UNIVERSITY OF ZIMBABWE

Conceptual Design Submission to The Efficiency for Access Design Challenge

Submitted by:

Team 2023-34

Energy and Power Research Cluster

Faculty of Engineering and The Built Environment

University of Zimbabwe

OVERVIEW

For our bird deterrent device project, we are looking to develop and implement an effective and affordable solution to reduce the impact of bird strikes on crops. Our goal is to create a device that will deter birds from causing damage without harming the birds themselves. We plan to use a combination of sound, light and visual deterrents to keep birds away from the farm lands. We believe that our solution has the potential to improve food security, improved energy access, and contribute to a more sustainable and eco-friendlier environment.

We would like to express our sincere thanks to our Educator, H. Chingosho and our Mentor, R. Atwal, for their valuable guidance and encouragement throughout thesis. This would not have been possible without their timely and constructive suggestions.
Finally, we would like to convey our heartfelt thanks to our loving friends and family for their support and encouragement.
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ACRONYMS

I.	CW	Continuous wave
II.	DC	Direct current
III.	FMCW	frequency modulated continuous wave
IV.	GND	Ground
V.	MCU	Micro controller unit
VI.	PIR	Passive Infra-red
VII.	RX	receiver antenna
VIII.	TX	Transmitter antenna

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1 OBJECTIVES SCOPE, STRATEGY & DELIVERABLES

1.1 The Challenge

Rural farmers rely on farming to support to their livelihood. They often plant cereal crops to boost their productivity and sell the surplus to support their lives. However, their farming lands are prone to invasion by animals such as birds which then decrease farming harvest.

1.2 Objective

To design a DC Bird deterrent Device that auto detects birds and deploys effective deterring mechanisms.

To simulate different conditions and to optimize device for real world application.

To develop a prototype that solves the problem and is accessible to remote farmers of all classes.

1.3 Scope

The scope of our design will include the development of a bird deterrent device that can installed in Agricultural fields. We will be working to create a product that is effective, affordable, and easy to use. The device will need to be able to emit sound, light and visual deterrents that can be programmed to respond to different types of birds and environmental conditions. We will also be considering the durability and lifespan of the device, as well as the feasibility of large-scale manufacturing and distribution.

1.4 Strategy:

The strategy for the designing and implementing our bird deterrent device will include the following steps:

Research and design: We will begin by researching the different types of birds that cause damage to crops, and most effective deterrent methods.

Prototyping: based on our research, we will develop and test prototypes of our device, and make adjustments as needed.

User testing: we will work with farmers and other stakeholders to test our device in real world settings.

1.5 Deliverables:

The design team will be expected to ensure the following deliverables:

A final version of our bird deterrent device that is effective, Affordable, and easy to use.

A detailed user manual and installation instructions for our device.

A marketing and distribution plan to promote our device to farmers and other potential customers.

A sustainability plan for our device, including a strategy for disposal and recycling.

An evaluation and feedback report based on user testing and customer feedback.

2 IMPLEMENTATION ACTIVITIES

The following activities were envisaged under the design challenge:

2.1 Methodology & Approach

2.1.1 Research approach

Our research approach was a combination of primary and secondary research. For primary research we compiled articles and interviews with farmers to gain an understanding of their experiences with bird strikes and their current methods of deterrence.

The birds that impact wheat farms in Zimbabwe include:

1. Red-billed Quelea (Quelea quelea)

Fig1.

https://upload.wikimedia.org/wikipedia/commons/a/a7/Red-billed_Quelea_%28Quelea_quelea%29_%286040990915%29.jpg?download

2. Village Weaver (Ploceus cucullatus)
3. Cape Turtle Dove (Streptopelia capicola)
4. Laughing Dove (Streptopelia senegalensis)
5. Cape Sparrow (Passer melanurus)
6. Southern Red Bishop (Euplectes orix)
7. Red-billed Firefinch (Lagonosticta senegala)
8. Egyptian Goose (Alopochen aegyptiaca)

9. Helmeted Guineafowl (Numida meleagris)

10. African Sacred Ibis (Threskiornis aethiopicus)

“About 95 percent of wheat damage is due to quelea birds while rodents and insect pests cause minor damage. Small grain farmers (sorghum and millets) also face challenges with quelea birds. We are working closely with the Zimbabwe National Parks and Wildlife Authority to control and manage the birds.”

https://www.google.com/amp/s/www.herald.co.zw/quelea-birds-invade-more-farms-in-five-provinces/amp/

Farmers in Umguza and Bubi farming districts, Matabeleland North province, Zimbabwe are failing to control a massive outbreak of quelea birds, feasting on their crops, mainly small grains, which are close to harvesting.

The invasion of the farmers’ crops, who are mostly small-scale growers, have resulted the producers now spending most of their time clanging metal objects and shouting at top of their voices in a desperate bid to save their crops.

“We are appealing to the government to do something before the birds destroy more crops. A lot of farmers in this area were last year contracted to grow small grains by a local company. Now this outbreak is going to leave a lot of farmers with a crop deficit,” Lavenda Ndlovu, a farmer in Bubi district, said

Zim farmers count losses as quelea birds destroy crops - FurtherAfrica https://furtherafrica.com/2022/05/20/zim-farmers-count-losses-as-quelea-birds-destroy-crops/

A Review on Current Animal Scaring Methods and Devices in Remote Rural Areas:

Visual Deterrents:

1. Scarecrows: Traditional scarecrows, often dressed in human-like clothing, have been used for centuries to deter birds and other animals from crops. However, their effectiveness is limited as animals can habituate to their presence over time (Tinsworth & Shasta, 2006).

Fig 2.

(Visual deterrent, Nyanga rural farm setup, Manicaland Zimbabwe)

2. Reflective Devices: Reflective tapes, ribbons, or metallic objects that move and reflect light can startle animals and deter them from entering crop fields. These devices are relatively inexpensive and can be effective in the short term (Belant et al., 1998)

Auditory Deterrents:

1. Propane Cannons: Propane-powered cannons that produce loud, explosive sounds at regular intervals are widely used to scare away birds and other animals. While effective initially, animals can become accustomed to the predictable noise patterns, reducing their efficacy over time (Bomford & O'Brien, 1990).

2. Ultrasonic Devices: These devices emit high-frequency sounds that are inaudible to humans but can be perceived as disturbing by some animal species. However, their effectiveness is limited, and many animals can habituate to the sound (Koehler et al., 1990).

3. Bio acoustic Deterrents: These devices play recorded distress calls or alarm calls of specific animal species, which can effectively deter animals of the same species. However, their effectiveness is species-specific and may require frequent updating of the audio recordings (Delwiche et al., 2005).

Chemical Deterrents:

“We are targeting badly affected areas in all Mashonaland provinces, Matebeleland north and south, Midlands, Masvingo and Manicaland. I understand more than US$230 000 has been spent to procure the chemicals and we are quite confident that we will control the birds,” Nyamutukwa said. “The arrival of chemicals will help a lot in controlling the menacing birds. We are very optimistic that we will save the current wheat crop.”

Tsiko. S, (2021) The Herald, 'Zim imports chemicals to control quelea birds'

1. Repellents: Various chemical repellents, such as methyl anthranilate or anthraquinone, can be applied to crops or seeds to make them unpalatable or unattractive to animals. However, their effectiveness can vary based on the target species, and they may require frequent reapplication (Avery & Cummings, 2003).

2. Taste Aversion: Compounds like methiocarb or thiram can induce illness in animals after ingestion, leading to a conditioned taste aversion towards the treated crops. However, these methods are controversial and may raise ethical concerns (Conover, 1984).

Physical Barriers:

1. Netting or Fencing: Installing physical barriers, such as netting or fencing, can effectively exclude animals from crop fields. However, these methods can be labour-intensive and costly, especially in remote rural areas with large land holdings (Engeman et al., 2002).

2.1.2 Design Approach

Our design approach will be iterative, starting with a focus on identifying and analysing the problem and then moving on to prototype and user testing. We will then use this information to design our bird deterrent device, taking into account factors such as size, range, weight, effects on birds, effects of harsh weather conditions and power requirements. We will also consider the potential environmental impact of our device and the feasibility of mass production. Once we have a prototype, we will conduct user testing to evaluate the effectiveness of our device and gather feedback from potential customers.

2.1.3 Model development

Our model development process will involve several key steps:

Developing a baseline model that is based on existing research and understanding of bird behaviour and deterrent methods.

