Title of the Project:

Ravaging of crops by animals, birds and pests.

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Introduction:-

Our topic is "**Ravaging of crops by animals, birds and pests**". It is a very serious issue as it involves agriculture and farming. Agriculture is the largest source of livelihoods in India. 70 percent of its rural households still depend primarily on agriculture for their livelihood. Every year roughly Rs 50,000 crore worth of crops are destroyed by pests, wild animals, birds and disease. In our country, 82 percent of farmers are small, marginal and their livelihood is very much dependent on how good the crop is every season. Their profit is not even enough to afford a living, leave alone money required to cultivate their next crop. And in this kind of situation when their crop is affected by pests, wild animals etc. They are deeply troubled financially. These kinds of happenings force poor farmers to even commit suicide sometimes. To help farmers the government spend crores of rupees every year in compensation amounts.

We will talk about the theoretical and physical aspects of our problem. The increasing rate of decrease in forests and encroaching agriculture land is leading to an uprise in the animal invasion of fields which has led to a drastic change in farmers' perception towards them.

We will also emphasize a clear description of the village problem. Why are crops devastated by wild animals wandering in the field in search of food and shelter damaging the crops in a germinating state, hampering the growth, reducing the quality of the crops?

We will look upon four methods for data collection used by The Department of Agriculture and farmer welfare. First, visual examination of damaged crops in areas harmed by animals, birds, and pests. Second, The net grain yield per unit area, At the time of harvest farms are visited at the total grain production per unit area for each crop is noted. Third, Comparing crop yield to exposed and safe neighbour farms. A significant size of the farm is divided in even numbers of small farms then half of them are left unprotected and remaining farms are properly protected by methods available to farmers during a whole season. Fourth, Comparing grain yield after controlled artificial herbivory. How collected data is used for assessing the crop damage, Simple random sampling In this method, Every item in the population of the area which was selected for doing research has an even chance and likelihood of being selected in the sample.

We will see strategies used by present-day farmers to prevent their crops/farms from wild animals, yet they fail to protect their farms from wild animals. Nowadays there are also new technologies and methods available for the farmers for the protection of their farms but they also have some limitations in their respective ways.

We have analyzed 2 technological solutions for our problem statement.

1. **Motion detector:-**
   This automated system works on the principle of thermal heat generated by the body and detecting motion from a distance and producing sounds required to scare the animals. We are using a motion sensor that sense the animals from a distance to stop them from entering the field. We are using motion PIR sensor that has range of 5m to 12m.These machines can be planted on the outer boundary of the farms so that the animals cannot even enter the farms.

Components Required:

- **PIR Sensor:** PIR stands for "Passive Infrared Sensor". The word "passive" here means that this sensor does not use energy for the input but uses the external energy generated by the things which reach the sensor senses in the form of heat energy. The sensor has a "pyroelectric sensor" which generates energy when exposed to heat. So, when animals or human bodies come in the range of the sensor,the sensor experiences the infrared energy radiated by the body. The sensor also has "Fresnel Lens" which focuses the infrared rays on the pyroelectric sensor. These lenses are convex in nature as they are concentrating the radiated infrared rays.
- Buzzer:- It is an audio signalling device which will produce sound when animals will try to enter the field.
- IC:- 555 and 8 pin IC is used.
- Transistor:- S8050 model of transistor is used.
- LED
- Capacitor: 10uF capacitor is used
- Resistor: Four 10k ohm and two 1k ohm resistors are used.

