ISSN No:-2456-2165

Esp-32 Based Smart Chasing System for Crop Raiding Animals

[1]Ateeq Ahmed Y
IV Sem M. Tech in DECS
Adichunchanagiri Institute of Technology
Chikkamagaluru. India

[2]Dr. Anil Kumar C
Associate Professor
Adichunchanagiri Institute of Technology
Chikkamagaluru, India

Abstract:- Indian Farmers contributes around 15 percent in the nation's *economy* as indicated by the current GDP report, and Farming provides more than 45 percent employment opportunities to citizens. Our farmers even in this globalization period are suffering from poor income because they are not getting according to their expectations, due to many factors like unfavourable weather, various crop disease, monsoon failure, unavailability of necessary timely guidance and fertilizers etc. among them one of the major reasons of poor income is the damage of ready to sell crop by rogue, ravaging crop raiding animals both domestic and nondomestic especially in areas near forest zone or hill top. As reported frequently in many periodicals from various parts of the country, Farmers are spending their nights restlessly in their farms to guard the yield from ravaging animals. Even though government sanctions compensations to the aggrieved farmers, it is not meeting the expectation of farmers as some times the gap between actual loss and sanctioned amount is very big. Therefore, many farmers take an extreme steps of illegal high power electric fencing around their farms, due to which many lives endangering instances are reported in newspapers both of ignorant humans and crop raiding animals. To answer all this serious problem faced by our farmers I have proposed this model which is not just a prototype solution to be experimented in a laboratory (using small range sensors like IR, PIR, ultrasonic sensors.) but it is a real field implementable model powered by solar power supply to be able operate without interruption in remote areas which either has no access or poor access to the traditional power supply. This proposed model is based on ESP32 a very promising, advanced microcontroller. In this proposed solution I have used the various high pitch audios to scare away the crop raiding animals without harming them. Here I have also used the fog lights to repel the nocturnal animals in night time.

Keywords:- *Indian Farmers ; GDP; Crop Raiding Animals; PIR ; Ultra Sonic Sensor; ESP32*

I. INTRODUCTION

Indian Farmers since thousands of years has given their major contribution in nations economy, even today agriculture contributes majorly towards nations GDP approximately around 15%, but it's share in employment is approximately around 42% [1]. Despite all contributions mentioned above, our farmers are still not able to get the expected outcome in the form of revenue/profits even after they spend their time, money and many laborious activities in the field. Among several factors like unfavorable weather events such as heavy rain eroding the soil, floods, insufficient cover of vegetation, various plant diseases, the menace of crop raiding and damaging by animals intruding into the farmlands is a one of the major contributors for our farmer's poor economic condition. As reported frequently in various periodicals from different parts of the country, farmers are now forced to spend their sleepless nights in the farms to avoid crops being destructed by rogue non-domestic animals. Even governments are not compensating aggrieved farmers as per their loss and expectation. From earlier time, many traditional/crude techniques are implemented by farmers to avoid the destruction of crop. Some of those techniques are agricultural fencing, natural repellents, biophysical barriers, all of which are only temporary measures with very low success rate, hence situation is not improving. Therefore, these conditions at times forced the farmers to resort to the extreme steps of using illegal high power electric fences around their farm to protect their yield, thereby proving fatal for animals in the form of serious injury or in some instances the death of the animal.

Indian Farmers grieve for their huge financial losses due to the ravaging of crops in their farmland as illustrated in figure 1, by Crop raiding animals (like buffaloes, boars, cows, goats, birds.) which devastate for example maize and paddy fields, cause damage to food crops like tomato, groundnut crops etc. Problems faced by our farmers definitely need to be taken care off as they are producing variety of vegetables and other edible foods for us. Even though an average Farmer suffer from the natural problems like poor rain fall, he/she always plans and keep hopes for getting good profit on his/her current crop yield, based on which he/she has scheduled future spendings. Due to heavy deforestation and increased human intervention, Farmers of remote areas sharing border with forest and areas near hills are more prone to life-hostile attacks from wild animals (like Elephant, wild boar etc.). Due to human limitation, it is

nearly impossible for any farmer to barricade and guard his entire farmland area 24X7. To circumvent these serious problems, hereby I propose and implementing a system which is smart enough to cast away crop raiding animals, both domestic and non-domestic, thereby providing enough protection to the farmers property. This system uses ESP32 MCU as its central point of control and command. As I am implementing a low-cost real-field model, deprived any of those low range sensors which are used in many prototype applications of similar cause.

