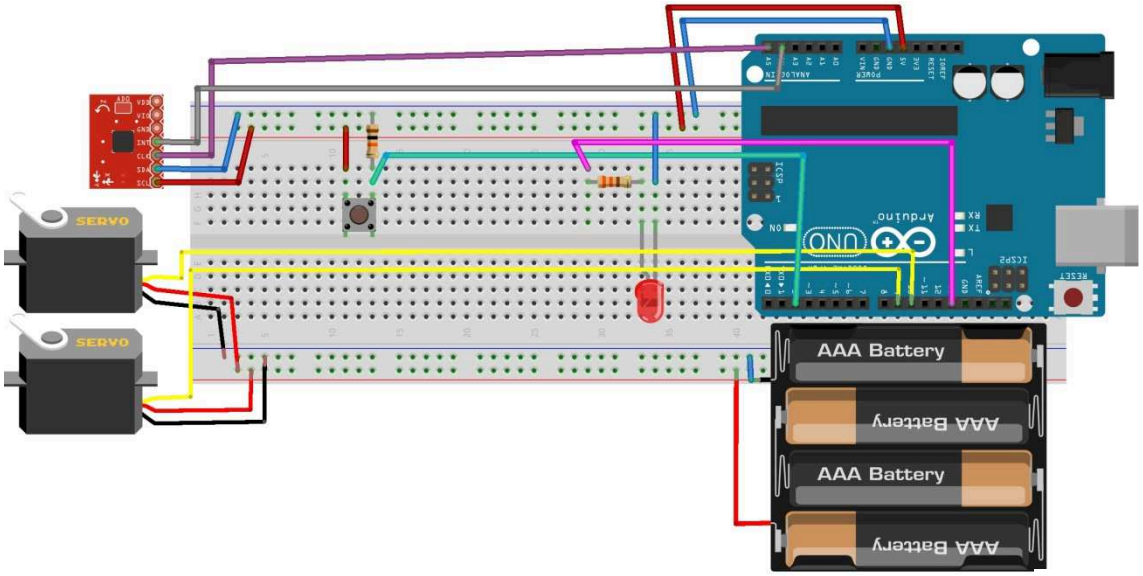


Figure 2: The electronic model of tank barrel gun stabilization system

Arduino Uno microprocessor card is programmed with the software named "Arduino" which is provided by the producer. In this software, wiring software language is used. Software algorithm flowchart used in the study is as in Figure 4:

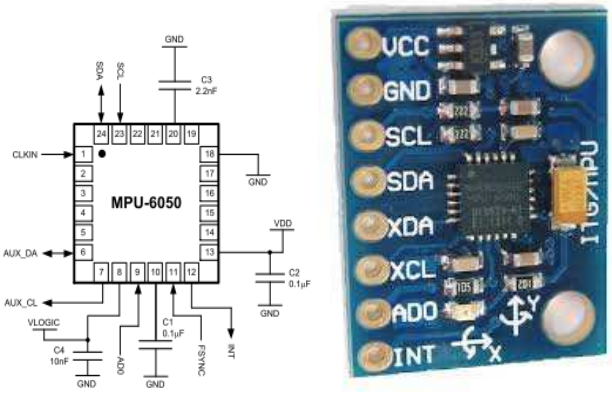


Figure 3:View of the MPU-6050 Six-Axis (Gyro + Accelerometer)

**Results and Discussion**

The aims of the study are as follows:

- tank gunners using weapon system on different/rough road and land would be able to shoot straight,
- the application of tank barrel gun with Arduino Uno so that it is more probable for tank gunners to shoot straight,
- the preparation of experimental setup with which the weapon would stay on the target area in a stable position

and these aims are achieved. With this aim the software of Arduino Uno microprocessor's card is used.

The algorithm used does not act consistently on high speed movements. Therefore, filter program and software algorithm should be developed. Additionally, thedata obtained from MPU-6050 are calculated on microprocessor, which increases the processing load of the microprocessor. To deal with this, data should not be calculated with microprocessor but with the digital movement processor (DMP) which is stable on MP6050 sensor.

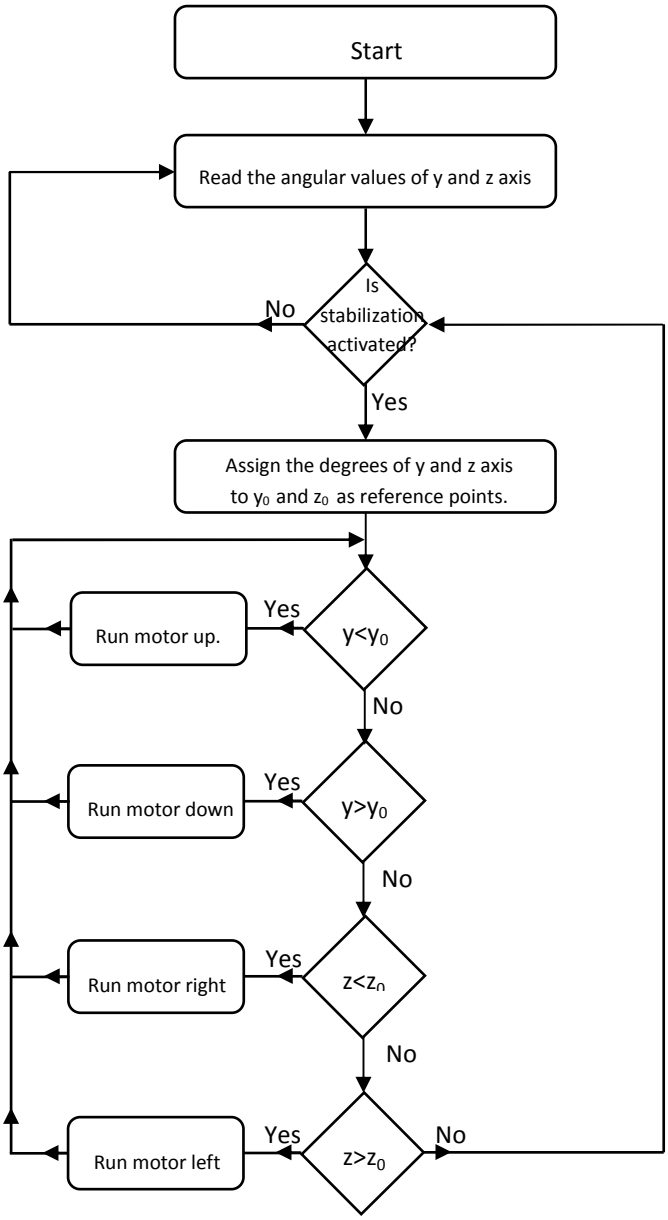


Figure 4: Flowchart of software

Finally, since the movement of GT9 Servo Engines is limited to $180^0$, it is not possible to add movement to the system other than this. In order to use the system more comprehensively and efficiently, Servo Engines which can move $360^0$ or DCengines should be used instead of GT9 Servo Engines.

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