- Jumper wire: For connecting the components.
- Piece of vero board: All the components will be fixated on this board
- 3Pin Female Header

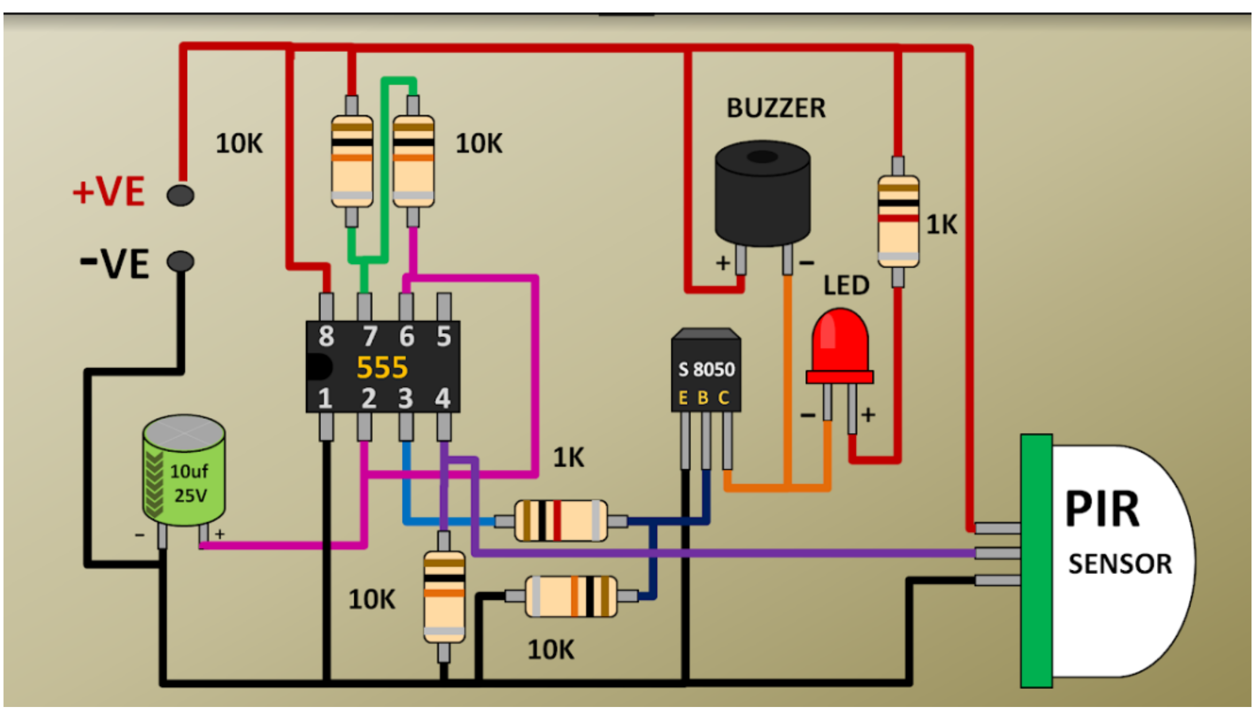
Design Concept and Working:

It will sense using a PIR sensor at one point which detects the change in Infrared waves which are emitted by movement of hot-blooded animals or humans. PIR will sense movement of Nilgai and give signal to the circuit. This data will be used to trigger the action at another point..

For large scale usage we have to use larger sounds so we require horns instead of the buzzer. And also for lights we can use a board with multiple LEDs for more intensity.

We can use voltage regulator IC to convert 12V (2.5 Amp) into 5V dc(1 Amp) to operate the circuit from the same battery as the bike horn requires 12V(2.5 Amp) and circuit requires 5V(1 Amp).

Circuit design of the motion detector:



All the above mentioned components will be connected on the veroboard using jumper wires and soldering of aluminium wires.

Step 1: Connect the positive supply of the voltage supply to the 8th pin of the IC and negative supply to the 1st pin of the IC.

Step 2: Short the pin 6 and pin 4 of the IC.

Step 3: Connect the 10k ohm resistor to the positive supply the pin 7 of the IC

Step 4: Connect the 10k ohm resistor between pin 6 and pin 7 of the IC.

Step 5: Connect the positive of the capacitor to the pin 2 and negative pin of the capacitor to pin 1 of the IC.

Step 6: Connect the pin one of the transistor to the negative supply of the voltage and pin 3 of it to the negative pin of the buzzer. The positive pin of the buzzer will be connected to the positive supply.

Step 7: Connect a resistor of 1k ohm to IC pin 3 and transistor pin 2.

Step 8: Connect two 10k resistors, one between pin 4 of IC and ground. Another one between pin 2 of the transistor and ground.

