DESIGN AND DEVELOPMENT OF AUTONOMOUS ROBOT BASED ON CATAPULT MECHANISM

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Abstract: This day by day need of the automation made the man addicted towards automotive world. Automation industries attain efficient production and manufacturing processes by eliminating issues related to their production with the help of every day changing technologies. An industrial robot exceeds any human performance based on precision, accuracy, and speed. These robots operate on various mechanical, electrical, and software systems to overcome the fatigue experienced by the humans. This makes the human interference less towards any work and make them easy and simple. In this paper we are making autonomous slingshot throwing robot or catapult mechanism robot which is used to hit on target via parabolic path. The various types of PCBs, sensors and other technologies are used to make this automatic robot.

***IndexTerms* - Pneumatics, Robot, Catapult Mechanism, Omni Wheels.**

I. INTRODUCTION

The current scenario of automation in the world makes focus of all the researchers towards the automation. Need of humans interference reduces because the Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. The conventional method consists of one load which were placed on a bucket and load on other side is applied by bigger stone or load manually, in this the target possible may be wrong sometimes and high human efforts required to fire the sling shot. This paper gives the brief construction and manufacturing of throwing of sling shot by completely automatic Mechanism. The mechanism is achieved by using pneumatic cylinders. The sling shot is thrown from tail. The highly precise notches are used to hold the string of sling shot. The arduino is used for the complete automation system. We can hit the any target position by changing the angle of arm, pressure by pressure gauge or hinge point. The multi-directional moving Omni wheels are used on the chassis to avoid any turning problems in a small areas. To make the bot light, aluminum channels are used for the manufacturing purpose. The RFID system is used to activate the bot so that only authorized or legal person can operate the bot. The motors, relays, sensors are used for the automatic actuation. The slingshot is made up of specific material in order to achieve a desired range and height

II. SCOPE OF INVENTION:

1) The mentioned system is used on only flat surfaces, thus by using independent suspension system, we can use it for the irregular surfaces.
2) It can be also used for army purpose for various types of military operations.
Advantages:

- Throwing of multiple slingshots at a time.
- Different arm is used for generating different trajectories.
- Mobile robot for on road as well as off-road conditions.

III. FLOW CHART

The Robot control circuit is divided into two section (1) Autonomous mode (2) Manual Mode. There is a mode selector button on Robot, which specifies the respective mode of the robot as mention above. The robot control circuit is sub divided into two section that is remote section (Used only for manual mode), Robot section (works in both autonomous and manual mode). Both the section is been explained in details below.

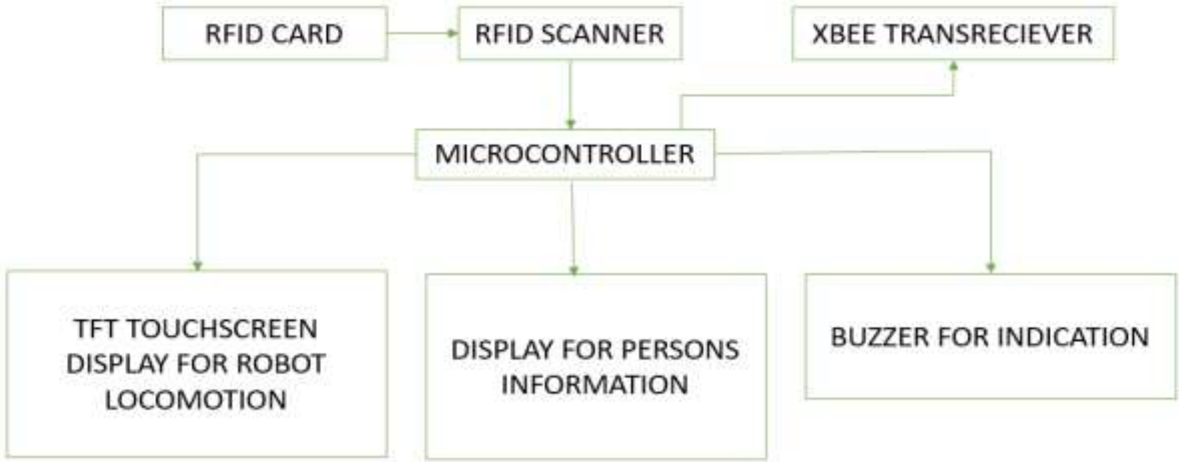

Figure 1: Remote Controller

Figure 1 shows the remote section circuitry. The whole system operates only by the RFID card, by which only authorized person can operates this remote. Thus as the authorized card is been scan by the RFID scanner it sends signal to the microcontroller which then matches the card information with the available information. And hence the robot is activated. The information from the remote is been send to the robot using the XBEE module for controlling the robot. In advance we have placed the TFT Touch screen Display in order to get the capture data from the robot to the remote section with zooming capability. The display is used for displaying the person's information who is using this robot. Whenever the robot is triggered and ready to throw the slingshot the buzzer buzzes three times and then the robot shoot the slingshot. In this way the Remote section works.

