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Development of Rice Plants Avian Repellant Manipulative Scarecrow using Solar Interruption Technique

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ABSTRACT

The challenges of preventing birds from devouring farm plants is an enormous task that has bedevil the farmers for centuries. Diverse techniques and mechanisms have been applied with less substantial result as a result of delay in response, inadequate movement of mechanism and limited level of sound. In this work, the developed system uses mechanisms with high sound intensity and manipulative movement to produce scarecrow device to drive away avian pest from rice plantation. The scarecrow arm was designed based on an assumption of a maximum carrying capacity of 0.9 kg and an arm length of 0.5m. D.C motor for the arm has 20watt, 0.03hp with 12v (DC) while that of the base has 30watt, 0.04 hp. The scarecrow has a maximum height of 1.95m with orientation of 360°. The machine is highly effective in scaring birds that flew around the North West region with the help of the Passive Infrared (PIR) sensors position. The efficiency of the scarecrow arm is 65.7 %, while the visual capturing efficiency is 25% at the centre and over 95% when positioned at the South- East corner of the field. In maximizing the effectiveness of the machine the sensors need to be four in number and positioned on a semi-circular frame for optimal capturing of the obstruction at different cardinal orientation. The developed scarecrow can be used to chase away birds from Airports, roofs of residential or commercial buildings, Institutions of learning and offices where birds' causes distractions or sanitation problems can also utilize the mechanism.

KEYWORDS: Scarecrow, Mechanisms, Repellent, Technique, Capturing, Avian pest

INTRODUCTION

Automatic scarecrow technology is a reliable way to control major avian crop pests. The technology of scarecrow has many applications which include reducing financial loss due to crop damage caused by birds, removal of human surveillance stress and safe bird dispersal (Beringer, VerCauteren and Millspaugh, 2003). Scarecrow is a decoy or mannequin, often in the shape of a human. Humanoid scarecrows are usually dressed in old clothes and placed in open fields to discourage birds from disturbing and feeding on recently cast seed and growing crops. Scarecrows are used across the world by farmers, and are a notable symbol of farms and the countryside in popular culture (Gilete, 2013). Scarecrow is a device posted on cultivated ground to deter birds or other animals from eating or otherwise disturbing seeds, shoots, and fruits. Its name is derived from its use against the crow (Walaa, 2020). The scarecrow of popular tradition is a mannequin stuffed with straw; free-hanging, often reflective parts movable by the wind are commonly attached to increase effectiveness.

The first scarecrows recorded in history were made along the Nile River to protect wheat fields from flocks of quail. Most African farmers put wooden frames in their fields and covered them with nets. Therefore, to protect agricultural production areas from various animals having the tendency to damage the fore mentioned areas is an age-old problem (Bailleul-lesuer, 2012; 2016. Kimball, 2016 and Wassell, 1991).

Farmers today still use scarecrows all over the world. In countries like India and Arab nations, old men sit on chairs and throw stones at the birds trying to eat or damage their crops. Some farmers display dead bird corpses on different areas of the farmland. This is to serve as a warning to other birds that see the corpse and eventually scare them away.

Trained predators have been deployed for bird scaring. Amongst these are dogs and hawks. The predator attacks the bird flock dispersing them and is supposed to serve as a real threat to the birds. Some killed by the predator will confirm the threat as real and sends them fleeing from the vicinity. It has been proposed that, birds could be scare from a field by using loud noise and scaring movement (Wan et. al., 2019). Such loud noise can be produced by an air gun that ignites combustible gas at predetermined intervals (Król, Kao and Hernik, 2019). However, after a period of using loud noise, birds became accustomed to the noise and the scaring effect is diminished. Although the adverse impact of birds on cereals like rice, has received much international attention in the past and is still generally recognized, little research on bird damage control is currently conducted. Therefore, it is desirable to provide a system to repel birds, and overcomes the disadvantages of the previous methods. Birds have always been a problem for farmers (Noske, 1990). Sometimes the birds could eat so much corn or wheat that a farmer and his family would not have enough food to last through the winter. So for more than 3000 years, farmers have been making scarecrows. Most of the devices developed for bird scaring fail due to habituation.

The birds study the devices, read their patterns and predict their behaviour in order to avoid them. The system developed in this study will avoid habituation by behaving erratically, investigate roosting areas around the farm and attack bird flocks so as to register as genuine threat. The current traditional techniques employed by these farmers such as the use of static scarecrows are only effective for very small fields. Large commercial rice farmers also faced extensive labour requirements for bird scaring, this is tedious, costly and sometimes the device may not be readily available. Religious techniques such as shamanism and fetishes are also still widely adopted in Africa (De Mey and Demont, 2013).