Farmers Wildlife Conflict has become a very grave issue to be resolved on top most priority basis, because these conflicts are usually result in life- threatening situation to either for the Famers or to the wild animals.

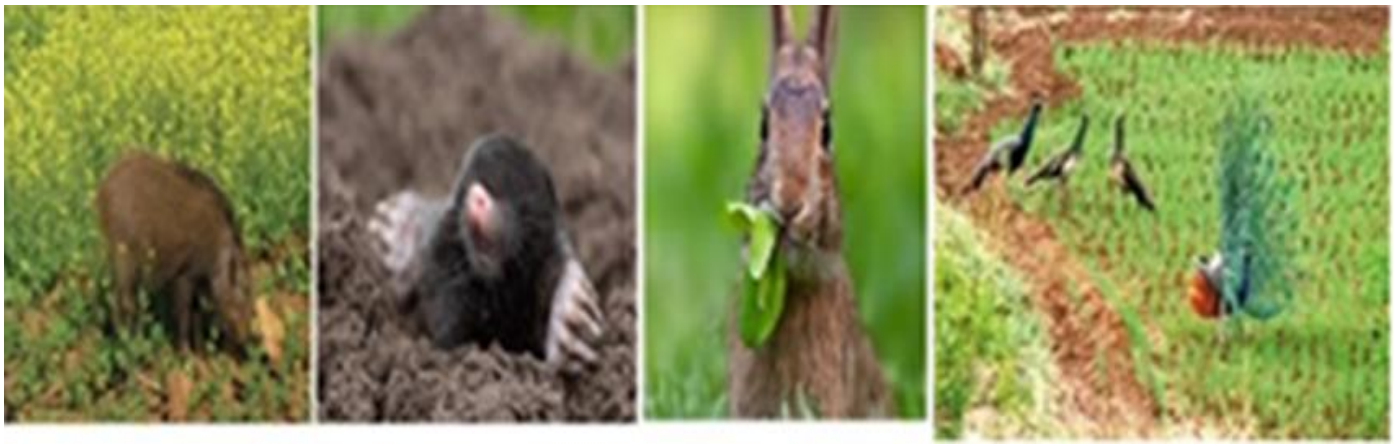

Fig 1 Destroying of Crops by Animals in Farm.

That means either Farmer life and crop will be in danger due to sudden and direct attack from non-domestic animals as indicated in various news articles about crops raiding on various newspapers. Those wild animals also subjected to a life-threatening situation like high current electric fences, resulting usually in the loss of precious animal life, as reported now a days in various newspapers.

II. LITERATURE REVIEW

Dr. B. Venkateshulu et al.2023[3] present a system in which a captured image (in frames per second) of animal by a Pi camera is send for further processing in image processing software platform TensorFlow and YOLO algorithm, then once the image is recognized a cognise nemesis sound is processed and played through speakers.

Ms. Lakshmi KM &Mrs.Vinutha A V 2022 [4] introduces a system in her design she has used the YOLOV3 algorithm to classify the intruder upon image captured by a camera which is triggered to do so by an ultrasonic sensor via Node MCU after it detects an object. Then the system by using BLYNK app send appropriate notifications to both farmer and forest official.

Atharva Mane et al. 2022[5] proposed a surveillance system built around Raspberry Pi microcontroller. How many PIR sensors triggered is decided on the size of intruder and are these sensors can detect movement within the range of 5m. an image of intruder is captured if any movement is detected and an alert message will be sent via email along with an audible alert is issued via alarm buzzer to notify nearby farmers and to scare away the intruder.

Varshini B M. et, al. 2021[6] proposed a crop monitoring, where system utilizes the service of PIR, smoke, soil moisture and fire detector sensor to gather updated information about his farmland. The PIR sensor upon detection of an approaching animal will immediately signal the Arduino Uno to activate both GSM module and buzzer to send SMS and play sound respectively**.**

P. Navaneetha et al. 2020[7] in their proposed work has used both PIR and Ultrasonic sensors to send an alert input signal to be send to the controller if they detect any presence of animals, then an APR board will play a sound and divert the intruder.

III. EXISTING SYSTEM

➢ *Traditional Approaches*

Some of the traditional methods followed by farmers from early times are listed below.

➢ *Agricultural Fencing*

- *Wire Fences; Plastic fences ; Electric fences.*

➢ *Natural Repellents*

- *Smoke; Beehive fencing; Chilli peppers;*
- *Egg Based Repellent etc.*

➢ *Chemical Repellents: Such as*

- *Anthraquinone; Butanethiol and Methyl Anthranilate*

➢ *Electronic Repellents*

- *Ultrasonic repellents: silent on humans i.e. these high frequency sounds are only audible to animals.*

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- *Sonic repellents: loud scaring sounds audible to both human and animals.*

➢ *Other Measures:*

Various other strategies used in preventing animals from raiding the crop.