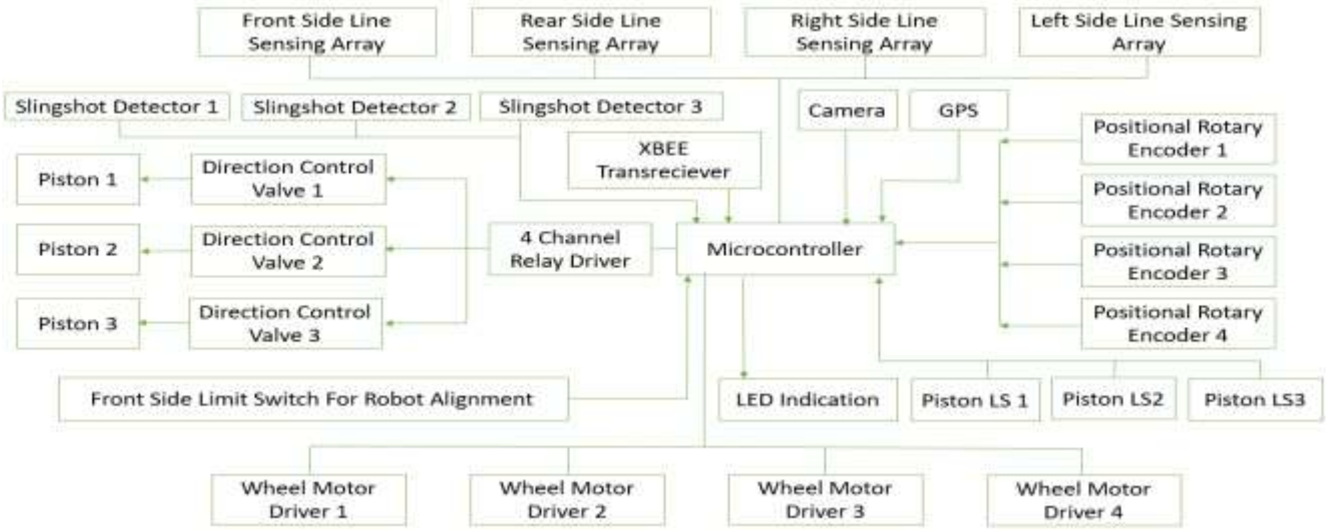

Figure 2: Robot Circuit Configuration

This system is the main section of all kind. Whenever the user places the slingshot on the notch either of arm one, two, three, the respective slingshot detector detects on which arm the slingshot is placed, and sends the signals to the microcontroller. Now, the robot knows on which arm the slingshot is placed then the camera which captures the target via image processing sends the data to the microcontroller, this microcontroller calculates the range, height and velocity required or the slingshot and thus varies the pressure of the respective piston via pressure proportional regulator. And thus the microcontroller activates the respective arm relay to hit the slingshot on the target. The Minimum and maximum rotation is been detected from the arm LS (Limit Switch) 1, 2, 3. As mention in the figure 2. Thus in this way when the arm is at its minimum position then the air flow is stopped from the DCV (Direction Control Valve) 1, 2, 3 with the help of the respective limit switch 1, 2, 3 respectively. In this way the shooting mechanism works with these feedback circuit.
The path of the robot is been traced with the help of two components. First one is LSA (Line sensing array) and second one is GPS module. When the robot is on off road then GPS is used and then when it is at the on road then the LSA is used where for detecting the path entered in to the controller. Now, as the GPS and the LAS signals is been captured then it sends the signals to the controller. This controller then drives the motors of the base. The base motor is been drive using the PID (Proportional Integral Derivative) function where the encoders mounted on the motors is used to control the acceleration and deceleration of the robot along with the calculation of the number of steps the motor moves. The function of the camera in the autonomous mode is similar as that of in the manual mode.