Creating a prototype device that can be tested and refined based on user feedback.

Using a combination of physical and computational modelling to optimize the design and functionality of our device.

Using physical modelling to test durability and longevity of our device under different environmental conditions.

2.1.4 Testing and validation Plan

Our testing and validation plan will involve several stages of evaluation and refinement:

We will conduct lab test to evaluate the effectiveness of our device under controlled conditions.

We will conduct field tests to evaluate the performance of our device in real-word settings.

We will also conduct user testing with farmers to evaluate the ease of use and effectiveness of our device.

3 DESIGN / CASE STUDY ANALYSIS

3.1 Case study

For our design case study analysis, we will focus on successful bird deterrent systems that have been implemented in other agricultural setting. We examined the Karlack Outdoor Bird Repellent and we analysed the strengths and limitations of this approach and considered how we can improve upon it in our own design.

Karlack Outdoor Bird Repellent (Passive Infrared based sensor).

Strength:

The sensor can detect the presence of birds at a range of up to 30 feet

The sound system can be programmed to emit a loud noise that is unpleasant for birds, which effectively scare them away.

Can be placed in areas where birds are known to roost or gather, such as in trees or on roof tops, which can provide targeted deterrence.

Limitations:

Uni directional sensing range.

PIR based repellents are often used in combination with other deterrent methods.

Can be limited by the type of birds that are being deterred, as some birds may be less sensitive to the deterrents than others.

PiR based repellents may not be effective in windy or rainy conditions, as the sensor can be triggered by weather conditions and false alarms.

3.1.1 Underlying theories

The underlying theories and principles that guided our bird deterrent device include; Behavioural theory, sound physics, and visual perception.

Behavioural theory was used to understand the motivation and behaviour of birds, and develop effective deterrent methods that target birds.

Sound physics was used to optimize the sound and frequency of our device, so that it is most effective at deterring birds without causing harm.

Visual perception was used to optimize the visual deterrents, such as flashing lights, to make our device as effective as possible.

3.1.2 Novelty of research

The novelty of our design lies in the combination of different deterrent methods and the customization of our device to target specific types of birds. Most existing bird deterrents use a single method of deterrence, such as sound or visual deterrents. Our device will combine these methods, using sound, light and visual deterrents to create a more effective and comprehensive deterrent system. our device will be customizable to target types of birds, which will allow us to optimize its effectiveness.

3.2 Detailed Design

The design of the system will automatically detect birds using a millimetre wave sensor within the range of the field. When a bird is detected, the system will respond automatically by activating the buzzer, flash lights and servo motor flags and then shutting down once the detection is over. The components will be constructed to create corrosion-resistant materials that can cater for moist environment and other harsh weather conditions. The system approach comprises robotically implementing prototype device work and controlling it with a microcontroller that has been programmed. The microcontroller's purpose is to maintain optimal operating conditions. Furthermore, the remote-control module will be used to remotely control the system to improve usability.

System block diagram.

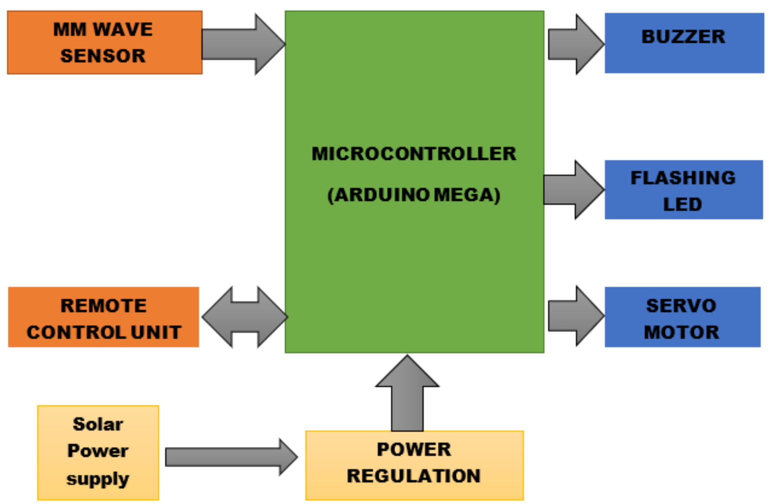


Fig 3.

The figure above displays the bird deterrent electrical system based on a microcontroller that competently monitors the detection and deterring conditions. Using this method, one can reduce personnel manual intervention, saving energy, and improving efficiency, resulting in higher production.

Project process flow diagram

The diagram below shows the general flow and dependencies of the system. Diagram illustrates how the various processes are intertwined to deliver the desired deliverables.

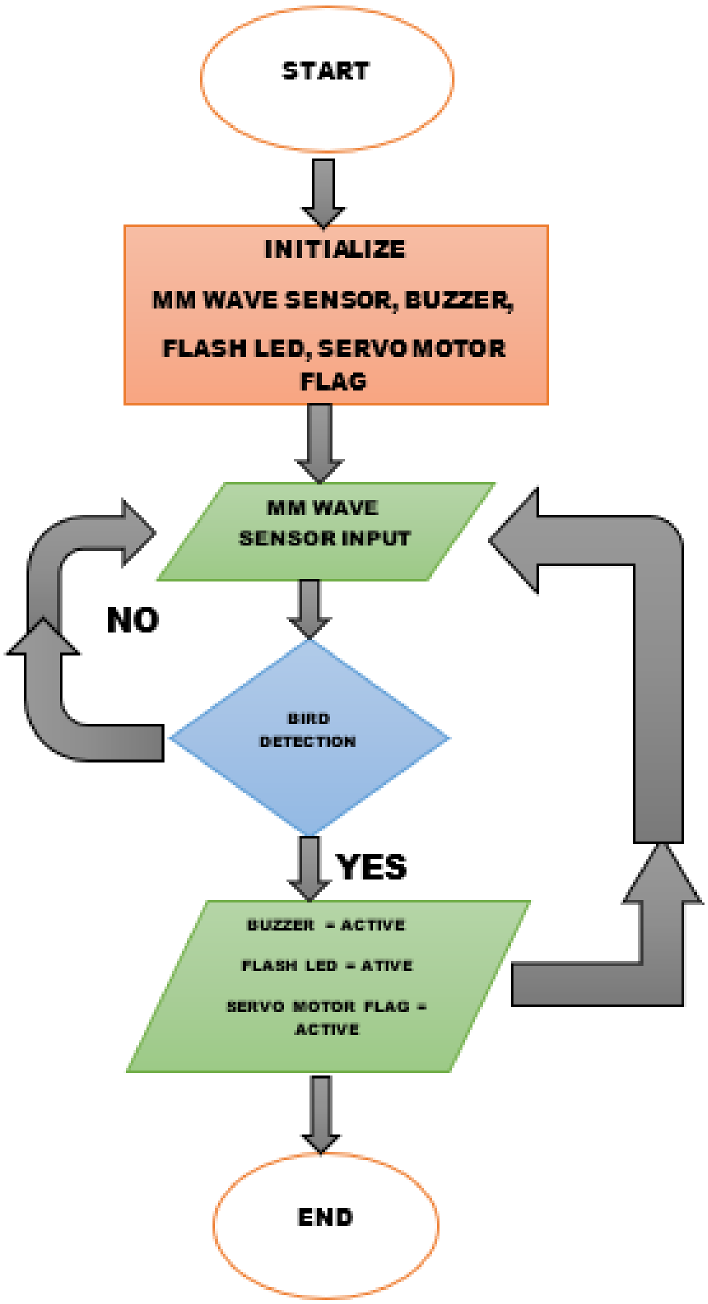


Fig 4

Design of FMCW mm wave sensor circuitry.