Protective method**s** focus on protecting the rice crop when birds do visit the field. These include the use of repellents (chemical substances aimed at deterring birds), protecting fields or nurseries with nets or wires, covering the individual heads of ripening crops with grass or clothes, and manual bird scaring efforts. The latter may consist of a combination of auditory noise-making devices, shouting), visual (scarecrows, flags, reflective tape) and physical measures (e.g., throwing rocks or mud) (De Mey and Demont, 2013). In general, traditional protective methods such as manual bird scaring, flags and scare-crows can provide satisfactory protection on small-scale, privately owned farms when bird numbers are low.

In recent years, many new devices of scarecrows have been invented and implemented in the United States' rural landscape. A peregrine falcon, which is equipped with a remote-controlled 3D-printed raptor robotic bird, can move and soar to frighten real birds. The sonic bird cannon craftily plays the sound of shotgun blasts to signal imminent danger for many birds. There are also high-tech motion-driven models that hurl water at any intruder that strays onto the territory.

There is also a hawk-like drone that features a GPS-guided autopilot mode, which can be programmed remotely, patrols a sprawling property, and generates a deafening whir. The drone has a built-in megaphone to broadcast distress cries and predator calls to fright intruders. The solar-powered scarecrow with its long twin wings spins around to scare away prowlers. In addition, the solar-powered robot wolf is designed to scare wild boar, deer, and other animals. Ejiko *et. al*, (2022) have worked on automated vacuum cleaner whose operation is robotic in nature. High-Tech Scarecrow-A digital scarecrow, which is a solar-powered robot was designed and equipped with an infrared sensor that observes a cultivated field within a 178,000 square foot range. Spread out arms is the only thing that the digital scarecrow has in common with his “analog” counterpart. The inventors assure that the compact design and a movable stand enable the device to be quickly and easily repositioned. When the infrared-sensitive eye detects the presence of a bird or another animal, the robot emits a series of ultrasound waves in order to deter them. However, a futuristic-looking robot placed in a cultivated field can be perceived as an envoy of an alien civilization that is just creating another, somehow “famous” crop circle, especially after dark. In general, traditional protective methods such as manual bird scaring, flags and scare-crows can provide satisfactory protection on small-scale, privately owned farms when bird numbers are low. However, when bird pest pressure is elevated, these methods become ineffective (De Mey et. al., 2012). Crop raid can be defined as animals moving from their natural habitat onto agricultural land to feed on the produce that human grow for their own consumption. When people think of damage to their crops they probably think chiefly of the damages caused by insects. Crop raiding by vertebrates such as birds and mammals is also a major issue. It is not a new phenomenon; it has most likely been occurring since human has first settle down and started practicing agriculture (Electronics, 2023).

Many different crops are targeted by animals, from cereals, to fruit to vegetables to trees on large-scale governmental production schemes; these methods are not practicable, costly and ineffective. This study suggests that the development of bird populations needs to be monitored and farmers need to be protected against the consequences of massive bird invasions through insurance systems (PINORD, 2009). The absence of reliable information on the magnitude and characteristics of crop damage by wildlife hinders effective management. In a survey carried out by Wilfred in Uganda, 1375 individual farmers were interviewed, and 97.3% acknowledged that they were experiencing problems with birds attacking their rice which could feed on the grains in the milky stage of the crop (Wilfred, 2006).

This work is a kind of bird repellent that scares off birds and animals from fields hence reducing the physical damage that birds would cause to the crops. And hence there is increasing on the quantity and quality of the harvest as well as increasing the monetary gains of the farmers. The device saves the large scale commercial farmers on money they will spend annually to prevent the damages that are done to their crops by birds.

Sound alarm system a major technique in scaring birds have been considered by several authors such as William and Della (2022) that worked on evaluation of controls on noise levels for audible bird scaring devices in Whakatāne district. They came up with advice on the use of Audible Bird Scaring Devices (ABSD), such as gas guns or gas cannons, and a proposal to reduce the permitted noise level ABSD from 100dB to 85dB.