Step 9: Connect the negative pin of LED to pin 3 of the transistor and positive pin to the resistor of 1k ohm. The other end of the resistor will be connected to the positive supply of the voltage.

Step 10: Connect the positive pin of the PIR sensor to the positive supply, the negative pin of it to the negative supply and the signaling pin to the pin 4 of the IC

For sensing the motion of any object, the IR sensor and photo transistors are placed in such a way that the beam emitted by the IR LED towards the transistor gets obstructed. In the transmitter section, the IR sensor produces a high-frequency beam of 5 kHz with the help of the 555 timer, which is set to unstable the multi-vibrator; and, the frequency that is produced by the sensor in the transmitter is received by the photo transistor.

When there is no interruption in between the IR sensor and the photo transistor, then the frequency will be in one phase, and therefore, this circuit will not give any output in the receiver side. When there is a disturbance between the infrared sensor_and the photo transistor, the frequency detected by the transistor will be in a different phase. This triggering makes the timer to give a buzzing sound. In this way, one can design the motion-detector alarm for several applications.

Advantages of motion detector:

1.It can detects motion in light and dark conditions

2.It can provide security to farmers if sleeping in the farm itself.

3.It is easy to install motion sensors.

4 It is eco friendly to a great extent and even affordable.

Disadvantages of Motion Detector:

1.Passive motion sensors do not operate above temperature of 35’C so it could be problematic in extreme summers.

2.Passive type is insensitive to very slow motion of the object.

3.The circuit is fragile hence, needs to be placed at a place where animals can't walk over it

Now to create an autonomous bird deterrent system that works to keep birds away from places like airports, crops, and public buildings. To accomplish this, a report will be undertaken to assess the efficacy of existing bird deterrent systems.After that, the most appropriate system will be chosen based on a set of parameters and combined with a monitoring system to form an autonomous deterrent.

Bird Deterrent Systems

- **Scarecrows**

  Visual bird deterrents are visual stimuli that are intended to mimic a predator in the form of a person or a larger bird to nearby birds.

  Scarecrows only provide short-term security because the danger they produce is perceived rather than actual, and because they are motionless.When the birds in the area realize there is no threat, the scarecrow loses all of its power, to the point that some birds have been observed to prefer them.

  Scarecrows, no matter how lifelike they are, do not pose a serious enough threat to scare birds.

  As a result, it is recommended that scarecrows be used in conjunction with real human interaction or audio deterrents to increase the danger they pose.

Figure :Rotating Scarecrows (Scaring Birds Website)

- **Corpses**

  Deploying replicas or even live corpses of birds in a way that indicates threat has been used as an alternative approach to discourage birds. While this method is inexpensive, its efficacy is dependent on whether the corpse is moved frequently and whether alternative places for the birds to migrate are available.This system, like most visual deterrents, should be used in combination with others to be effective for an extended period of time.

- **Kites**

  Hawk kites are mobile predatory devices that pose a threat to birds in the local region. The majority of kites have a soaring eagle outline and are attached to the deck.

  Mirrors, hawk-eyed balloons, and big hawk eyes are only a few of the other visual deterrents on the market today. These deterrents, on the other hand, are less common and powerful, and are best used in smaller areas.

- **Audio Systems**

  The most widely used product in avian pest control is audio deterrents. They work by omitting either bird calls or ultrasonic sound waves to keep birds out of the field. Most audio devices produce bird distress calls or predator calls at random from various locations throughout the area.

- **Bio-Acoustic Devices**

  Tools that transmit biologically important sounds such as bird alarm and distress calls are known as bio-acoustic deterrents. Alarm calls are used by birds in the wild when they sense threat, whereas distress calls are used by birds that have been captured, restrained, or injured.

Figure: Bird Chaser (www.pest-control.bz)

Their effectiveness is determined by species-specific calls and the number of alternate moving areas available in the region. However, as with most bird deterrent devices, if they are not moved on a regular basis, they lose their effectiveness and perform better when used in conjunction with a variety of techniques.