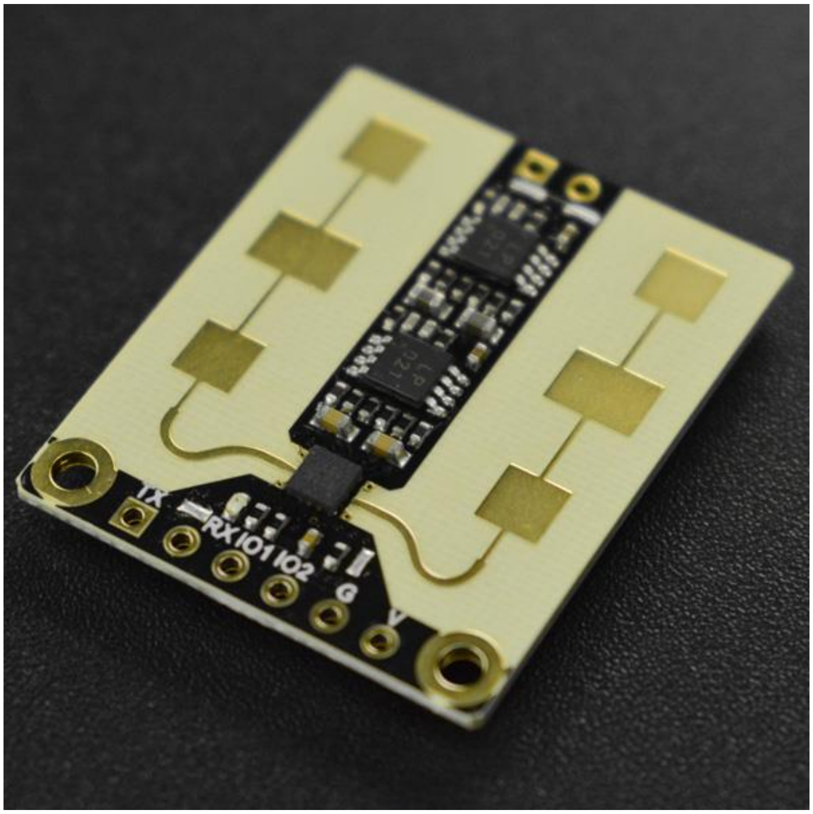


Fig 5

https://dfimg.dfrobot.com/nobody/wiki/d66965cdc976d535785aaa68ba932e08.png

This 24GHz millimetre-wave radar sensor employs FMCW, CW multi-mode modulation and separate transmitter and receiver antenna structure.

In working, the sensor first emits FMCW and CW radio waves to the sensing area. Next, the radio waves, reflected by all targets which are in moving, micro-moving, or extremely weak moving state in the area, are converted into electrical signals by the millimetre-wave MMIC circuit in the sensor system. After that, these signals will be sent to the processor and processed through the related signal and data algorithms. Then, the target information can be solved out.

The millimetre-wave radar can sense the presence, stationary and moving of birds within the detection area. There are two ways provided to output detection result: serial port and I/O port switch quantity. Besides that, the sensor module features strong sensing reliability, high sensitivity, small size, easy to be used or embedded in applications.

Features

- Bird presence sensing
- I/O port switch quantity input and output control

- Serial port input and output control
- Strong anti-interference ability, not to be affected by snow, haze, temperature, humidity, dust, light, noise, etc.

Specification

- Power Supply: 3.6~5V
- Operating Current: 90mA
- Detection Distance: 9m-15m
- Equivalent Transmit Power: 13-15dBM
- Beam Angle: 100×40°
- Modulation Mode: FMCW, CW
- Operating Frequency: 24GHz
- Operating Temperature: -40~85℃
- Baud Rate: 115200
- Dimension: 24×28mm/0.94×1.10”

Board Overview

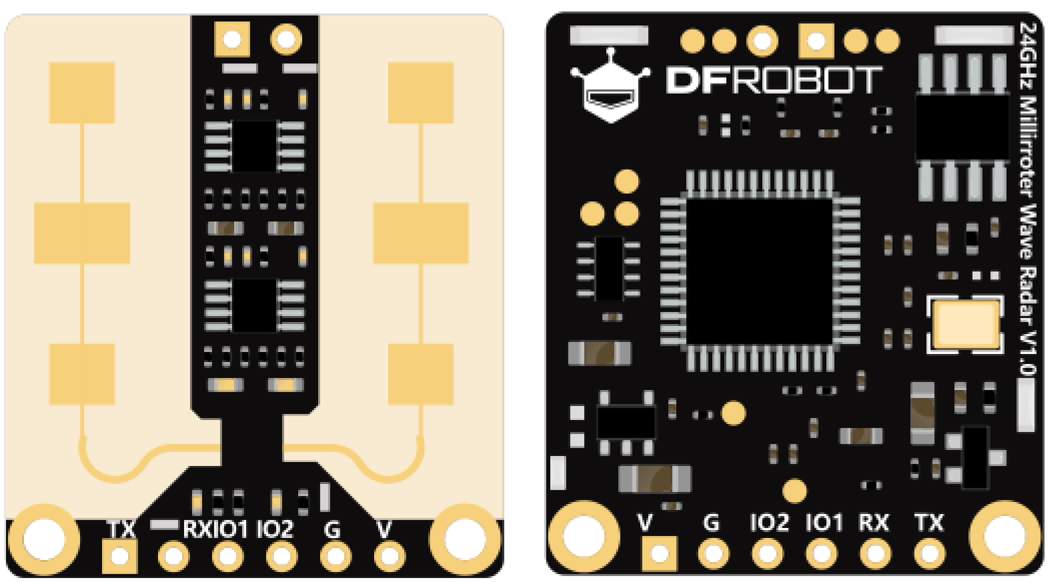


Fig 6

https://dfimg.dfrobot.com/nobody/wiki/140df7f22a101572454b118c1b059876.png

Num	Label	Description
1	UART Tx	Sensor UART Transmiting
2	UART Rx	Sensor UART Receiving
3	GPIO1	Universal Input and Output
4	GPIO2	Universal Input and Output(By default, it outputs high when people presence detected, otherwise, output low)
5	GND	Ground
6	VCC	Power +
7	NC	Reserved, left floating
8	NC	Reserved, left floating

Table 1.

The two I/O ports can be used for level trigger input and output applications; The 1 UART port can used to configure input and sense result.

Installation

Horizontal installation

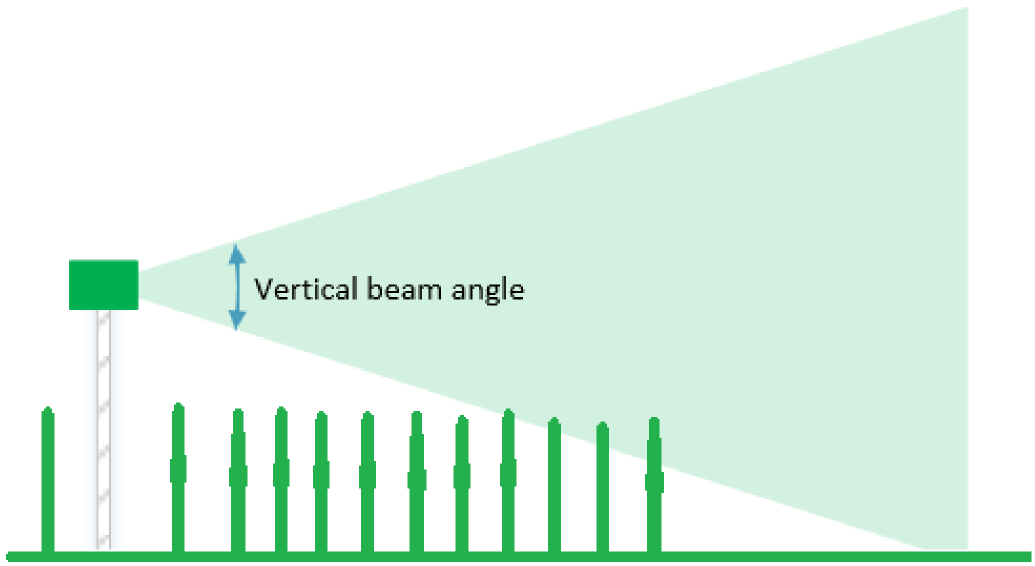


Fig 7

Connecting diagram

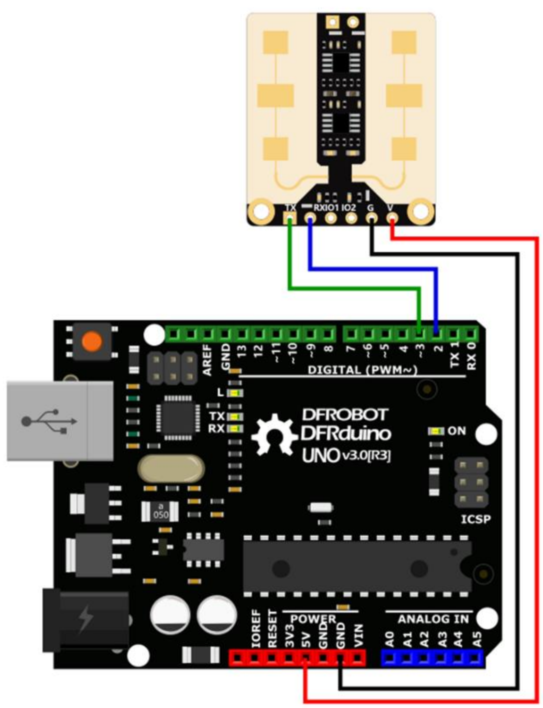


Fig 8

mm Wave Radar	Arduino Uno
VCC	5V
GND	GND
RX	D2
TX	D3

Table 2.