This issue relates specifically to the use of gas cannons in the horticultural industry where the activity is in proximity to Significant Indigenous Biodiversity Sites (SIBS) in Natural Areas reveals the potential effects on indigenous fauna using SIBS, hence the propose noise level of over 85dB in a SIBS can restrict discretionary activity. Other findings shows the relative effect on varying birds such as No effect was detected on laying broiler chickens when a conveyer had a constant noise of 66-76 dB (Scott and Moran 1993). Another study of domestic chickens showed stress and fear at 90 dB compared to 65 dB (Campo *et al*. 2005). Starlings were found to be sensitive to sudden repellent tones that caused disturbance to feeding, and the level of response increased linearly in the range of 50-100 dB (Langowski *et al*. 1969). White-crowned sparrow decreased foraging by 8%, increased vigilance levels by 21% and decreased feeding duration by 30% when exposed to traffic noise at 61dB (Ware *et al.* 2015). Fewer birds will breed within 400 metres of a busy road compared to an area 700 metres away (Dooling and Popper 2007).

METHODOLOGY

This work was established by comprehensive design of the mechanism through the conversion of electrical energy via power generated from photovoltaic cells to power a gear connected motor of 60 watts. The motor gear was made to transmit motion with other gear for rotational movement of 180°at both sides. The system works by the Passive Infrared (PIR) sensors covering a visual area of 5m radius such that any obstruction within the circumference is detected and signal are transferred to the motor switch which enable it to trigger all mechanisms and effect the movement coupled with sound of 134 decibel (DB).

Design Analysis

Figures 1 to 3 are the design diagrams of the solar powered scarecrow. Its major component parts such as Gear, D.C motor, Solar panel and the 12V D.C alarm were designed as follow:

Degree of Freedom

The degree of freedom of plain mechanism is defined as the number of input or independent coordinates needed to define the configuration or position of all the links of mechanisms with respect to fixed link.

- The degree of freedom of every gear train is two
- The degree of freedom of cam and follower is always one

The degree of freedom is calculated using equation (1) as given by Kutzbach in Khurmi and Gupta, (2005), Robert, (2013), Ejiko *et. al*, (2018)

$$DoF = 3 \times (L - 1) 2j - h \qquad (1)$$

where, L = number of links in the mechanism

J = binary joint pair

H = higher pair

Binary joint pair is when two links are joined at the same connection.

Higher pair is a constraint that requires a curve a surface in the moving body to maintain contact with a curve or surface in the fixed.

L = 4

J = 3 (between 1 and 2, 1 and 4, 3 and 4)

DoF= $3 \text{ x } (4 - 1) 2 \text{x } 3 - 1 = 2$

Gear Design

Gears are essential mechanism for the transmission of energy. Specifications of gears are required to specifically fit in as designed. This implies that the thickness, number of teeth, addendum, deddendum, will have to be estimated for proper application in determining the gear teeth (Robert, 2011) which was captured in equation 1 was applied

The principle of gear design

Pitch diameter (D)

Number of teeth = Pitch diameter × Diametrical pitch

=9.9,

where Pitch diameter = 99mm and Diametric pitch = 0.101mm

Velocity ratio (V.R) of gear

=: $\frac{NOOFTEETHDRIVER\ (N)}{NOOFTEETHDRIVEN\ (n)}$ (2)

= 1 where, Number of teeth of Driver and the Driven =10, 10 respectively.

Pitch diameter D $= 99mm$

Circular pitch P $= \frac{\pi D}{N}$ (3)

= 31.106 mm, where π =3.142, D =99mm and N =10

Diametral pitch pd $= \frac{N}{D}$ (4)

= 0.101 mm, where, N= 10 and D = 99 mm

Diametral pitch pd $= \frac{N}{D} \frac{10}{99} = 0.101mm$

Module $= \frac{D}{N}$ (5)

= 9.9 mm, where D = 99mm and N =10

Addendum $= \frac{1.00}{pd}$

Stress on the Arm

In order to determine the stress on the arm, estimation was made base on the weight of the arm and the area of the arm to establish the total stress on the arm. The stress was determined with equation (2) as given by Ejiko and Olakolegan, (2018)

$stress = \frac{Force}{Area}$ (6)

Force = mg

m stands for mass of the arm

g acceleration due to gravity)

$Area = \frac{\pi \text{d2}}{2} + \pi dL$ (quora.com)

$A = \frac{\pi(0.5)2}{2} = 3.142 \ x \ 0.5 \ x \ 0.005$

= 0.7885 + 0.00756

= 0.40061mm^2

$Force = 0.8 \text{ x } 9.81$

0.8 x 9.81= 78.96N

Therefore,

$stress = \frac{78.96}{0.4001} = 197.099 \text{N/m}^2$

Thickness of the Link

The thickness of the link is calculated using the equation below

Volume = T x A (7)

where T is thickness & A is area

Given that;

Volume, V = area x length

$$V = \frac{\pi d2}{4}\ x\ L$$

$$V = \frac{3.142 \text{ x } 52}{4} \times 0.005$$

$V = 0.0982m^3$

$$Area = \frac{3{,}142\ \times 52}{4}$$

$A = 19.64m^2$

Therefore,

Thickness = $\frac{0.0982}{19.64}$

T = 0.0046m

Resultant Force

The resultant force is essential in determining the equivalent force of the combine effect of the vertical and horizontal forces whose presentation is captured in Figure 4.