- **Ultrasonic Devices**

  Ultrasonic devices, which emit frequencies of 21-26 kHz to discourage birds from areas such as factories, manufacturing plants, stadiums, and loading docks, are examples of such bird deterrents.

Figure : Bird Chase Ultrasonic (BirdBGone Website)

Despite the system's superior capabilities, there is no proof that ultrasonic systems discourage birds, with research showing that most birds cannot hear frequencies above 20kHz , implying that there is no biological need to employ ultrasonics. As a result, ultrasonic devices are unsuccessful at scaring birds away, and their use should be avoided.

Light Systems

- **Strobe Lights**

  Birds are exposed to novel stimuli such as flashing, spinning, strobe, and searchlights, which cause them to flee (Harris and Davis 1998). Though stationary lights are known to attract birds at night, noisy, blinking, rotating lights cause confusion by blinding them. Light systems are most successful between dusk and dawn for deterring birds from roosting and feeding in particular areas.

Figure : BirdLite (Critter Ridders Website)

Light deterrents like the BirdLite are simple to set up and maintain, but they should not be used in places where they can pose a visual annoyance to nearby properties. They're also ineffective during the day, and their ability to deter birds is limited.

They're still ineffective during the day, and their ability to discourage birds varies by species. Light deterrents work better when combined with other strategies.

- **Lasers**

The use of lasers, especially low-power lasers that operate in low light conditions, has risen in popularity as the demand for non-lethal, environmentally friendly methods of bird scaring has grown.

The most common laser used in this form of deterrent is a Class III B laser, which has been determined to be safe for use by the US Department of Agriculture. Lasers with a power level of 5 to 500 mW are classified as Class III B and are not capable of generating hazardous diffusion unless they are specifically directed at the eye.Until recently, laser systems were either used as a human-guided torch, such as the Avian Dissuader in Figure, or as a laser field that covered a wide area with little precision.

Since the efficacy of lasers decreases with increasing light levels, they can only be used for bird deterrence from dusk to dawn, and since hand-held lasers need a user, the total cost of the deterrent rises.

Figure : Avian Dissuader (SEA Tech Website)

<u>Chemical Systems</u>

- **Taste Repellents**

  There are two types of taste repellents: primary and secondary repellents. Primary repellents are substances that should be avoided at first contact because they have an unpleasant odour or taste, or cause discomfort. Secondary repellents aren't immediately offensive, but they can make you sick or give you a bad time.
- **Tactile Repellent**

  Tactile repellents make use of sticky substances that deter birds due to their ‘sticky' texture. To discourage settling birds, they can be applied as clay-based seed coatings, pastes, and liquids on ledges and other roosting structures.

  They have been shown to be effective in preventing larger birds from perching on antennas, but they are less effective in preventing smaller birds from perching on antennas.

Structural Systems

- **Wires**

  Bird deterrents such as overhead wires can be efficient and inexpensive. Many different types of lines can be used, but it appears that the width and height of the lines decide which bird species they are most effective against. Wire systems are relatively inexpensive to instal and maintain, but they require constant inspection for broken lines that bird pests can exploit. On large sites, they are effective at deterring birds, but they are possibly more effective on roof tops, wetlands, and small open areas.

- **Spikes**

  Spike deterrents are made of plastic or metal strips with stainless steel or plastic spikes pointing upwards that are connected to building ledges.

  These systems are inexpensive and simple to instal, but they must be checked frequently for debris that could cover the spikes, much like wires. Some countries prohibit the use of this deterrent due to the sharpness of the tips and the danger they pose.

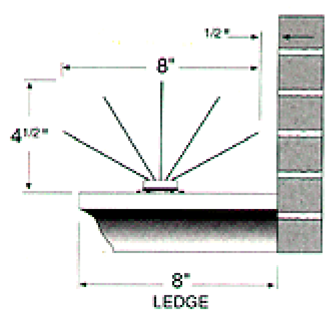


Figure : Bird Spike 2001 (Bird-B-Gone Website)

- **Electric Track**

  An electric shock track is another common deterrent. The shock track is mounted along the ledges of a building and an irregular electric charge is transmitted through it, similar to an electric fence. When a bird lands on the wire, the electric circuit is completed and the bird experiences a slight shock.

