AGRI-IOT TECHNIQUES FOR REPELLING ANIMALS FROM CROPLAND

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Abstract

With the ongoing growth of the Internet of Things (IoT), multiple large-scale IoT platforms can now analyze a high proportion of sensor data streams. These IoT frameworks are used to gather, process, and analyze data streams in real-time, making it easier to deliver smart solutions for decision-making. Current IoT-based solutions are primarily domain-specific, delivering stream processing and analytics for a narrow range of applications (smart cities, healthcare etc.). In this paper, we are proposing an Agri-IoT based model for continuous guarding of the agriculture field in order to protect the crops from being destructed by animal-raiding. These animal- attacks mostly happen in some specific months of the year. So a proper guarding system of the agricultural areas can be done using IoT techniques. In this research paper, a crop protection system of the field has been proposed using Agri-IoT Techniques.

Keywords: Agri-IoT, Crop protection, Agriculture, IoT, Field Guarding, Animal attacks

1. Introduction

Precision farming or smart farming is an agricultural management approach centered on monitoring, assessing, and responding to crop variations between and within fields. Precision agriculture promotes smart farming, which incorporates real-time data collecting, parsing, and analysis, as well as automation technology in agricultural procedures, allowing for better overall farming operations and management, as well as better informed decision-making by farmers. Agriculture is highly unpredictable due to it's rely on environmental and climatic conditions (e.g. rain, temperature, humidity, hail), unforeseen events (e.g. animal diseases, pests), and price swings. IoT technologies can assist us in more effectively securing our crops. The need for more settlements on the land is influenced by rapid population increase(Sandeep Kumar et al., 2018). Farmland is likely to be built as a result of considerable transition to new land uses, such as dwelling or the more economical land use. Furthermore, growing population on the land during this time period has the tendency to diminish agricultural production. The Internet of Things (IoT) will be the cornerstone of Smart Computing in the future. The transition of existing technology from the home to the office into "next-generation computing" is a critical aspect. Along with increasing the crop production in limited resources, it is also very necessary to decrease the crop-loss because of various factors(Siddhant Kumar et al., 2019).The factors of crop losses or crop damages can be flood, fire, drought, wildlife attacks or pests and diseases in crop. Flood is a natural calamity. And it is impossible for us to solve out this problem alone. But next two causes i.e. Pests/Insects and Animal Attacks can be prevented by using the given proposed IoT model. In rest part of this paper, Section 3 describes the methodology used for prevention of crop loss, Section 4 describes the results and discussions and section 5 tells about conclusion part.

2. Objective and Problem Statement

Crop invasions by animals are a common and serious problem that causes major losses. Buffaloes, pigs, goats, birds, and fire have all caused damage to farm crops in the past. As a result, the goal of this study is to use IoT techniques to help solve the problem of these attacks to some extent. In this paper, we have proposed models to:

- Sense the various animals coming to the field especially during nights.
- An ultrasonic sensor radar to guard the agriculture field from animal attack in highly probable months of the year
- Prevent the animals from attack using Repeller devices by frequency production to frighten the animals.

3. Methodology

Buffaloes, pigs, goats, birds, and fire have all caused harm to farm crops in the past. Producers suffer enormous losses as a result of this. Farmers are just reluctant to erect barricades across complete fields or stay on the land for 24 hours to protect it(Raju, n.d.). As a result, we've suggested a fully automated method to safeguard crops from wildlife and fire. This Proposed System would transform the typical inert scarecrow into a smart, adaptable scarecrow competent of repelling both birds and dangerous animals.

3.1 Working Principle

In this proposed model, By combining sensors and Repeller Devices that can detect animals in the area of a farmer's crop field, a classic scarecrow sculpture will be upgraded and expanded. We're utilizing a GSM module to send the output signals of these sensors to the farmer's phone, so if there's any activity noticed on the farms while he's gone, he'll be notified (Journal & Engineering, 2019). Here, in Figure 1, we have shown the diagram of proposed model.