Resolving Horizontally,

$$\sum fx = 50 - 100\cos 90°$$

$= 50N$

Resolving Vertically,

$$\sum fy = 50 + 100\sin 90°$$

$= 150N$

Resultant Force,

$R^2 = \sum fx^2 + \sum fy^2$

$= 50^2 + 150^2$

$= 2500 + 22500$

$= \sqrt{25000}$

$= 158.11N$

Angular and Linear Velocity

The linear and angular velocities are calculated as below

$$\omega = \frac{\Delta\theta}{\Delta t} \quad (8)$$

where, ω = angular velocity

$\Delta\theta$ = change in angle, and;

Δt = change in time

Thus, $\omega = \frac{270° - 180°}{11-9}$

$= \frac{90°}{2}$

$\omega = 0.7855 rad/s$

V = $\frac{d}{t}$

where, V = linear velocity

d = distance

t = time

Thus, V = $\frac{1}{3}$

$V = 0.33ms^{-1}$

Power output = Torque (T) x (ω)

Torque T = force x radius of rod (wikihow.com)

Where radius r = 0.5m

Force = mass x acceleration

Given that, m = 0.9kg, $\omega = 0.7855 rad/s$ and $g = 9.81m/s^{-1}$

Therefore,

$P_{output} = 0.9 * 9.81 * 0.5 * 0.7855$

$= 3.4676 watts$

12v DC motor produces 0.44amperes

P input = IV where, I = 0.44A and V = 12volts

P input = 5.28watts

From the above calculations we have determined the power input which is denoted by P input and also the power output denoted by P output for calculating the efficiency of the dc motor using equation (9).

$$efficiency = \frac{Poutput}{Pinput} \times 100 \quad (9)$$

$= \frac{3.4676}{5.28} x100$

= 65.7 %

Solar Panel

Solar panels receive sunlight energy and convert it into electric energy in the form of direct current (DC). Electricity arrays of a photovoltaic system can be used to generate solar electricity that supplies electrical equipment directly, or feeds power back into an alternate current (AC) grid via an inverter system. In order to determine the battery capacity selection base on the battery type use in solar PV power system application. It is deep cycle battery, specifically designed such that even when it is discharged to low energy level it can still be rapidly recharged over and over again for years. With an assumed load of 40watts, the selected PV capacity was determined using Regression equation as given by Ejiko and Olaniyi, (2018) in equation (10), in which 100watts PV was selected.

$$PV = 2.4L \quad (10)$$

$$= 2.4 \times 40$$

$$= 96 watts$$

DC Alarm

Determination of the Alarm's Sound Intensity requires the application of the selected device and the threshold of human hearing as given by Tao, (2022) in equation 11

$$\beta = \text{I0} \log\left(\frac{I}{I_o}\right) \quad (11)$$

β, Sound Intensity in decibel (db).

Power = 12V, Distance (d) = 5 m

I = 25 W/m^2

Io = 10^{-12}

Sound Intensity$= 134db$

Components Used:

Solar Panel: A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light.

Connecting Wire:- This allows an electrical current to travel from one point on a circuit to another because electricity needs a medium through which it will flow. Most of the connecting wires are made up of copper or aluminum.

Dc Motor: A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

Linkages: A slider-crank linkage is a four-link mechanism with three revolute joints and one prismatic or sliding, joint**.** The rotation of the crank drives the linear movement of the slider, or the expansion of gases against a sliding piston in a cylinder can drive the rotation of the crank.

PIR Sensors: A PIR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it, that is called a passive infrared sensor. Usually, in the infrared Spectrum, all the objects radiate some form of thermal radiation. The sensor can sense at a range of 5m to detect obstruction.

DC Battery: This is a power supply device that is used to store the charge from the solar panel and later used to provide a 40 Ah voltage supply for powering the system. A DC battery will use the same solar inverter to convert its stored DC power into AC power.

Loud Sound Buzzer: A buzzer or beeper is an audio signalling device which may be mechanical, electromechanical, or piezoelectric (Piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

Solar Charge Controller: - A solar charge controller is basically a voltage and/or current regulator to keep batteries from overcharging. It regulates the voltage and current coming from the solar panels going to the battery and that the power doesn't run backwards to the solar panel overnight and drain the battery.