Design of remote-control unit circuitry

Fig 9.

Arduino mini infrared wireless remote-control kit consists of ultra-thin infrared remote control and 38KHz infrared receiver module. This mini slim infrared remote control with 20 function keys. It transmits to distances up to 8 meters. IR receiver module can receive standard 38KHz modulation remote control signal. You can decode the remote-control signal through Arduino programming.

Specifications:

Transmission distance: up to 8m (depending on the surrounding environment, sensitivity of receiver etc.)

Battery: CR2025 button battery Karnack capacity: 160mAh

Effective angle: 60°

Sticking material: 0.125mm

PET Effective life: 20,000 times

Static current: 3uA - 5uA

Dynamic current: 3mA - 5mA

Interfacing remote control unit with Arduino

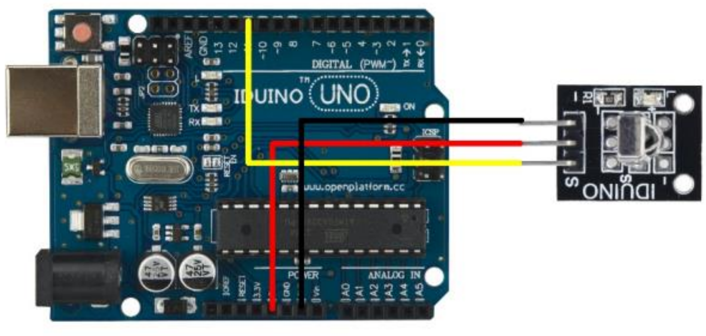


Fig 10.

Design of sound deterring circuitry

The deterrent sound system comprises of a DFPlayer Mini Module connected to a small speaker. A SD card with pre-recorded natural bird predator sounds is embedded into the DFPlayer module. The DFPlayer module is controlled by the micro controller which specifies activation, volume and deactivation of the system in accordance to bird presence.

DFPlayer Mini Module

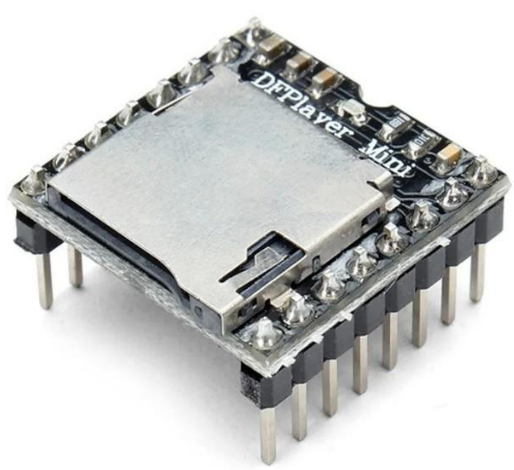


Fig 11.

DFPlayer Mini Module pin connections

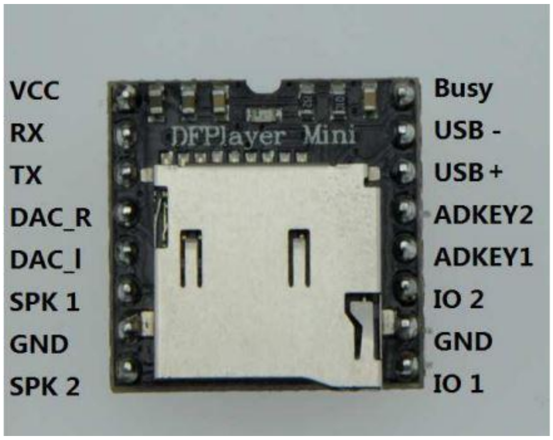


Fig 12.

Specification Description

ITEM	DESCRIPTION
MP3 Format	1、Support 11172-3 and ISO13813-3 layer3 audio decoding 2、Support sampling rate (KHZ):8/11.025/12/16/22.05/24/32/44.1/48
Working Voltage	DC3.2~5.0V; Type: DC4.2V
Standby Current	20mA
Operating Temperature	-40~+70 °C
Humidity	5% ~95%

Table 3.

Speaker

Subwoofer Aluminum Alloy Full Range Speaker

Fig 13.

Electronic Specifications

Item	**Description**
Rated Impedance	4ohms
DC Impedance	4ohms
Rated Power	15W
Maximum Power	30W
Sensitivity	92dB
Frequency Range	92Hz to 3.49KHz

Table 4.

Interfacing sound deterring circuitry with Arduino

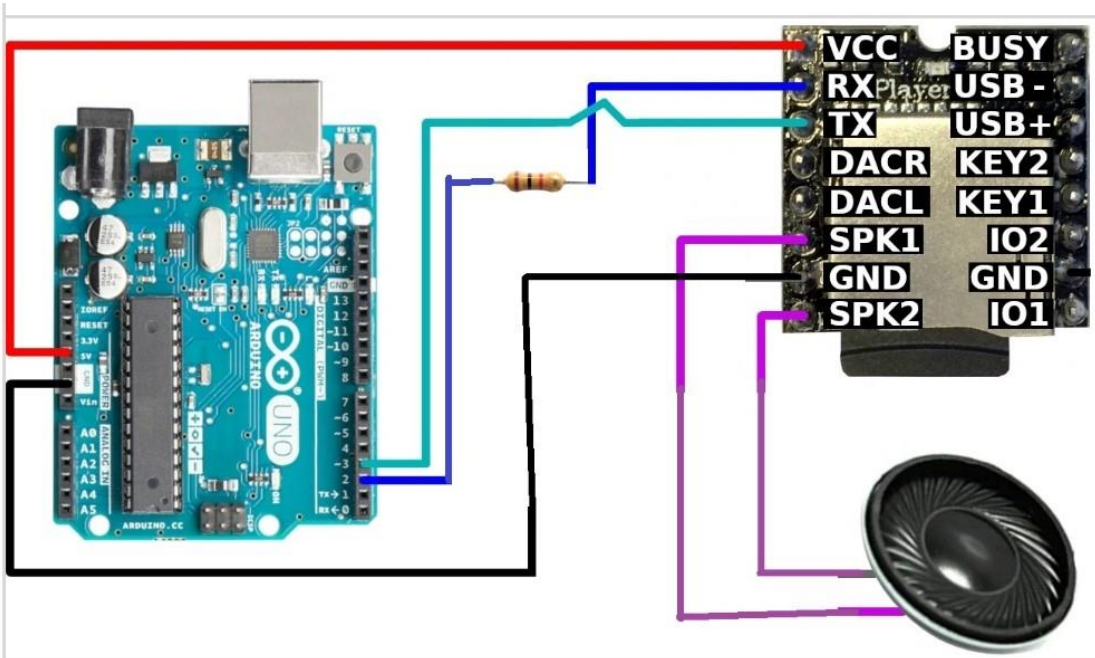


Fig 14.

LISTING OF SOUNDS THE SYSTEM WILL PRODUCE

- African Fish Eagle Calls
- African Hawk Eagle Calls
- Tawny Eagle Calls
- African Goshawk Calls
- Barn Owl Calls
- Bird Distress Call of local bird species
- Martial Eagle Calls
- Bateleur Eagle Calls
- African Wood Owl Calls
- African Harrier Hawk Calls
- Lanner Falcon Calls
- Loud mechanical sounds (clanging and explosions)

Design of flash light circuitry

Flashing red and blue led

Features

- High Luminous LEDs
- 5mm Round Standard Directivity
- Superior Weather-resistance
- Flashing Type Water Clear Type

Blinking LED Diagram

Fig 15.

Electrical-optical characteristics

Item	Minimum	Typical	Maximum	Unit
DC Forward Voltage	3.0	3.3	4.5	V
Current	20	20	24	mA
Dominant Wavelength Red	620	625	630	Nm
Dominant Wavelength Blue	465	470	475	Nm
Luminous Intensity Red	5800	7000		Mcd
Luminous Intensity Blue	2000	2500		Mcd
Oscillator Frequency		1.8		Hz

Table 5.