- Scarecrows
- Firecrackers
- Bright lights
- Fire
- Beating drums
- Dogs.

IV. BLOCKDIAGRAM OF SYSTEM

The figure 2 illustrate the block diagram of proposed project work. As shown for proper functioning of the system the hardware components and devices are interconnected as per the requirement. The list and purposes of hardware components used in the system is given below.

- Solar poles with frame – To hold the solar panels, battery box and rotating audio and fog lights system.
- Solar panels - To receive and convert the sun energy into equivalent electrical energy.
- Solar charge controller – To protect the battery from overcharging by effectively regularising the solar panel output (V & I) to the battery.
- ESP32 MCU - To receive inputs and give appropriate commands to various outputs according to stored program to play the sound, to rotate the servo motor and to control the fog lights.
- Servo motors - To rotate the Horn speakers by specified angle.
- MicroSD card – To store the audio files to be played.
- Class D amplifier – To boost the audio output.
- Horn speakers – To convert the audio signals into sound output.
- Ultrasonic sensor – To sense the approaching of subject.
- Relay - To make or break the circuit.
- Battery - As a source of power to all the blocks of the system.

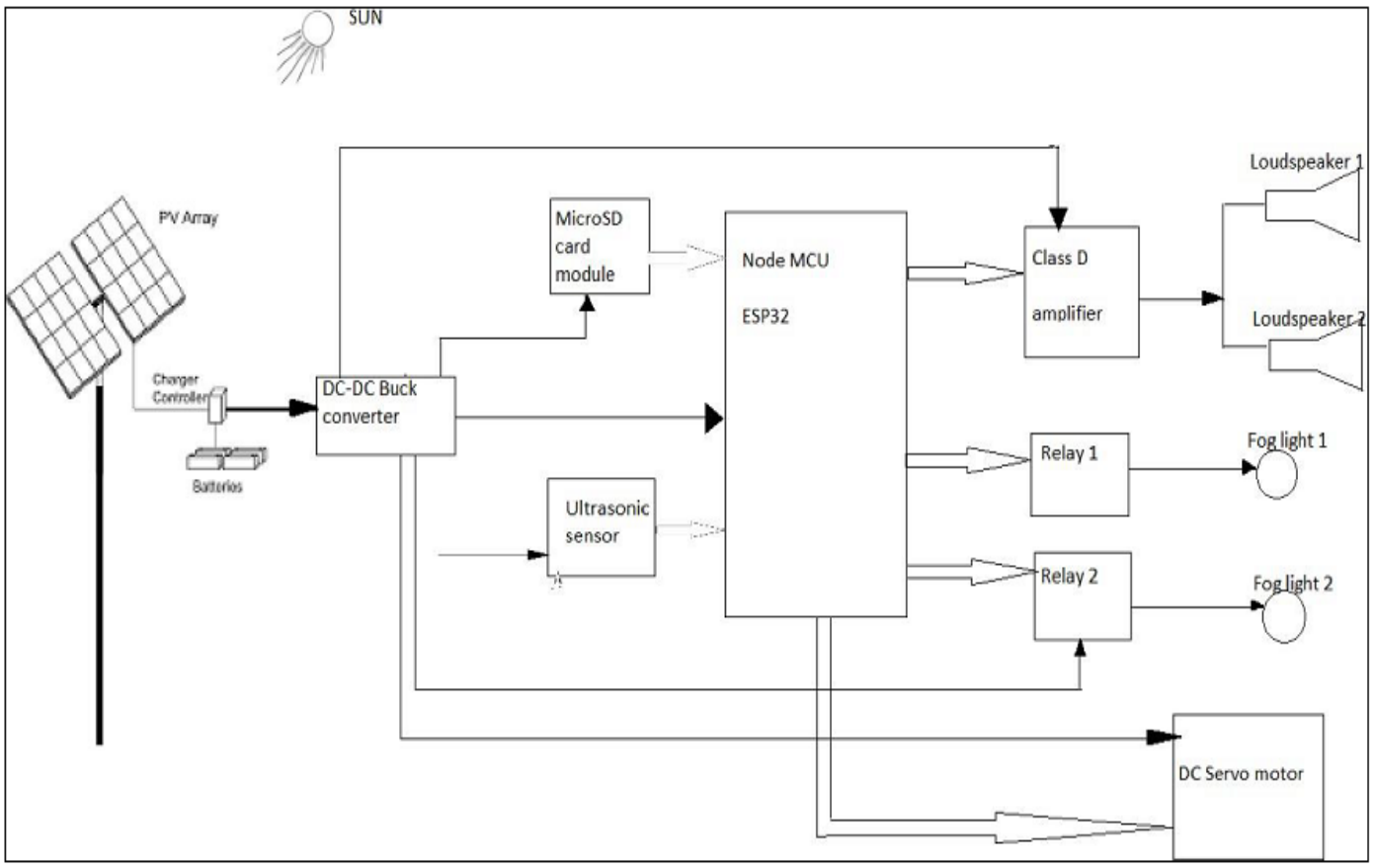

Fig 2 Block Diagram of Electronic Control System

V. METHODOLOGY

The basic principle of the system is, in day time to only produce high decibel animal scaring sounds from horn speakers for the time duration as set by the user. In night time along with sounds also turn ON high brightness fog lights for duration of time as set by the user to scare away nocturnal animals from the farm area.

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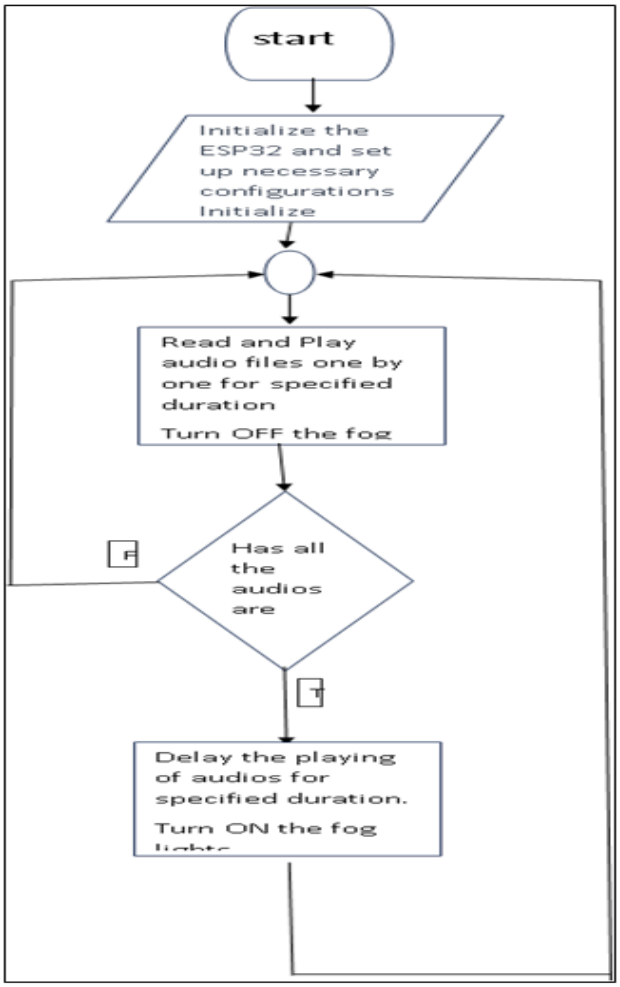