DC Motor Gear A servo motor is an electrical device which can push or rotate an object with great precision. It can rotate an object at some specific angles or distances, Servo motor is made up of simple motor which runs through a servo mechanism.

Output Sensor Feedback system is a closed system that uses the positive feedback system to control motion and final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Metal Pipe: a square hollow mild steel pipe was used for making scarecrow`s structure, also the solar panel frame. It provides strength to the surface of the structure of the scarecrow. The metal steel pipe used is strong, durable and could withstand harsh whether condition.

Block Diagram

Figure 5 shows the presentation of interaction between the components of the device. The microcontroller serves as the major controlling unit that is modelled through sensors interface.

System block diagram

The block diagram in Figure 5 above consisted mainly of two communicating devices designed with the help of RF modules that's a transmitter and a receiver both operating at the same frequency. The PIR motion sensor is used as an input to the microcontroller which processes the data and then provides wireless communication between the transmitter and the receiver and both the buzzer and the servo motors are activated on receiving the signal.

General Description of the Automatic Scarecrow Operational Mode

The designed and fabricated automatic sonic scarecrow consists of mainly two systems, that is, the motion producing the system, and the sound producing system. The motion producing system comprises of two high torque metal geared servo motors to rotate or revolve the arms while the sound producing system consists of Dc Alarm speaker switched on and off by a transistor which is activated by a passive motion sensor that is integrated with the system. Code written in embedded c language for system operation is captured in the Appendix I. The scarecrow operates after being positioned and switched on. The PIR sensor detects motion of about

5.0 meters. It takes 6seconds before the body starts rotating. Flapping of arm, sound production and the rotation occurs thrice before it is brought to rest when the PIR sensor is out of range. The rotation is achieved with the help of a DC motor that takes electrical power through direct current and converts this energy into mechanical rotation. This DC motor uses magnetic fields that occur from the electrical current generated, which power the movement of a rotor fixed within the output shaft. According to the designed specifications, the scarecrow is designed to sense at the range of 5m from afar which is the design length but the actual length is the distance at which it detects the obstruction for a particular period. So, using the relation

:-$\frac{actuallength}{designlength} \times 100$, with the design length of 5m and actual length of 1m, obstruction detection is 20%.

Similarly, at the actual distances of 2 m, 3 m, 4 m and 5 m, the obstruction detection is 40%, 60%, 80% and 100% respectively.

Calculations on the rotation of the scarecrow along the latitude, longitude for 360° (i) which is for calculation on the rotation along the East (E) and (ii) which is for calculation on the rotation along the South(S),(iii) which is for calculation on the rotation along West (W) and (iv)which is for calculation on the rotation along North (N).

(i) $\frac{90°}{360°} X100 = 25\%(E)$

(ii) $\frac{180°}{360°1} X100 = 50\%(S)$

(iii) $\frac{270°}{360°} XI00 = 75\%(W)$

(iv) $\frac{360°}{360°} XI00 = 100\%(N)$

RESULTS AND DISCUSSIONS

The scarecrow rotates around the circumference of 360 degrees and this rotation triggered period varies with the distance of the obstruction detected. The performance evaluation results are presented on Tables 1 to 5. Table 1 present the outcome for a constant distance of 1 m space obstruction, the sensors captured the obstruction at both the Northern and Western positions. The machine engaged with respect to the sensor orientation, the time taken trigger at west was longer than that of the north which implies the sensors are more aligned to the north than of the west. Table 2 shows that for a constant distance of 2m space obstruction, the sensor did not detect the obstacle at East and South .The machine engaged with those orientation , the time taken trigger at East was shorter than that of the South which implies that, the sensors are more aligned to the East than of the South, and Table 3 shows that for a constant distance of 3 m space obstruction the sensor detected the obstacle at North and West, allowing the machine engaged with those orientation , the time taken trigger at west in seconds which was longer than that of the North which implies that, the sensors are more aligned to the North than of the West. Table 4 shows that for a constant distance of 4 m space obstruction, the sensor did not detect the obstacle at East and South, allowing the machine to engaged with those orientation , the time taken to trigger at East was shorter than that of the South which implies that, the sensors are more aligned to the East than of the South, Table 5 shows that for a constant distance of 5m space obstruction, the sensor detected the obstacle at North and West allowing the machine to engaged with those orientation , the time taken trigger at West was longer than that of the North which implies the sensors are more aligned to the North than of the West. Figure 6 shows the mechanism trigger time against distance, the trigger time is slightly proportional to the distance of obstruction. The maximum time to start the mechanism rotation is 10 seconds for a distance of 5 m. The Automatic scarecrow works with use of solar energy, in the absence of solar radiation it efficiently work with the help of battery where the electrical energy is stored by using solar panel. The utilization of passive infrared sensor (PIR) sensor is used by the scarecrow to detect birds and motion up to 5 m front and back and produces the sound effect by the alarm of about 134 decibel (DB) which is uncomfortable for birds and therefore scare the birds and cause the birds to fly away.