  Electric track systems are only successful over a limited area and are illegal in some countries due to their hazardous existence.

<u>Hybrid Systems</u>

- **Gas Cannons**

  Gas cannons are instruments that use flammable gases to make loud banging noises. They have the same frightening effect on birds as shooting a shotgun. The sudden bang triggers the ‘startle' reflex, causing the bird to panic and flee.

Figure : Propane Gas Cannon (BirdBlaster Website)

If the firing frequency and direction are varied, and there is no noise nuisance problem in the surrounding area, gas cannons may be an efficient bird deterrent. The strength of sound output from gas cannons was discovered to be highly variable between guns and between explosions of a single weapon. The strength of the cannons was heavily influenced by factors such as wind speed and direction.

Other Devices

The "Scarecrow" is another form of hybrid deterrent (See Figure). This deterrent is activated by a motion sensor that detects movement and sprays a jet of water. The "Scarecrow's" form is often intended to mimic a large predatory bird as an added visual deterrent.

The "Bird Blaster" deterrent is one of the most complicated bird deterrents on the market today. A network of pressurised tubes surrounds a Doppler radar that detects birds in the surrounding area in this device. T-sections with small pieces of tube operated by solenoids are positioned in the tube.

When a bird enters the radar, the device causes the nearest solenoid to open, allowing the pressurised air to escape, resulting in a hissing noise and a 'waggling' motion.

Figure : The Scarecrow, (BirdBGone Website)

This device attempts to mimic a snake in order to elicit a ‘startle' response from the bird. Despite its self-contained existence, this deterrent mechanism is unsuccessful in scaring birds because the tubes are not long enough to pose a serious danger.

Evaluation of Current Bird Deterrent Systems

To assess current bird deterrent systems, a set of criteria must be developed, along with a grading scale. The goal of this project, as stated in the introduction, is to develop a system that is both efficient and non-intrusive, making these two requirements the most relevant. Other factors such as cost, physical requirements, and the area covered will be considered in this assessment to decide the best deterrent to undergo automation.

Table 2.1 Evaluation of Bird Deterrents

Name	**Cost** (1)	**Requirements** (1)	**Area Covered** (2)	**Stealth** (2)	**Effectiveness** (3)	**Automation Ability** (2)	**Total** (10)
Motion Sensing Water Spray	\$74.95 4	Electricity, Water 2	140 m^2 2	Good 2	Poor 2	Fair 3	
Score	4	2	4	4	6	6	26
Taste Repellent Gel	\$16.00 5	None 5	NA 2	Good 4	Poor 2	Very Poor 1	
Score	5	5	4	8	6	2	30
Wires	N	None	NA	Good	Fair	Very	

	A 3	4	3	4	3	Poor 1	
Score	3	4	6	8	9	2	3 2
Ultrasonic System	$225.00 3	Electricity 3	557 m^2 4	Good 4	Very Poor 1	Poor 2	
Score	3	3	8	8	4	4	3 0
Shock Track	Various 3	Electricity 3	NA 3	Excellent 5	Poor 2	Very Poor 1	
Score	3	3	6	10	6	2	3 0
Spikes	$220.20 3	None 4	NA 3	Fair 3	Poor 2	Very Poor 1	
Score	3	4	6	6	6	2	2 7
Hawk Kite	$59.95 4	None 4	NA 3	Poor 2	Fair 3	Poor 2	
Score	4	4	6	4	9	4	3 1
Hot Foot	$50.50 4	None 4	NA 2	Good 4	Fair 3	Very Poor 1	
Score	4	4	4	8	9	2	3