IV. CAD DRAWING

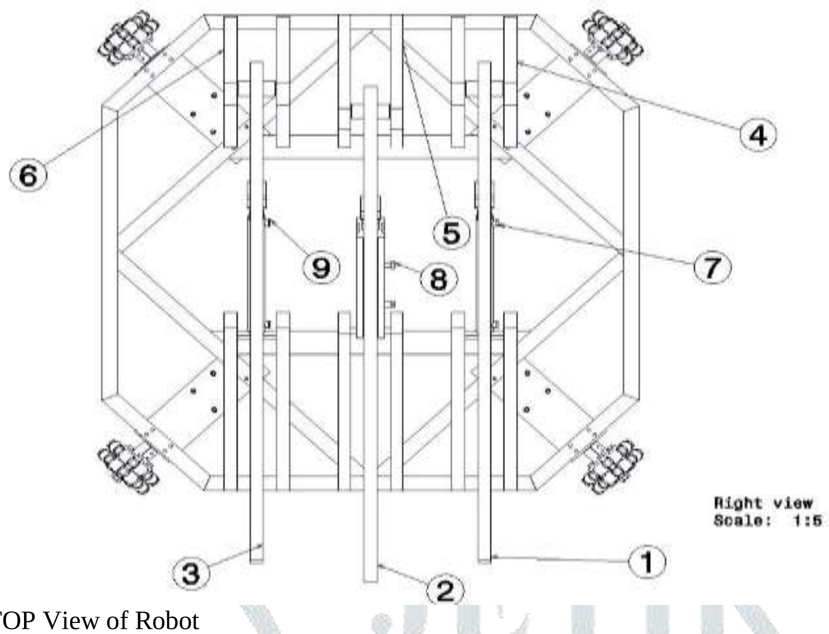

Figure 3: TOP View of Robot

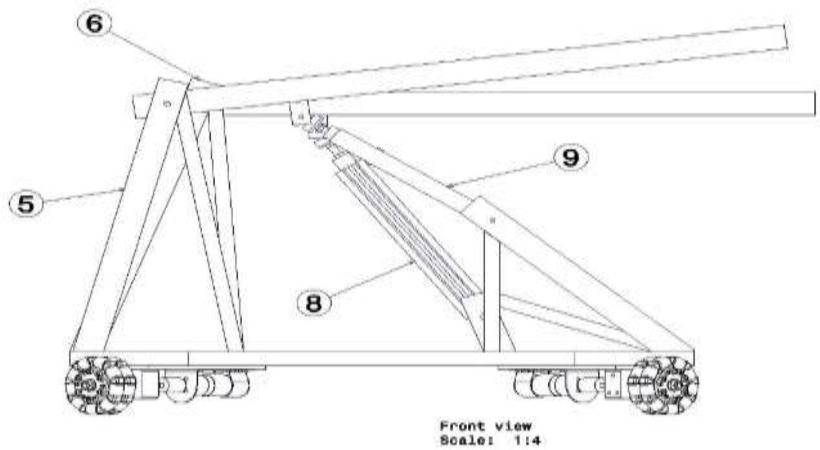

Figure 4: SIDE View of Robot

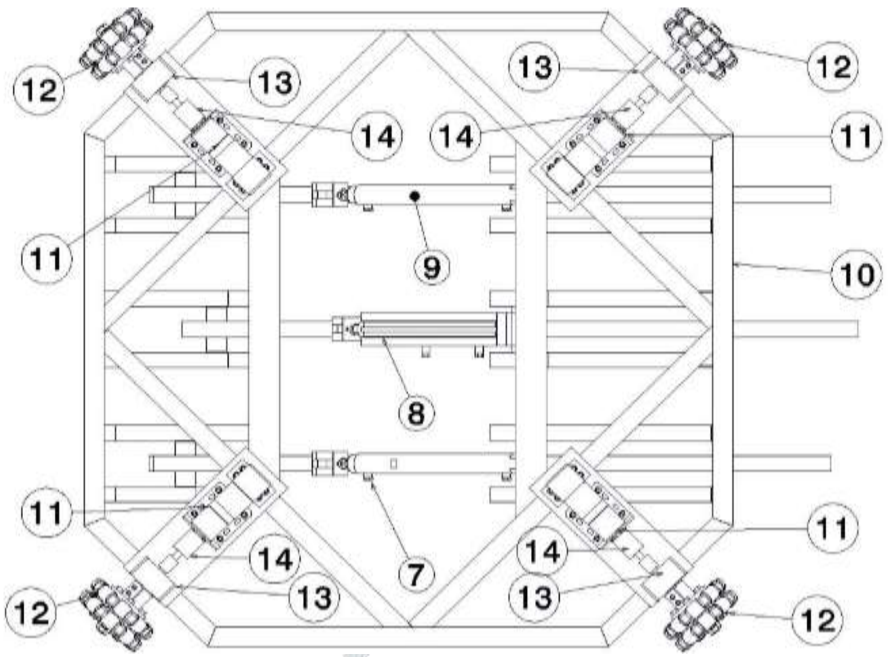

Figure 5: BOTTOM View of Robot

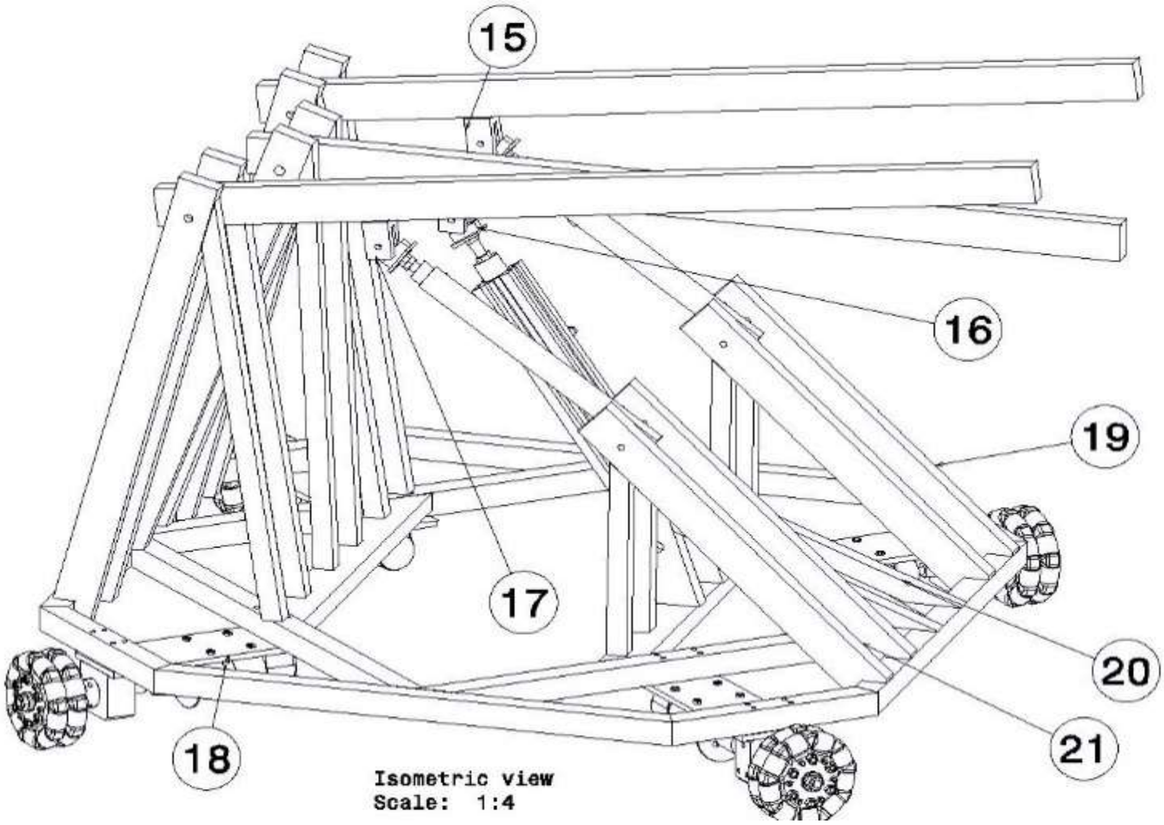

Figure 6: ISOMETRIC View of Robot

V. PART DISCRIPTION

PART 1: THROWING ARM 1
PART 2: THROWING ARM 2
PART 3: THROWING ARM 3.
PART 4: SUPPORT ROD FOR THROWING ARM 1
PART 5: SUPPORT ROD FOR THROWING ARM 2
PART 6: SUPPORT ROD FOR THROWING ARM 3
PART 7: PISTON FOR THROWING ARM 1
PART 8: PISTON FOR THROWING ARM 2