CONCLUSION AND RECOMMENDATION

The developed scarecrow is environmentally adaptable and highly efficient as bird repellent. This has brought relief to farmers as it removes human surveillance, brought increase to their products. The use of solar power has eliminated the use of electricity from the national grid. The Intensity of sound produced by the scarecrow device is (134db) to scare the birds without harming them. The developed scarecrow is also recommended to chase away birds from Airports, roofs of residential or commercial buildings, Institutions of learning and offices where birds cause noise pollution or problem of sanitation rising from their excreta droplets

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Appendix I

Code for system operation

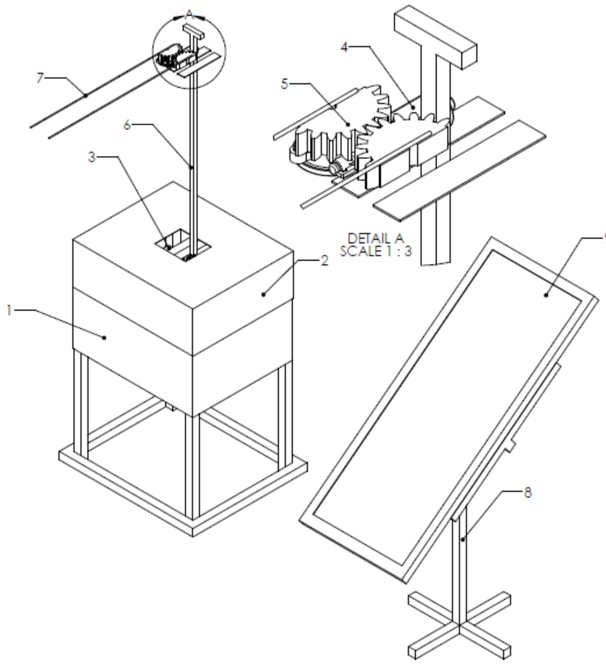
```
int baserelayPin1 = 2; // choose the pin for the relay
int baserelayPin2 = 3; // choose the pin for the relay
int armrelayPin1 = 4; // choose the pin for the relay
int armrelayPin2 = 5; // choose the pin for the relay
int pirSensorPin1 = 6; // choose the input pin (for
PIR sensor)
int pirSensorPin2 = 9; // choose the input pin (for
PIR sensor)
int alarm = 9;
int val1 = 0; // variable for reading the pin status
int val2 = 0; // variable for reading the pin status
inti=0;
void operation(){
digitalWrite(alarm, HIGH); // turn alarm ON alarm
digitalWrite(baserelayPin1, HIGH);
digitalWrite(baserelayPin2, LOW);
delay(800);
digitalWrite(baserelayPin1, LOW);
digitalWrite(baserelayPin2, HIGH);
delay(800);
digitalWrite(baserelayPin1, HIGH);
digitalWrite(baserelayPin2, HIGH);
digitalWrite(armrelayPin2, LOW); //
digitalWrite(armrelayPin1, HIGH); //
delay(1000);
digitalWrite(armrelayPin2, HIGH); //
digitalWrite(armrelayPin1, LOW); //
delay(1000);
digitalWrite(armrelayPin2, HIGH); //
digitalWrite(armrelayPin1, HIGH); //
}
voidno_operation(){
digitalWrite(alarm, LOW); // turn alarm OFF alarm
digitalWrite(baserelayPin1, HIGH);
digitalWrite(armrelayPin1, HIGH);
digitalWrite(baserelayPin2, HIGH);
digitalWrite(armrelayPin2, HIGH);
}
void setup() {
```

```
pinMode(baserelayPin1, OUTPUT); // declare LED
as output
pinMode(baserelayPin2, OUTPUT); // declare LED
as output
pinMode(armrelayPin1, OUTPUT); // declare LED
as output
pinMode(armrelayPin2, OUTPUT); // declare LED
as output
pinMode(alarm, OUTPUT); // declare LED as
output
pinMode(pirSensorPin1, INPUT); // declare sensor
as input
pinMode(pirSensorPin2, INPUT); // declare sensor
as input

no_operation();

delay(5000);//give the sensor some time to calibrate
}
void loop(){
val1 = digitalRead(pirSensorPin1); // read input
value
val2 = digitalRead(pirSensorPin2); // read input
value

if (val2 == HIGH){
for (i = 0; i< 3; i++){
operation();
 }
 }
if ((val1 == LOW)&&(val1 == LOW))
no_operation();//check if the input is LOW
//no_operation();
```