Blinking LED Limiting resistor

Resistance = Maximum Voltage / Desired typical current

Resistance = 4.5V / 2.0mA

= 225ohms

Design of servo motor flags

The traditional use of scare crow to protect crops from being damaged by birds have not been efficient since birds can get used to the statue form hence the need for motion like mimicking human arm movements using rotation of motor shaft with gear connections to sets motion of arm movements.

DETAILED DESIGN

INTRODUCTION

This chapter will focus on designing the components of a bird deterrent unit. The parts making up the machine are sized and materials for the parts selected according to the design standards for mechanical parts. The designed parts are tested to configure if they can withstand the operating stresses and adjustments if any are taken in order to minimize failure of the parts during operation.

COMPONENTS

- Linkages and arms
- Gears
- Pole and Mounts
- Supporting Frame
- Electronics Box

COMPONENTS DESIGN CALCULATIONS

Gear Calculations for both Gears

Involutes Gears Design: Main Gear

Pitch Circle Diameter (D)=module(m)x no. of teeth(t)

2mm x 38 =76mm

Addendum(a) = module

= 2mm

Dedendum(d)= Addendum + Clearence

Clearence= 0.25 x module

=0.25 x 2

=0.5mm

Dedendum(d)=2mm +0.5mm

=2.5mm

Addendum Circle diameter=D+2a

=76+2(2)

=80mm

Dedendum Circle Diameter=D-2d

=76-2(2.5)

=71

Pressure angle=20 degrees

Circular pitch =pie (Pitch diameter)/number of teeth

=6.2831853072

Tooth thickness=circular pitch/2

=3.14

Gears Design:

Pitch Circle Diameter (D)=module(m)x pie (teeth(t)

2mm x 19 =38mm

Addendum(a) = module

= 2mm

Dedendum(d)= Addendum + Clearence

Clearence= 0.25 x module

=0.25 x 2

=0.5mm

Dedendum(d)=2mm +0.5mm

=2.5mm

Addendum Circle diameter=D+2a

=38+2(2)

=42mm

Dedendum Circle Diameter=D-2d

=38-2(2.5)

=33

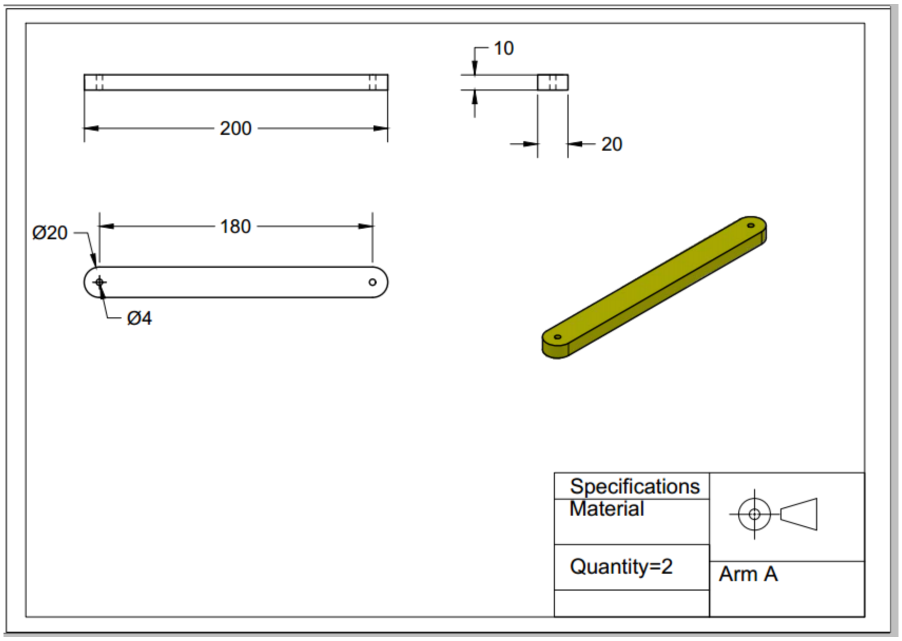
Pressure angle=20 degrees

Circular pitch =pie (Pitch diameter)/number of teeth

=6.2831853072

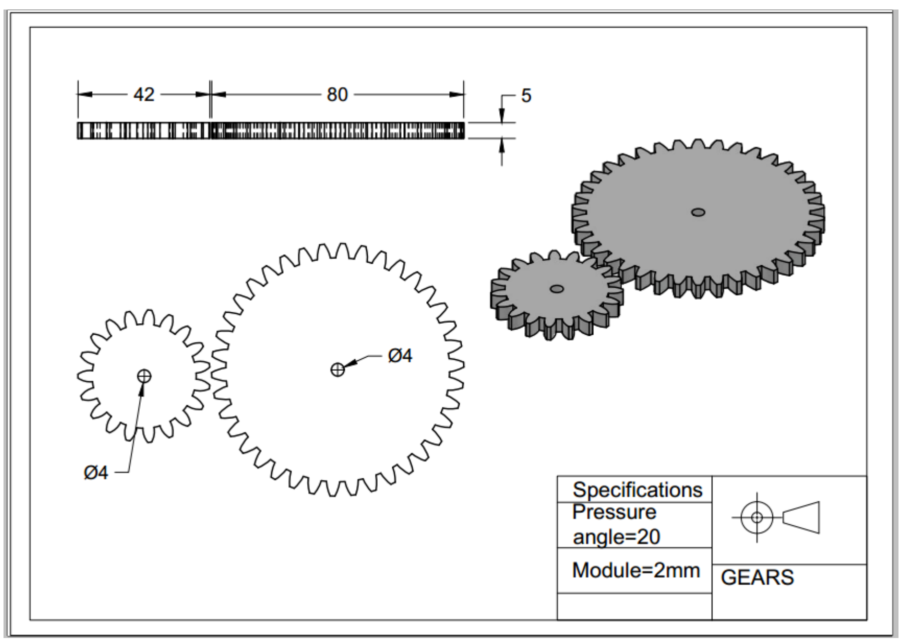
Tooth thickness=circular pitch/2

=3.14



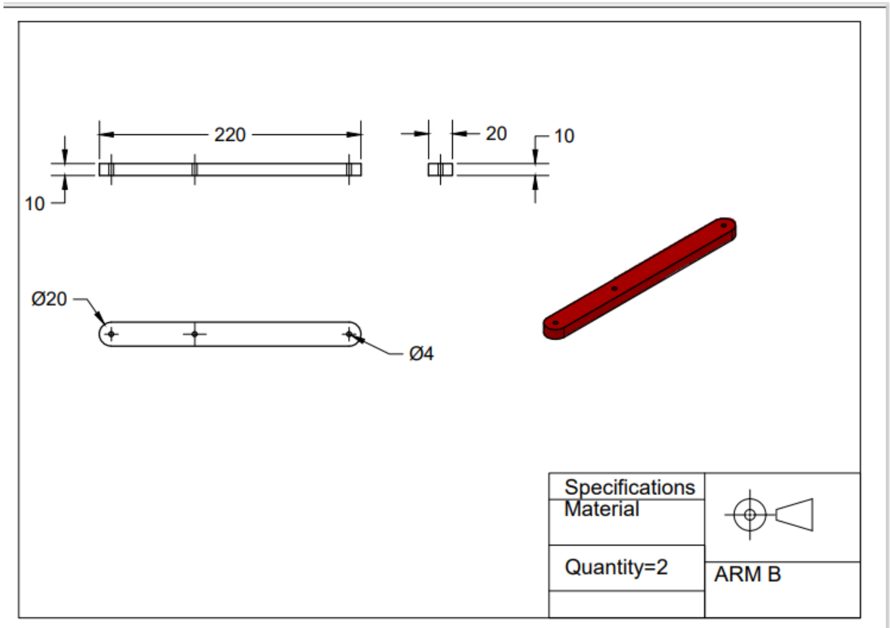
10
200
20
Ø20
180
Ø4
Specifications
Material
Quantity=2
Arm A

Fig 16.