							1
Corpses	$7.50 5	None 5	NA 1	Fair 3	Poor 2	Very Poor 1	
Score	5	5	2	6	6	2	26
Revolving Hawk Eyes	NA 4	None 5	NA 3	Poor 2	Fair 3	Poor 2	
Score	4	5	6	4	9	4	31
Movement Activated Audio Deterrent	$75.00 4	Electricity 3	100 m^2 2	Poor 2	Good 4	Fair 3	
Score	4	3	4	4	12	6	33
Doppler Radar Controlled Compressed Air Tube	Varying 2	Electricity, Air Compressor 2	930 m^2 4	Poor 2	Fair 3	Good 4	
Score	2	2	8	4	9	8	33
Propane Cannon	$790.00 2	Propane Gas, Spark	NA 4	Very Poor 1	Good 4	Good 4	

		Plug 2					
Score	2	2	8	2	12	8	34
Scarey Man	$1240 1	12 Volt Battery 4	6 Ha 5	Very Poor 1	Good 4	Very Poor 1	
Score	1	4	10	2	12	2	31
Laser Deterrents	$1300.00 1	Electricity, Operator 2	500 m 4	Excellent 5	Fair 3	Good 4	
Score	1	2	8	10	9	8	38
Strobe Light	$250.00 3	Electricity 3	930 m^2 4	Poor 2	Good 4	Fair 3	
Score	3	3	8	4	12	6	36
Revolving Scarecrows	NA 4	None 5	NA 3	Poor 2	Fair 3	Very Poor 1	
Score	4	5	6	4	9	2	30
						<u>Average</u> =	530/17=

		31.1 7

Results of Evaluation

The strobe light and the laser deterrent were the two bird deterrent systems that better suited the requirements in the table above. Both deterrents outperformed the average of 31.17 in most regions, with the laser system's expense being the lowest scoring group. As a result, the decision on which deterrent to automate for this project was between a laser deterrent and a strobe light, each with its own set of benefits and drawbacks.

Laser deterrents are a form of bird deterrent that is powerful, quiet, highly directional, and almost undetectable, and can be easily automated. It would also be extremely difficult to develop an efficient laser deterrent with the precision of a birds eye, necessitating the use of a larger laser, which would significantly increase the cost. Because of its low cost, efficiency, and coverage area, the strobe light was chosen as the best deterrent to automate. Since strobe lights in open areas may create a disturbance to nearby properties, a directional strobe would be used to only affect the desired areas.

2. **The strobe light with machine vision-driven camera-**

The strobe light has been traditionally an effective bird repellent. Also in our problem assessment we had found that the need for the bird repellent is more in night times than in day times, this is because in day time more often than not someone is present in the field and can physically repel birds.
So we thought of using strobe lights but there were two challenges that we needed to tackle before using strobe lights:-

1. Simple rotating strobe lights after a time will not repel birds as they will simply adapt to it.
2. If strobe light is not targeted then it will focus on an area for a very short period of time so even if birds don't become complacent to this beam they wouldn’t be scared.

So to solve this problem we thought of using machine vision to focus light beam in a certain direction. And like we have already mentioned this did not add substantial cost to out project.

Design of the prototype:-

We will use a machine vision-driven camera. This camera first detects motion then checks if it is over the tolerance limit and then strobe light focuses on that area to repel birds.

Mechanical design:-

We need a camera that is mounted on a base that can rotate and target a particular desired direction.

Components required:-

1. A solid base of wood.
2. A DC motor.
3. H bridge to control DC motor.
4. Universal gearbox
5. Wires
6. Camera(Like Logitech QuickCam)
7. Parabolic mirror
8. Arduino UNO
9. DC power supply source
10. Resistors
11. Strobe light