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	robot stand	38mm square mild steel pipe	1
2	cover	1mm mild steel	1
3	base motor	35watt/12v dc	1
4	arm motor	20watt/12 dc	1
5	gear	platic	2
6	upper body	18mm mild steel pipe	1
7	arm	5mm rod	2
8	solar panel frame	38mm square mild steel pipe	1
9	solar panel	1oowatt	1

Fig. 1: Solar Power scarecrow

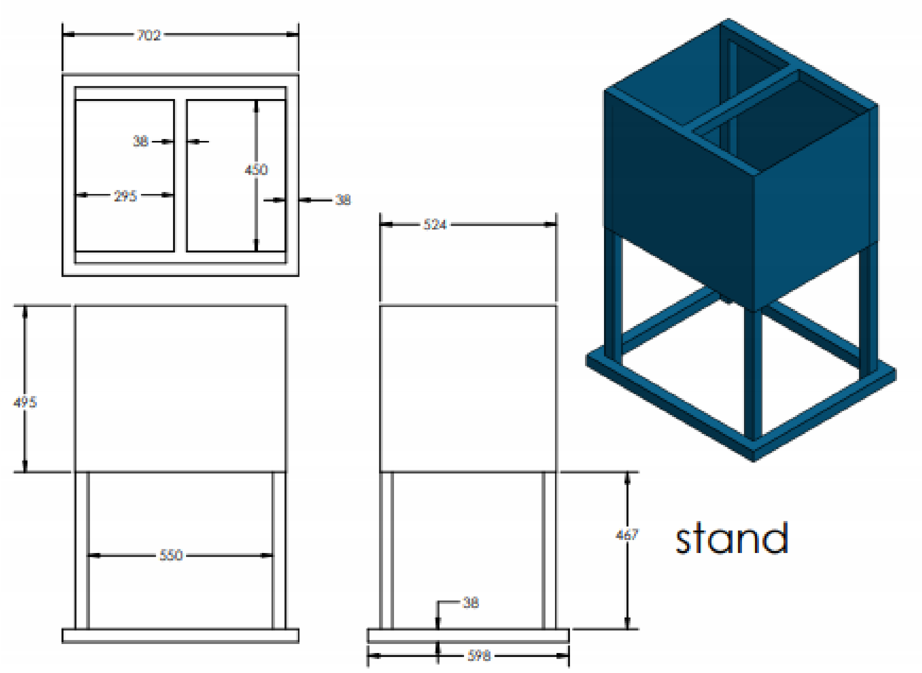


Fig. 2: Scarecrow Stand

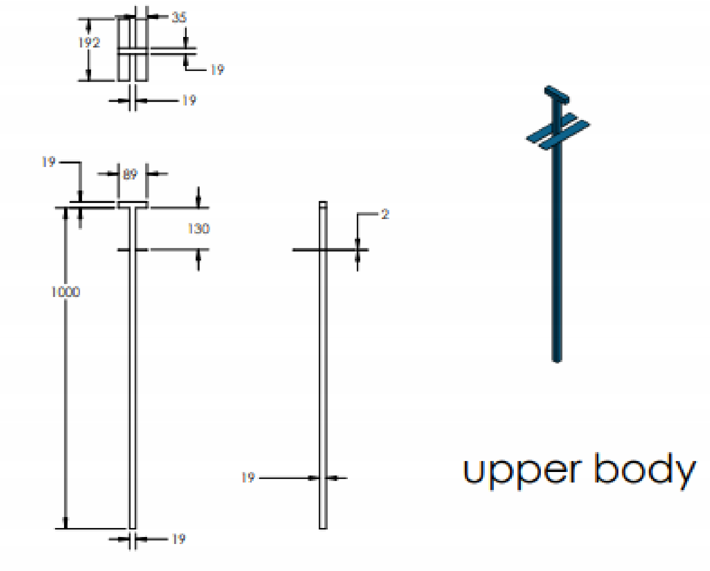


Fig. 3: Scarecrow Upper body Frame

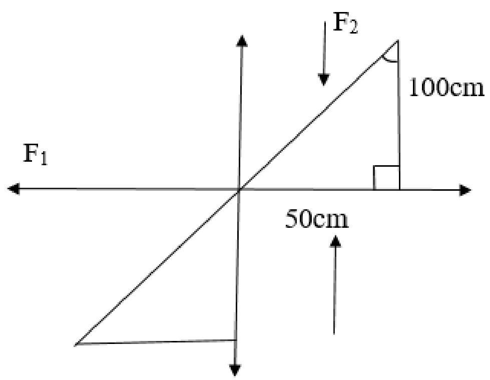


Fig. 4: Diagram for Force Resolution

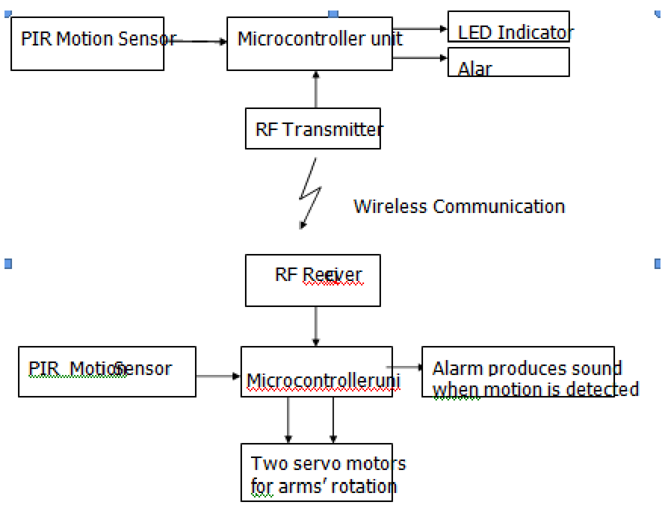


Fig 5: Flow chart of PIR Motion Sensor.

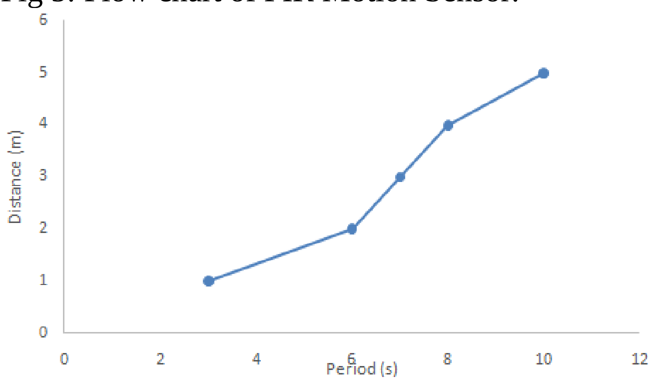


Fig 6: Mechanism Trigger Time against Distance

Table 1: Data Recorded During Performance Evaluation at 1 m Space Obstruction

S/N	Distance (m)	Obstruction (%)	Rotation (0°-360°)	Effect	Period (s)
1	1	20	0°	YES	3s
2	1	20	90°	NO	——
3	1	20	180°	NO	——
4	1	20	270°	YES	5s