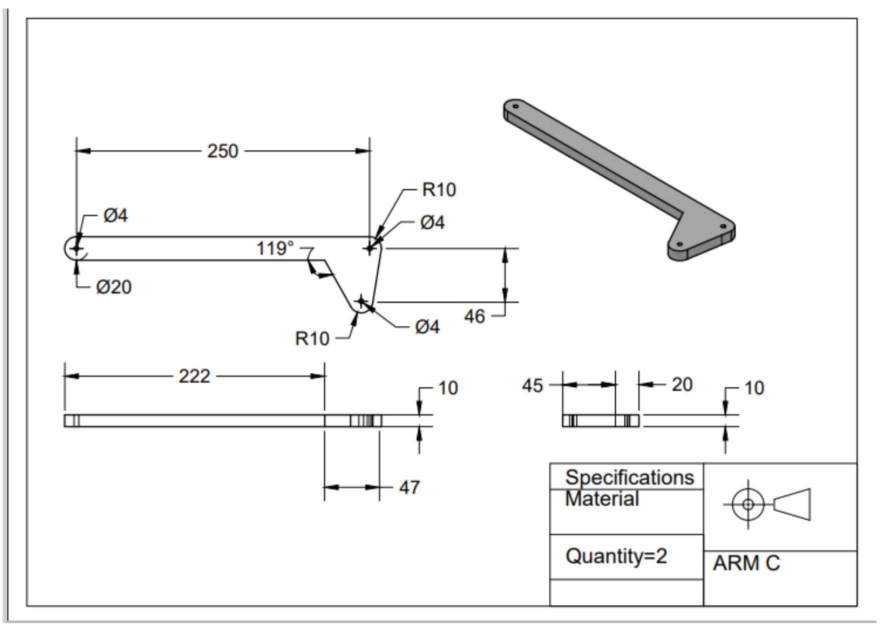
42
80
5
Ø4
Ø4
Specifications
Pressure angle=20
Module=2mm
GEARS

Fig 17.



220
20
10
10
Ø20
Ø4
Specifications
Material
Quantity=2
ARM B

Fig 18.



250
R10
Ø4
Ø4
119°
Ø20
46
R10
Ø4
222
10
45
20
10
47
Specifications
Material
Quantity=2
ARM C

Fig 19.

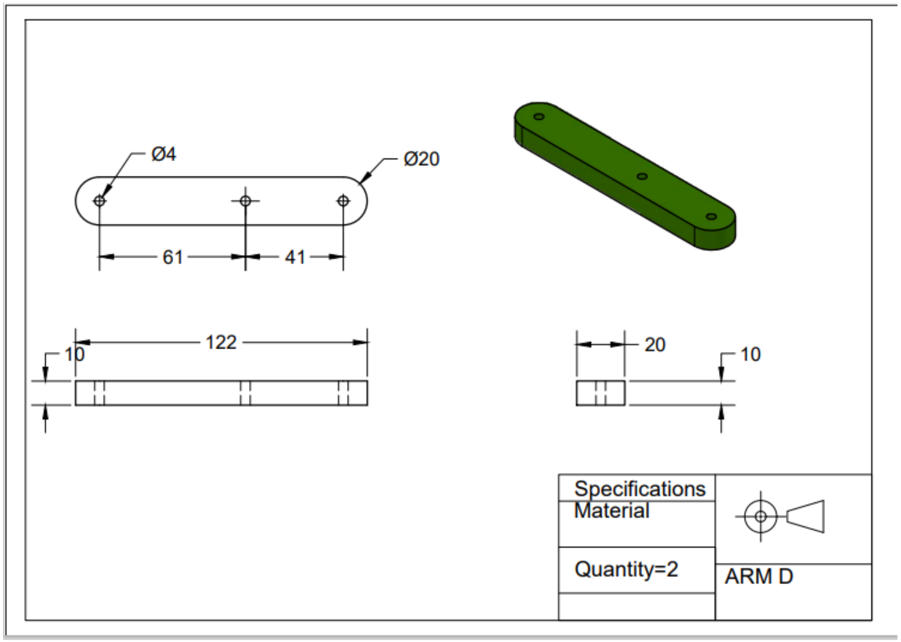

Ø4
Ø20
61
41
122
10
20
10
Specifications
Material
Quantity=2
ARM D

Fig 20.

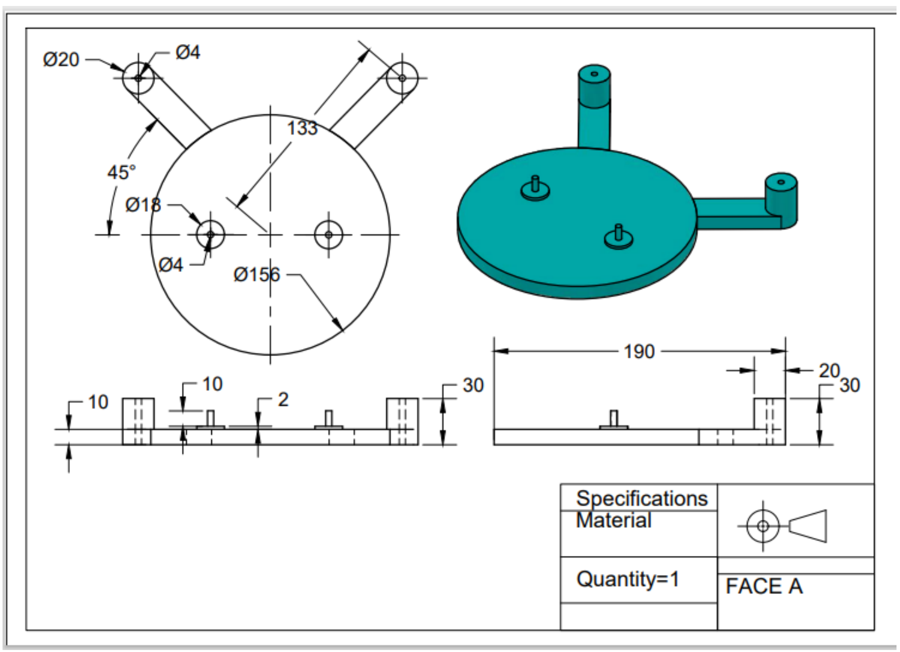

Ø20
Ø4
133
45°
Ø18
Ø4
Ø156
190
20
30
10
10
2
30
Specifications
Material
Quantity=1
FACE A

Fig 21.

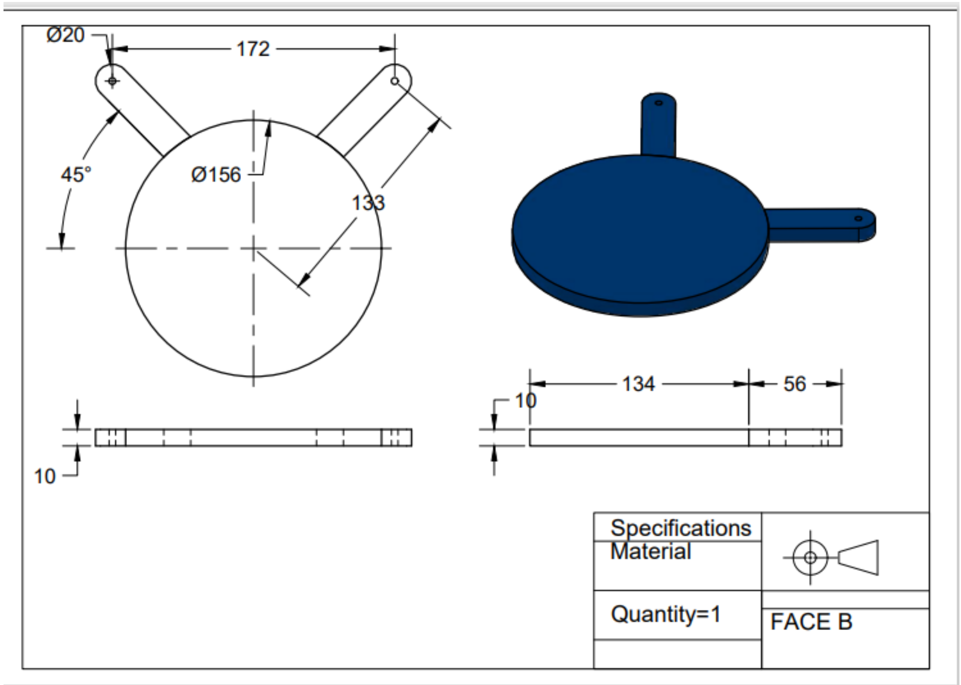

Ø20
172
45°
Ø156
133
10
134
56
10
Specifications
Material
Quantity=1
FACE B

Fig 22.