12. Parabolic mirror

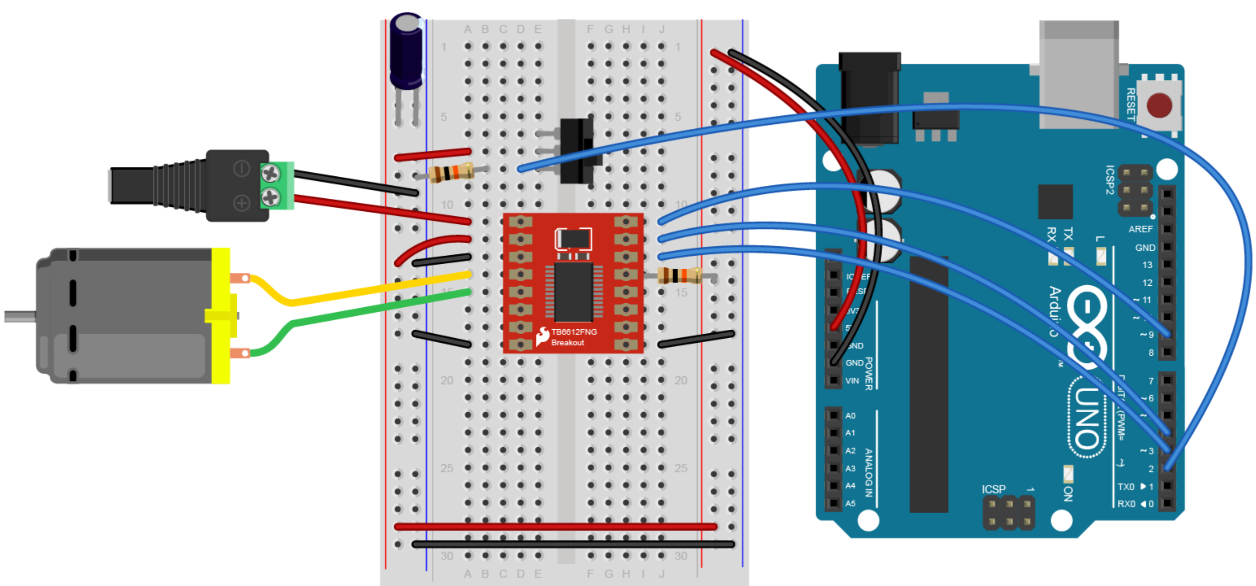
Step 1:-Creating a section on the wood and drilling various holes for our motor, gear, and wires.

Step 2:-Now we use a gearbox and attach it to a DC motor and our strobe light. We use the universal gearbox because it is a toy box of numerous gears but we can very effectively use it for our prototype.

Step 3:- We now create a platform. Then we connect our Logitech Quickcam to this platform. Then we connect this platform to our gear attached to the DC motor(connect QuickCam in the opposite direction of strobe light).

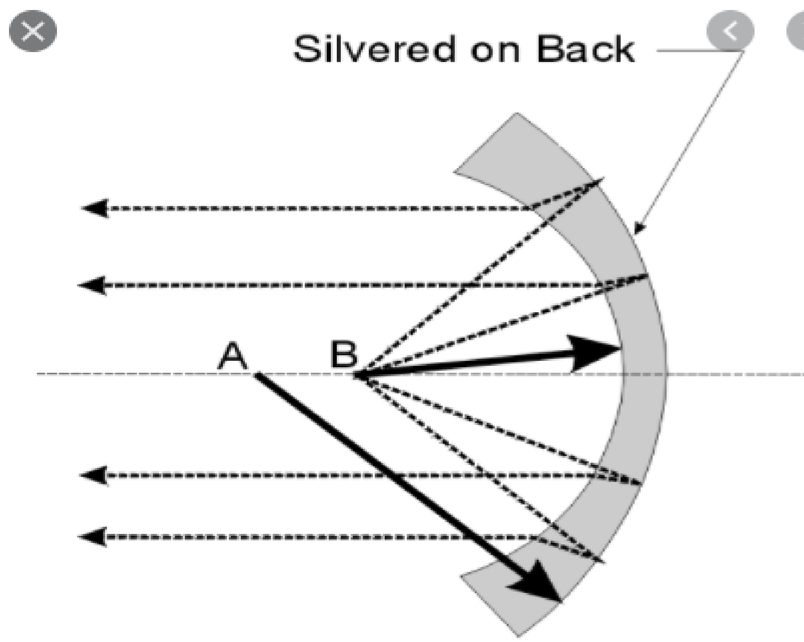
Step 4:- connect the H bridge to the DC motor using Arduino, resistors.