5	1	20	360°	YES	3s

Table 2: Data Recorded During Performance Evaluation at 2 m Space Obstruction

S/N	Distance (m)	Obstruction (%)	Rotation (0°-360°)	Effect	Period (s)
1	2	40	0°	YES	6s
2	2	40	90°	NO	——
3	2	40	180°	NO	——
4	2	40	270°	YES	8s
5	2	40	360°	YES	6s

Table 3: Data Recorded During Performance Evaluation at 3 m Space Obstruction

S/N	Distance (m)	Obstruction (%)	Rotation (0°-360°)	Effect	Period (s)
1	3	60	0°	YES	7s
2	3	60	90°	NO	——
3	3	60	180°	NO	——
4	3	60	270°	YES	10s
5	3	60	360°	YES	7s

Table 4: Data Recorded During Performance Evaluation at 4 m Space Obstruction

S/N	Distance (m)	Obstruction (%)	Rotation (0°-360°)	Effect	Period (s)
1	4	80	0°	YES	8s
2	4	80	90°	NO	——
3	4	80	180°	NO	——
4	4	80	270°	YES	10s
5	4	80	360°	YES	8s

Table 5: Data Recorded During Performance Evaluation at 5 m Space Obstruction

S/N	Distance (m)	Obstruction (%)	Rotation (0°-360°)	Effect	Period (s)
1	5	100	0°	YES	10s
2	5	100	90°	NO	——
3	5	100	180°	NO	——
4	5	100	270°	YES	11s
5	5	100	360°	YES	10s