Fig 3 Flowchart of task1

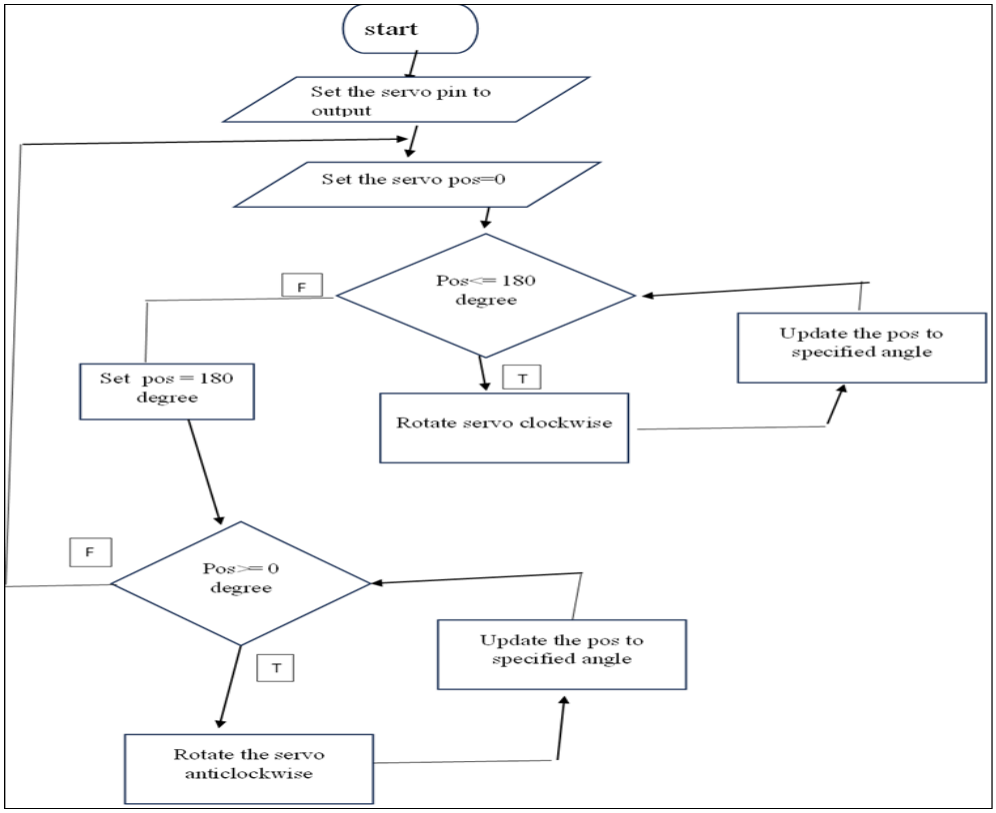

Fig 4 Flowchart of Task2

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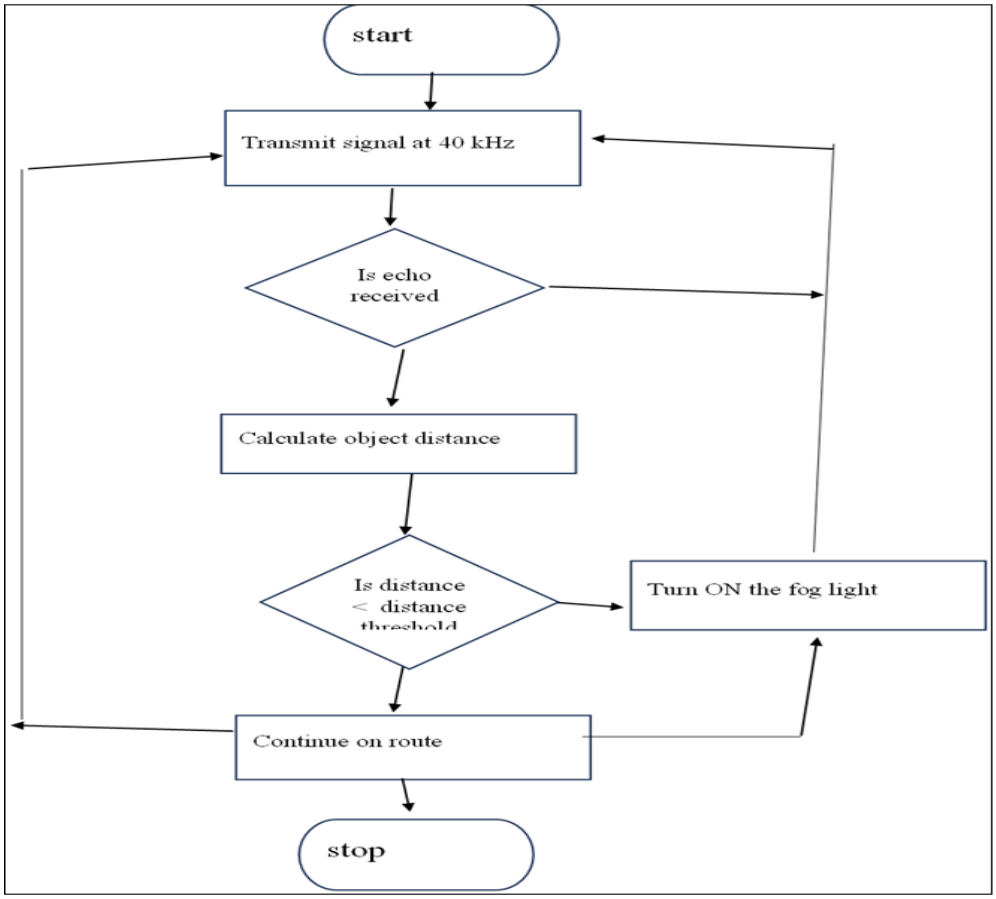

Fig 5 Flowchart of Task3

Relay switches are used to control the turning ON and OFF of fog lights. To turn ON fog lights only in night time user can manually control through a switch. Figure 3, figure 4 and figure 5 illustrating the working of task 1 (playing audio files), task 2(rotating servo motor) and task3(ultrasonic sensor operation) in the flowchart respectively.