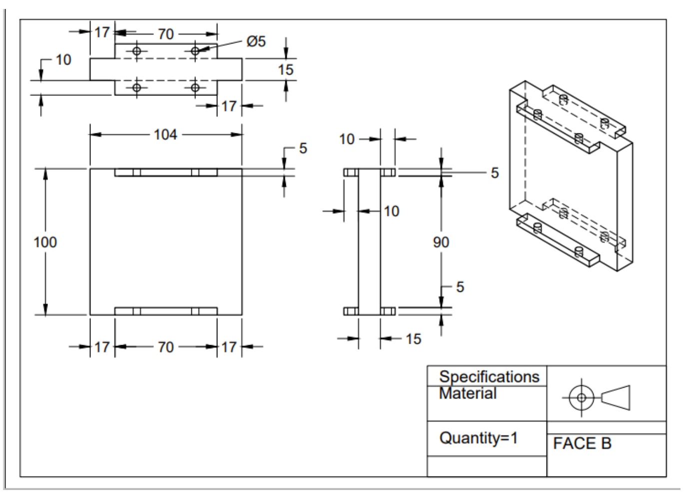

17
70
Ø5
10
15
17
104
5
10
5
10
100
90
5
17
70
17
15
Specifications
Material
Quantity=1
FACE B

Fig 23.

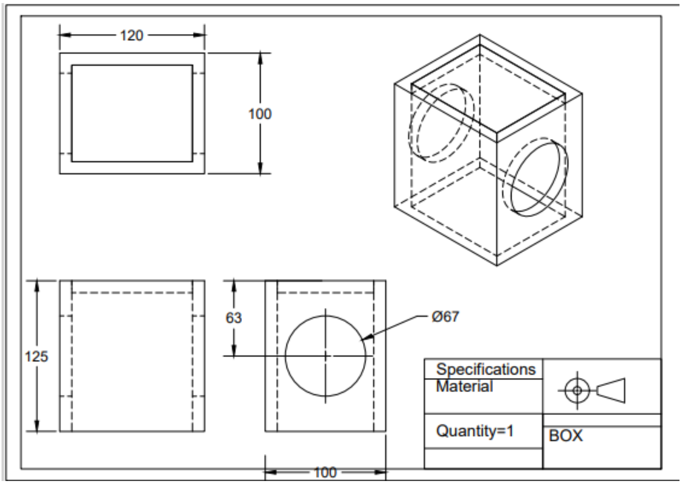


Fig 24.

Design of the servo motor

Fig 25.

https://dfimg.dfrobot.com/nobody/wiki/abe02dcc8aaa47bf5a341a29938a933a.jpg

DSS-M15S servos have been well received by customers in these years. It has extremely wide-angle control range, huge load capacity and excellent quality. This DSS-M15S with analog feedback has broken its internal potentiometer signal. This is an analog signal with 0~3.3V feedback. You can connect it to MCU to realize close-loop feedback control.

DSS-M15S 270° Metal servo with feedback is compatible with Arduino Servo library. You can drive it with Arduino Board and read the angle value from analog side.

Specification

- Electronic specifications
  - Operating voltage: 4.8-7.2V
- 6V test environment
  - Operating speed (no load): 0.18 sec/60 degrees
  - Resting current: 80mA
  - Locking torque: 11.5KG*cm
  - Stall current: 1.4A
  - Standby current: 4mA
- 7V test environment
  - Operating speed (no load): 0.16sec/60 degrees
  - Resting current: 100mA
  - Locking torque: 12KG*cm
  - Stall current: 1.76A
  - Standby current: 5mA
- Mechanical specifications
  - Gear material: metal gear
  - Operating angle: 270 degrees
  - Wiring gauge: 28PVC
  - Data line length: 320mm
  - Gear bracket spline: 25T/5.80
  - Gear ratio: 310:1
  - Size: 54.5*20*47.5mm
- Control specifications
  - Feedback signal: 0-3.3V
  - Control signal: RC PWM
  - Pulse range: 500-2500 us
  - Median signal value: 1500us

- Clockwise rotation: <1500us
- Control frequency: 50-330Hz (Arduino compatible)

Servo overview

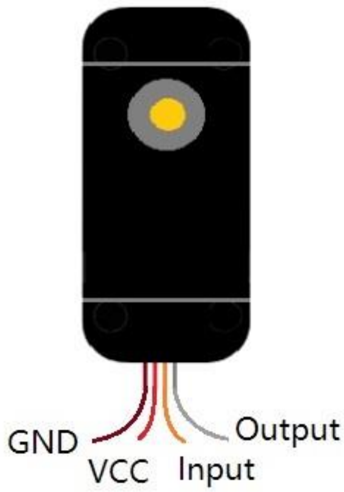


Fig 26.

https://dfimg.dfrobot.com/nobody/wiki/db5d9eaf71079acef09c7d2cb69a3895.jpg

Num	**Label**	**Description**
1	GND	GND
2	VCC	4.8~7.2V
3	INPUT	PPM Signal
4	OUTPUT	Analog feedback

Table 6

Connecting diagram

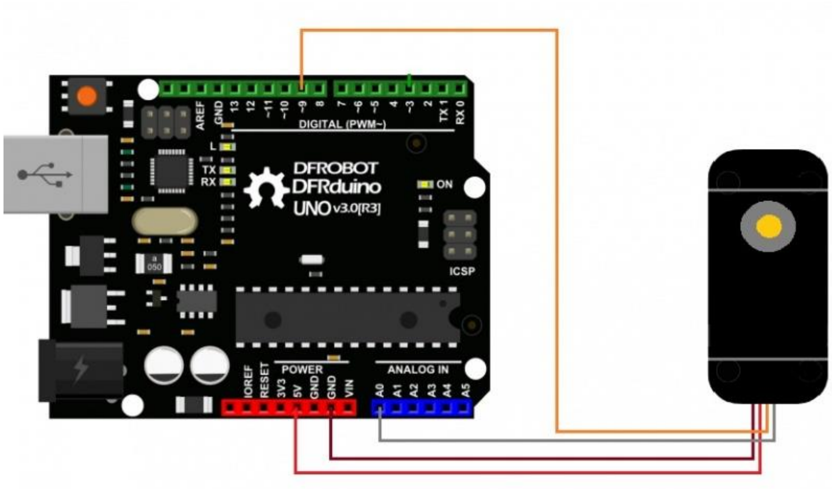


Fig 27.

Dimensions

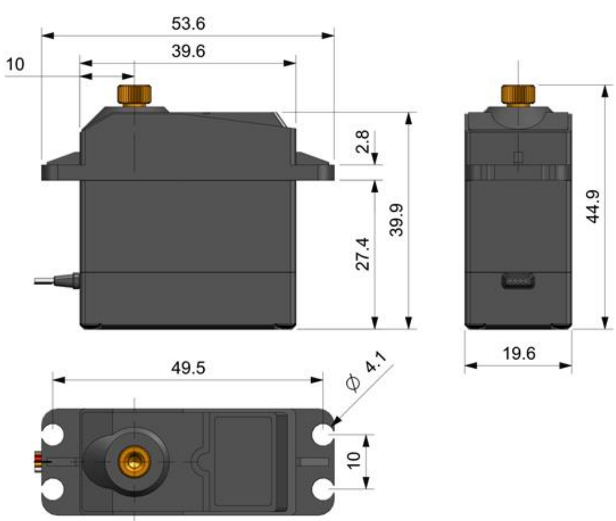


Fig 28

https://dfimg.dfrobot.com/nobody/wiki/359fcafa5efdf0155a2573a8834c1463.jpg

POWER ANALYSIS

Components power consumption

DFPlayer Mini Module:

Operating Voltage = 5

Typical current = 20mA

Power consumption = 0.1W

Rated speaker power 15W

TPA3116D2 Amplifier

Efficiency = 90%

Amplifier power consumption = 16.5W

Servo motors

Voltage = 5

Current = 1.4A

Power = 7W

Total = 7 x 2 = 14W

OLED = 3.3 X 20mA =0.66w

Remote kit = 3.3 X 5mA = 0.15W

Arduino Mega board = 12V X 0.2 = 2.4W

Total power = 49W

Considering 20% potential power losses

Estimated power 49 x 1.2 = 58.8W

=60W

Required solar size = 60W

BATTERY SIZING

For 24-hour operation without recharge total energy = 60 x 24 = 1440Wh

Assume device is active for 6 hours a day

Total energy = 60 x 6

Battery capacity = 360 /voltage

= 360 /12

= 30Ah

4 RESULTS

4.1 Results Presentation

4.2 Design Results

4.2.1 Device Architecture

The figure below shows the schematic diagram of the whole components using Proteus.