PART 9: PISTON FOR THROWING ARM 3
PART 10: HEXAGONAL CHASSIS
PART 11: PLANETARY DC GEARED MOTOR
PART 12: OMNI WHEELS
PART 13: BEARING HOUSE ASSEMBLY
PART 14: MOTOR COUPLING WITH SHAFT
PART 15: KNUCKLE JOINT FOR THROWING ARM 1
PART 16: KNUCKLE JOINT FOR THROWING ARM 2
PART 17: KNUCKLE JOINT FOR THROWING ARM 3
PART 18: BASE PLATE FOR MOTOR MOUNTING
PART 19: SUPPORT FOR PISTON OF THROWING ARM 1
PART 20: SUPPORT FOR PISTON OF THROWING ARM 1
PART 21: SUPPORT FOR PISTON OF THROWING ARM 1

VI. PNEUMATIC CIRCUIT

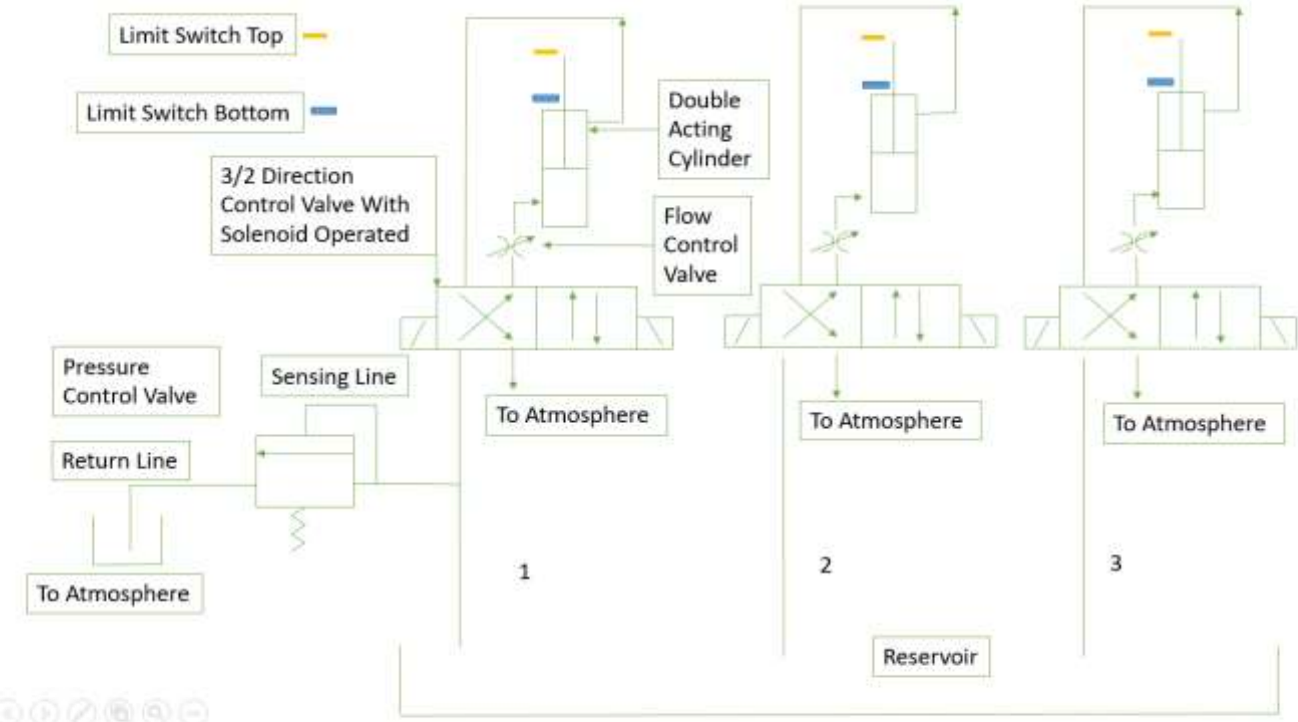

Figure 7: Pneumatic circuit of Robot

Pneumatic circuit comprises of 3 pistons, 3 DCVs and pressure proportional regulator (PPR), Each piston is used for projecting different trajectories according to their length and size of piston. Pneumatic reservoir is been prepared with the help of soda bottles. This bottles are used in order to reduce the weight of the system by eliminating heavy duty reservoir. Each bottle is good enough to supply approximately three to four strokes of piston according to their size and shape. Bottles are been covered with black masking in order to reduces the expansion rate and increase the durability of bottles. Each bottle is been connected in series and parallel manner with the adjacent bottles in order to increase the volume. At the exit of the reservoir, there is a flow control valve (FCV) used to regulate the flow of air .After this FCV one more device which is been connected is the PPR. This PPR is used for regulating the pressure and flow of fluid inside the piston in precise manner. The PPR is used because to control the force created by the piston. After this fluid is supplied to respective DCVs of piston. This DCVs controls the fluid as a switch inside a electric circuit where as soon as the fluid escapes the DCVs it enters into the piston and reciprocating motion takes place. Air inside the opposite valve of the piston is been transferred to the same DCV from which the air is been escaped to the atmosphere. In this way the whole cycle works for all arms.

VII. CALCULATION

To find every point on a trajectory we use the equation 1.