For rotating loudspeaker and fog light assembly, I am using a DC servo motor, which rotates the whole assembly in the angular steps as fixed by the user to cover 360 degrees. Servomotor accepts control signals from ESP32 GPIO pin 27.

An ultrasonic sensor is used to turn ON automatically the fog light on arrival of user towards the system and light up the surrounding to aid the user for performing any operation with the system in night.

After implementing this proposed model in his farm land, a farmer can take a sigh of relief, as he will be relieved from burden of facing this menace of crop loss from these crop raiding animals. To effectively deter nocturnal animals from the farm, proposed model provides the solution in the form of very bright fog lights, which will be turned ON and OFF in the time gap during which speakers are disconnected. This intermittent turning ON and OFF of fog lights appears to the nocturnal animals as that some-one is present in the field, so they keep away themselves from that area.

VI. HARDWARE REQUIREMENTS

This section includes the important specifications and features of various hardware components used in the proposed project model.

A. ESP 32 (ESP32-DevKitC V4)

ESP32 is an evolutionary board designed by Espressif systems. ESP series of microcontrollers are very powerful controllers with very high clock speeds, wireless connectivity, camera interfaces. It also has common peripherals and support protocols like I2C, ADC, SPI, UART. As a whole, it is one step below the computer. This board has a 5V to 3.3V voltage regulator, IC CP2102 USB to UART bridge which is used to programme the ESP32 and is available in many versions. esp32 microcontroller has different pins as given in table 1.

B. Solar Panel

Table 2 illustrate the technical specifications of the solar panel used. It helps the installer in configuring the solar PV system by providing essential information about the various operating parameters of a panel.

C. MicroSD Card

Memory cards are electronic storage devices. I have used the 8GB microSD card of SDHC standard for storing the audio files required for the project. SDHC cards use FAT32 file system, files are limited to 8GBin size and capacity of these cards is 2GB to 32GB.

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Table 1 Different Pins of ESP32

Programmable GPIOs	**34 no**
12-bit ADC Channels	18 no
8-bit DAC Channels	02 no
PWM Channels	16 no
UART Interfaces	03 no
SPI Interfaces	03 no
I2C Interfaces	02 no
I2S Interfaces	02 no
Capacitive Touch Sensing GPIOs	10 no
RTC GPIOs	16 no

Table 2 Technical Specifications of Solar Panels used in Project.

a) Maximum power (Pmax)	*b)* 225 W
c) Maximum power voltage (Vmp)	*d)* 21 V
e) Maximum power current (Imp)	*f)* 10. 72 A
g) Short circuit current (Isc)	*h)* 11.45 A
i) Open circuit voltage (Voc)	*j)* 25 V
k) Module efficiency	*l)* 20.40%
m) Module weight	*n)* 12.5 Kg
o) Module dimensions	*p)* 1590X 700 X 30mm

D. Solar charge controller

The basic function of a solar charge controller is to halt the charging by means of opening the circuit using a mechanical relay, when the voltage level of battery reaches to a certain level. Solar controllers come in various features, and available in variety of costs, and sizes.

Recommended order of connecting and disconnecting a solar charge controller with other devices.

➢ *Connecting Order*

- *Battery ------ > Controller*
- *PV array ----- > Controller*
- *Electrical load ------ > Controller*

➢ *Disconnecting Order*

- *Electrical load from the controller*
- *PV array from the controller*
- *Battery from the controller*

E. LiFePo4 Battery

Now a days technologically advanced batteries are becoming more affordable due to rapid advancements in the battery industry. Latest in this development is a subtype of lithium-ion batteries, the LiFePo4 (Lithium iron phosphate) also known as lithium ferro phosphate (LFP). Table 3 lists specifications of LiFepo4 battery.

Table 3 Specifications of LiFePo4 Battery

Model	**BLE12100 – 12V 100Ah**
Cell type	Prismatic
Cell configuration	3.2 V 20 Ah
Maximum Charging voltage	14.6 V
Discharge cutoff voltage	10 V
Normal charging current	20 A
Fast charging current	33 A
Weight	14 Kgs
Passive protection function	Over current and over discharge protection

F. Horn Speakers

I am using 50 watts PA Horn Speakers with line matching(100V) ,these are ideal in installations where lengthy speaker cables are used, to avoid power loss in the cables. For directivity of sound rectangular models are particularly suitable. Protection also provides by them against particles such as dust and jets of water and they features 8 ohms impedance & 103bd output, making it ideal for outdoor & indoor spaces.