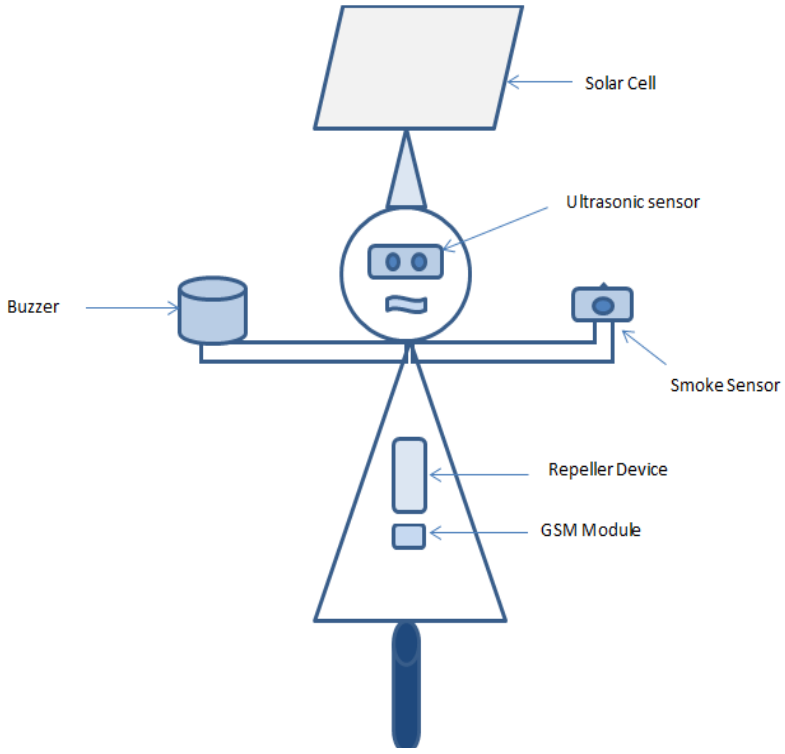

Figure1. Proposed model in shape of traditional scarecrow

This model is going to use the working algorithm as mentioned by (Haque et al., 2021). In this algorithm it is clearly described how the Animals in farm will be detected as soon as they will enter the cropland and message will directly be sent to farmer to take a proper action.

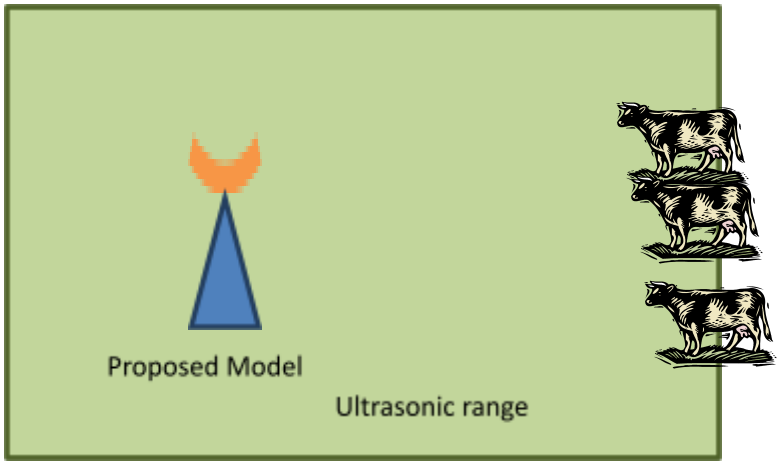

Figure2. Animal Invasion Detection by Proposed Model

Here, Figure 2 is showing the working principle of the proposed model. It works day and night for guarding the agricultural field. As any animal attack is done in field, it detects the animals by its ultrasonic sensor device and buzzer the alarm, generate the Repeller frequency to frighten animals and simultaneously send message to farmers.

4. Data and Results

The factors of crop losses or crop damages can be flood, fire, drought, wildlife attacks or pests and diseases in crop. Here is a survey data done on some farmers to find out the percentage of crop loss due to various factors. Flood is a natural calamity. And it is impossible for us to solve out this problem alone. But next two causes i.e. Pests/Insects and Animal Attacks can be prevented by using the given proposed IoT model.