$$y = x\tan(\theta) - \frac{g\,x^2}{2(\cos(\theta)U)^2} \qquad (1)$$

Where,

$$\theta = angle\ of\ elivation$$

$$y = displacement\ in\ y\ direction$$
$$x = displacement\ in\ x\ direction$$
$$g = gravitational\ acceleration$$
$$U = initial\ velocity$$
$$R = range\ of\ the\ projectile$$
$$H = maximum\ height\ of\ the\ projectile$$

In order to find the range of the projectile we use the formula of range which is given by the equation 2.

$$R = \frac{U^2 \sin(2\theta)}{g} \qquad (2)$$

In order to find the height of the projectile we use the formula of height which is given by the equation 3.

$$H = \frac{U^2 (\sin\theta)^2}{2g} \qquad (3)$$

VIII. ACTUAL PROTOTYPE

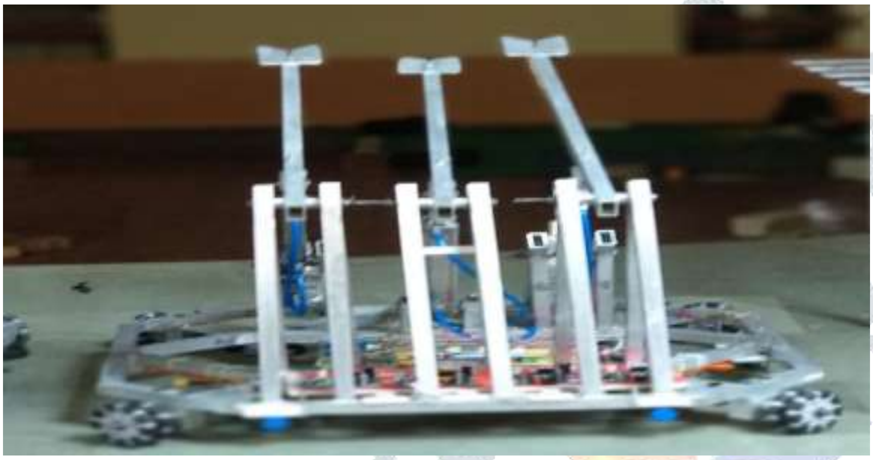

Figure 8: Actual Model

IX. RESULTS

	ARM 1	ARM 2	ARM 3
PRESSURE (BAR)	4	5	5.5
RANGE (MM)	5020	10770	7020
HEIGHT (MM)	2400	3400	2400

X. DISCUSSION

1) Pressure required for arm 1 is 4 bar, the corresponding height and range obtained is 5020 mm and 2400 mm respectively.
2) Similarly for the arm 2 and 3 the results obtained are shown in the above table.

XI. CONCLUSION

The presented model is absolutely feasible and workable shuttlecock throwing robot. This robot reduces human efforts as it is autonomous. The construction consists of more efficient use of materials, better product quality, improved safety while operation. The Omni wheels used in the robot makes robot perfectly aligned on the target. The shuttlecocks used in the mechanism has proper aerodynamic shape which reduces air resistance. Thereby increasing the target efficiency. Even if the target changes, we can hit on the target with same efficiency as we are using pressure gauges to control the range and height of shuttlecock. The notches made by highly precision manufacturing method have good holding capacity of shuttlecock by string. Thus the overall construction make the complete bot more feasible and good. This system may is also used for army bomb attack system which detect the location of criminals and hit on them via automatic system.

XII. REFRENCES

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