G. DC Servo Motor

A servo motor which runs through a servo mechanism is used to rotate precisely an object at specific angles. DC servo motor is powered by DC power supply. With a Gear arrangement in servo motor, we get a very high torque. Gear assembly is used to increase the torque by reducing RPM.

➢ *Following are the Some of the Features of SF3218MG DC Servo Motor:*

- Large Torque - 20KG Servo Motor
- High Rotation which is Well controlled from 0 to 270 degrees, and it also waterproof.
- High Precision – Make sure the high linearity and accuracy of the servo with the use of dual ball bearings design and advanced potentiometer.
- Good Heat Dissipation - Use of CNC aluminium alloy case which effectively cool the servo motor during its working.
- Dimensions - 1.58*0.79*1.60 inch (40.0*20.5*40.5mm);Weight: 56g (1.98oz)

VII. SOFTWARE REQUIREMENTS

➢ *Arduino Ide*

Figure 6 shows a sample Arduino sketch.

Fig 6 A Sample of Arduino Sketch

Among the development methods, I have chosen the beginners friendly method i.e. Arduino IDE. Even though written using Java, this cross-platform (for Microsoft Windows, macOS, and Linux) based integrated development environment with the use of special rules enhance its support to both C and C++ coding languages. Some of the editing features available to it with its embedded code editor are cutting, pasting, searching, replacing of textual data and it also includes automatic indenting, highlighting of syntax etc. compiling and uploading is as simple as that it just requires one click. Message area, common toolbar function buttons, a console for text and a menu with hierarchy of operation is also the part and parcel of this IDE. Which means Arduino IDE have all functionalities like a suitable compiler, loader, board manager, serial monitor etc required in development of a board. The setup() and loop() are the only available pre-written functions with following characteristics.

- *Setup ():*

✓ Called only once at the beginning of the sketch after power-up or reset.
✓ All variable initialization, I/O pin mode setting are done here.
✓ Analogous to main () function.

- *Loop ():*

✓ This function is in the main program and executes repeatedly on exit of setup() function. Board is under the control of this function until power is cut- off or is reset is pressed.
✓ Analogous to while (1) function.

The term sketch is used to address a program developed in Arduino Software. Sketches are saved with ".ino" extension. The programmable device will be detected automatically upon connection established to a computer with Arduino IDE in it. If automatic detection fails, manual selection is performed using tools options. The upload option is used to download a program into the programmable device.

➢ *Operating System*
Arduino IDE support following OS

- Arduino IDE 2 runs on the following systems:
- Windows: Win 10 (64-bit) or newer
- macOS: 10.14: "Mojave" or newer, 64-bit
- Linux: 64-bit

VIII. I2S COMMUNICATION PROTOCOL

Animal scaring sounds are stored digitally in a micro-SD card. Audio files are in mp3 and wav format, which are converted into equivalent PCM code by the ESP32. A digital audio interface in MAX 98357a along with I2S communication protocol is used to draw sound data out of the MCU without any degradation in quality, and then convert digital audio in to equivalent analog form using DAC because speakers only work with analog signals. A class D amplifier in MAX98357a increases the power of the analog signal to increase the sound intensity.

For connecting together digital audio devices I²S (Inter-IC Sound) is used, which is an electrical serial bus interface standard. It communicates audio PCM data in between integrated circuits of an electronic device. Due to separation of clock and serial data signals by the I²S bus, receivers become more simpler than those receivers of an asynchronous communications systems. Figure 7 illustrates the schematic of I2S, the three I2S pins BCLK, WS, and the SD pins are connected to ESP32 as follows.