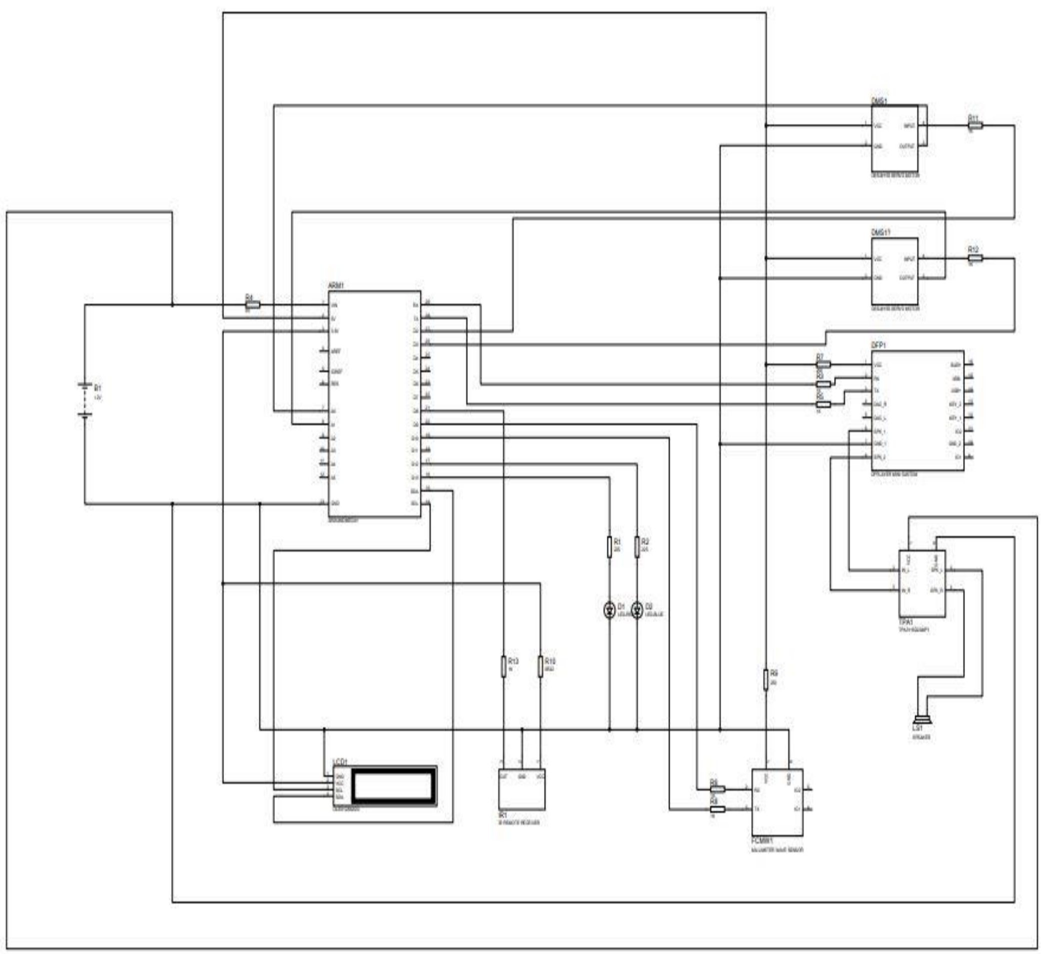


Fig 29.

4.2.2 Drawings

The figure below shows the isometric diagram of the design using AutoCAD.

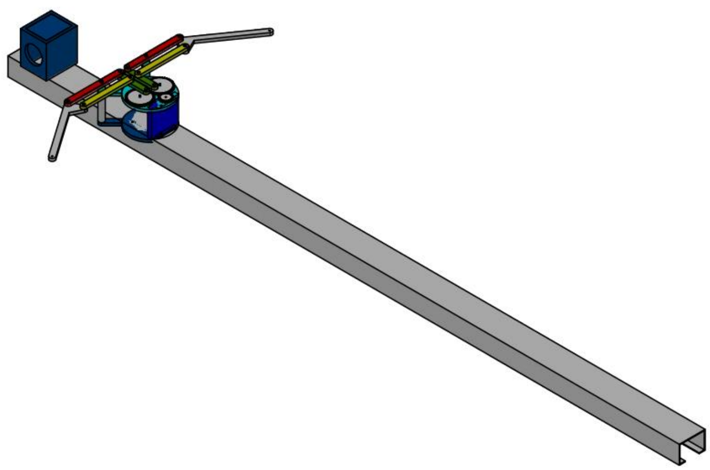


Fig 30.

4.2.3 BoQ

Item number	Item name	Quantity	Price
1.	Mm wave sensor	1	$15.00
2.	Arduino mega	1	$16.00
3.	12 V 30Ah	1	$70.00
4.	60 W solar panel	1	$80.00
5.	Speaker	1	$15.00
6.	Remote kit	1	$2.00
7.	Df player mini module	1	$10.00
8.	OLED Display	1	$4.00
9.	Servo motor	2	$5.00
10.	Flash light	1	$2.00
Total			**$219.00**

Table 7

4.3 Deductions

The cost of the prototype will most likely surpass the cost of one device in large scale production.

5 DISCUSSION / ANALYSIS

5.1 Discussion

Our bird deterrent device will be an innovative solution for reducing bird strikes and improving food security. It will be designed to be both effective and affordable, making it accessible to farmers in rural areas. The device will use a combination of sound, light, and visual deterrents to create an unpleasant environment for birds, causing them to avoid sensitive areas. This approach will be more effective and humane than traditional methods of bird control, which often involve trapping or killing the birds. We believe that our device has the potential to make a significant impact in the agriculture as well as in the wider community. While our bird deterrent device has many potential benefits, there are also some potential drawbacks to consider. For example, some people may be resistant to the idea of using technology to control bird populations, preferring traditional methods of bird control.

5.2 Conclusions

In conclusion, our bird deterrent device will be an effective and affordable solution to reduce the impact of bird strikes on crops and infrastructure. By using a combination of sound, light, and visual deterrents, and by optimizing these deterrents for different types of birds, our device will provide a comprehensive and customizable solution. We will use behavioural theory, sound physics, and visual perception to guide our design, and we will conduct lab and field testing to validate the effectiveness of our device. We believe that our device will be a valuable addition to existing bird deterrent systems and will provide a much-needed solution to a common problem.

5.3 Recommendations

1. Continue to refine our design through lab and field testing to ensure that the device is effective and durable in a variety of environments.

3. Develop partnerships with local farmers and other stakeholders to gather data on bird strikes and to optimize the effectiveness of the device.
4. Ensure the device's usage adheres to local regulations regarding noise pollution and impact on local wildlife
5. Educate the public on the device functionality and the importance of responsible bird control measures to promote understanding and acceptance

6 INNOVATION AND INDUSTRIALISATION

6.1 Consumer uptake

Farmers are the targeted consumers, and they have a great deal of investment in the success of their crops. Birds are such a threat to their success, and the use of chemicals is not always the best solution considering the effects of these chemicals in the environment and the human body. This will indeed give the device an advantage.

6.2 Opportunity for innovation, commercialization and internationalization

There is great opportunity to innovate. By eliminating the use of chemicals in the elimination of birds that prey on crops we reduce the amount of long-lasting pesticides, some of which have been proven to accumulate in the ecosystem and evidently hurt humans and wildlife. The problem is not limited to Zimbabwe, and by far and large is severe in other nations such as India. This provides a market for device in other regions of the world, and can be modified so as to suit the sounds, and calls that work best for the species of birds present. In light of the fact that Zimbabwe has chemicals on its import bill for handling quelea birds, it is a chance for commercialization as it will mean the local production of an alternative will be much welcomed.

The target market of our product is farmers and the opportunity for commercialisation is through the farmer's market. The farmers market is where they buy agricultural inputs. In Zimbabwe these shops would include Agricura, farm and city, veterinary shops, feed mix, and so many shops where we can arrange contracts and they will sell our product.

These days farmers are digitalised, they are found on social media handles like WhatsApp, Facebook, Twitter, tiktok and many more. This will be an opportunity for internationalization and direct marketing to those farmers.

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