H- Bridge:- A circuit containing 4 simple high-frequency switches(e.g. Transistor can be used as a switch) that can be controlled and with the help of these switches we can control the direction of the motor's motion and also its speed.



Circuit diagram to connect Arduino and H bridge with a motor.

Step 5:- we can now place our entire system such that the strobe light is on the focus of the parabolic mirror and the mirror can be used to channelise the light beam in a straight line.



B is the focal point of our parabolic mirror.

Step 6:-connect the camera to the PC via a USB cable.

Software design:-

We will use machine vision by using digitised video footage.

Step 1:- We have the following methods available for **acquiring our image**:-

- **Single point scanning**:- basically we use a light source detector. This light source-detector consists of a single source of light that sends a beam of light and a detector that then detects this light beam and measures the distance between two surfaces. However, this method is not very effective for larger-scale applications.
- **Line scanning:-** here a small photo sensor with a lens and light is used to detect the entire line of the image at a time. It is similar to a fax machine. But this method cannot be used in our model as it cannot tell the exact location of birds.

- **Frame/Area scanning:-** here each pixel is stored as a number in an array that tells the user which colour goes in what position. As using a 2d array we can determine an entire image this method is superior to the above two methods. But this method is cumbersome and can take greater time.

So we perform area scanning using our camera in the first step.

Step 2:- we now need to select an image processing technique. We can use:-

- **simple image comparison method**:- we have to constantly update the image and hence generally requires higher time and can make our entire system slow.
- **Edge detection:-** using numerical filters we can simply detect the edges of the image and then can work on those edges and compare only them.

Numerical filters:- a square array with elements that can be convoluted with the original image easily used to detect edges.

We will first use image comparison however if we need we can use edge detection to improve the speed of our system.

Step 3:- we now need to create a program that can detect movement and control the motors with the help of the H bridge.
We will use visual basic language.

Using image comparison we can determine if there is a motion. Also, we can change this code such that only motions of objects of a certain colour(colour of the birds) triggers the system.
Such codes are very easily available on many open source platforms and we can try and use them directly.
Sample code(this code represents an advanced version of what we have explained, here the overflow data problem has been managed by using two colours in case of movement detection)**:-**

```
w = Squiz.pwidth
h = Squiz.pheight
Debug.Print w, h
ReDim picbytes(2, w - 1, h - 1) As Byte
Do
Debug.Print "STA call "; stoppit
Squiz.SnapToArray picbytes()
Debug.Print "STA return"; stoppit
 i = DoEvents
 For j = 0 To h - 1
 For i = 0 To w - 1
 p = picbytes(2, i, j)
 q = picbytes(1, i, j)
 r = picbytes(0, i, j)

 Pic.PSet (i, h - j), RGB(p, q, r)
```

Now, this motion is detected and we can very easily determine the total movement of the object.

Once this total movement is determined we can check if that movement is more than a certain threshold that we can set according to the place where it is used

E.g. in a place with higher wind on average, the threshold should be set higher.

Now if this threshold is breached our camera will keep monitoring only that direction and hence our strobe light will also point towards that direction and hence will repel the birds.

This is our design.

Our design and codes might need correction to accommodate distortions and noises (particularly those created by the strobe light itself). We might also need to implement edge detection and other advanced methods to get exact results.

Advantages and disadvantages of design:

Advantages

1. Strobe light has relatively low cost, more effectiveness and area covered.
2. Our device uses a line scan device which is quicker in image analysis time with respect to frame scan devices.

Disadvantages

1. Strobe light can cause nuisance around it if kept in an open area. Therefore strobe is focused in a specific area using a parabolic concave mirror.
2. Device is not effective for large scale application and can't be used to project on birds in flight.

Conclusion:-

We can use one or both the technologies simultaneously depending on our need.

However there are still a few challenges for our project:-

1. Modifying our prototype to be effective in the field
2. Accounting for various cases(particularly animals and birds) which might render our model ineffective in the field.
3. Making it easy to use for farmers.
4. Publicise our model so that people actually see it as an effective option.

For this initially we can also target gardens, we can also use our strobe light with other methods to make it more effective.