ESP32 Pin 25 = LRC Pin of the Module = Word Select pin of I2S

ESP32 Pin 26 = BCLK Pin of the Module = BCLK pin of I2S

ESP32 Pin 22 = DIN Pin of the Module = Serial Data pin of I2S

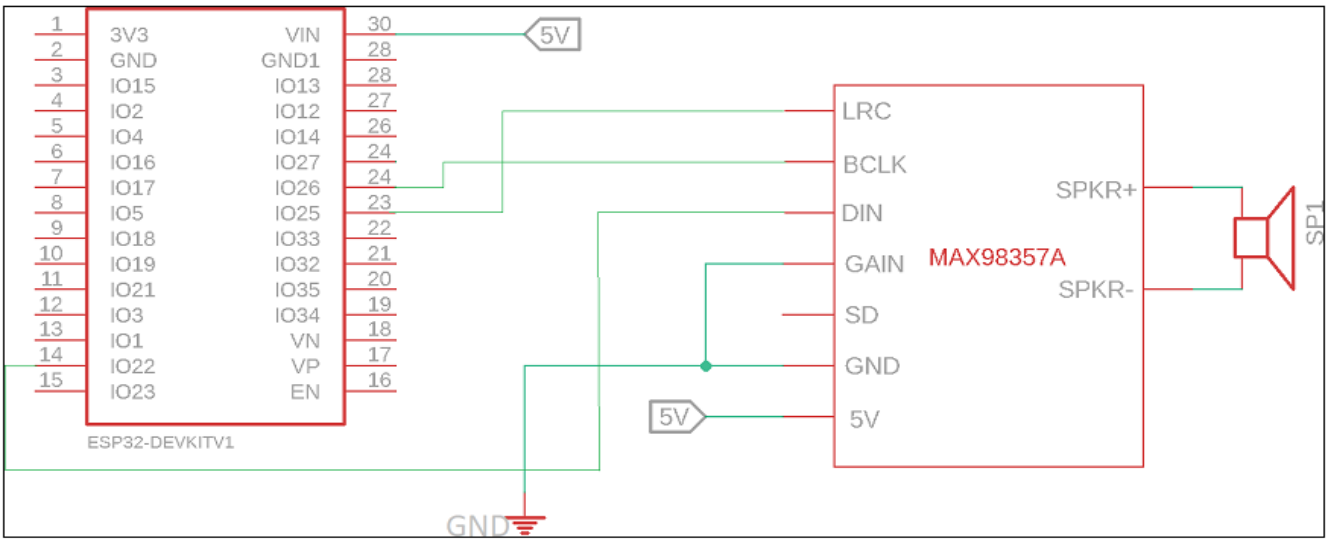

Fig 7 Schematic Diagram of I2S Communication.

IX. RESULT ANALYSIS

The actual model is successfully installed for testing in one of the areca-nut farms of two acre. After installation model achieves all Its objectives set for it as given in Table 4. Figure 8 (a) and (b) shows the view of installed project model from directions. During our testing the entrance of cow and bullocks is averted from entering the farm.

During the day when there is enough amount of solar energy received by the panels, charge controller runs the system on solar panel, simultaneously charging the battery connected. In the evening time when either sun rays are low or absent, the battery will take over the responsibility of powering the system.

(a) (b)

Fig 8 (a) and (b) Different Views of Installed Model.

Table 4 Performance Analysis Data

NAME	ACTION	EXPECTED OUTCOME	OBSERVED OUTCOME	STATUS
SOUND	STREAM AUDIO THROUGH SPEAKERS	Play the different sounds stored in a microSD card sequentially for specified duration	System played the different sounds stored in a microSD card sequentially for specified duration	SUCCESS
ELECTROME CHANICAL ROTATION	ROTATE THE SPEAKERS USING SERVOMOTOR	Servomotor rotates in specified angular direction for given time duration	System rotates Servomotor in specified angular direction for given time duration	SUCCESS
FOG LIGHTS	FOG LIGHT ON	Turn ON the fog lights for specified duration at night time	System Turned ON the fog lights for specified duration at night time	SUCCESS
ULTRASONIC SENSOR	DETECT OBJECT	Turn ON the fog light on detection of object	System Turn ON the fog light on detection of object	SUCCESS

X. CONCLUSION

The crop damage by crop raiding animals is the major problem today faced by farmers. Both domestic and nondomestic animals are contributing to this menace. Therefore, an effective solution is to be provided to the farmers. The design and development focus of this project was to devise a ESP32 microcontroller-based device, which is reliable, cost- effective and user friendly. This project is a solar powered system and it is deprived of any sensors, so there is no detection-based prevention, instead the system operates continuously to prevent crop vandalization by rogue crop raiding animals. The project is also a boon for crop raiding animals as it avoids the traditional practice of electric fencing around the agricultural field, hence safeguarding animal lives as well. The system is cost effective solution for maximizing agricultural farm, crop prediction, and wild animal prevention. It also prevents man vs wild conflicts, thereby saving the human lives. In this proposed system the process is the fully automated process of the propose model is not causing any hurt to animals during the repelling action.

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