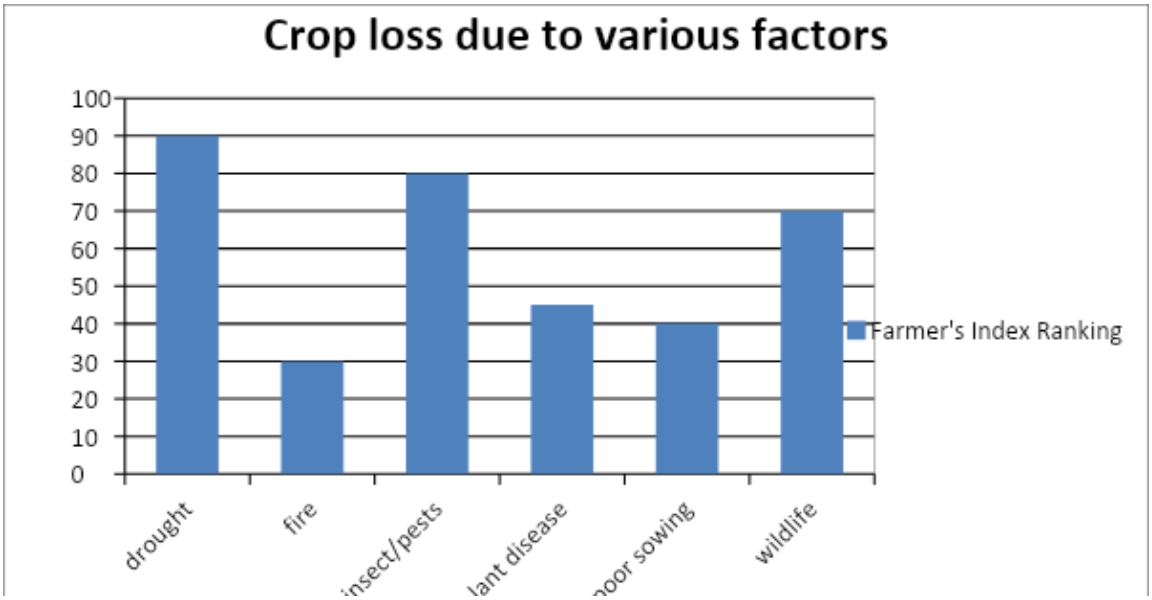

Chart1. Various factors of Crop Loss in Agricultural Field

In the above given Chart 1, the survey result is being plotted in which various farmers of a region were asked about the various factors of crop loss and the severity of loss due to that factor. In the graph, it is clear that flood, insects/ pests and wildlife-attacks are top 3 causes of crop destructions. Thus in this research paper, we have tried to give the solutions to solve out this problem using IoT Technique(Journal & Engineering, 2019).
The fundamental operational concept of this device is to employ ultrasonic frequencies to deter animals from farming, especially while the farmer is not present. Ultrasonic devices work by releasing high-frequency, short-wavelength sound waves that are too loud for the human ear to hear (generally frequencies accepted more than 20 kHz)(Chen et al., 2007). Due to physiological limitations in the eardrum, humans are normally unable to sense sounds higher than 20 kHz, but there are substantial differences between people, especially at such high frequencies. Ultrasonic frequencies can be detected by bats, dogs, and rats, for example (Ajit Kumar, 2020). In some cases, the device's frequency can be modified depending on the type of device and the animal species it repulses. The Repeller Frequency for different Animals is shown in **Table 2**.

For this, we have taken various observations on **Rabbits and pigs** using the given setup and analysis is done on that. Following are the data and analysis on those observations to draw some conclusions. Keeping the distance constant for these animals, we have observed whether the animals are repelled or not. **The maximum range of Repeller Device used in this experiment is 35000Hz to 65000Hz. And for ultrasonic sensor, maximum distance is 21 meters (70 feet).**

ANOVA: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10	356	35.6	9.6
Column 2	10	382	38.2	7.066667

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	33.8	1	33.8	4.056	0.059209	4.413873
Within Groups	150	18	8.333333			
Total	183.8	19				

Table1. Analysis of Variance to show whether the observation is significant or not

So, from the given ANOVA test, it is clear that the observations of experiment are significant as (**F-calculated value) < (F-Tabulated value) (i.e. 4.056 < 4.41).** Thus the experiment is significant. Here, below in Chart2, experimental data chart can easily be shown.

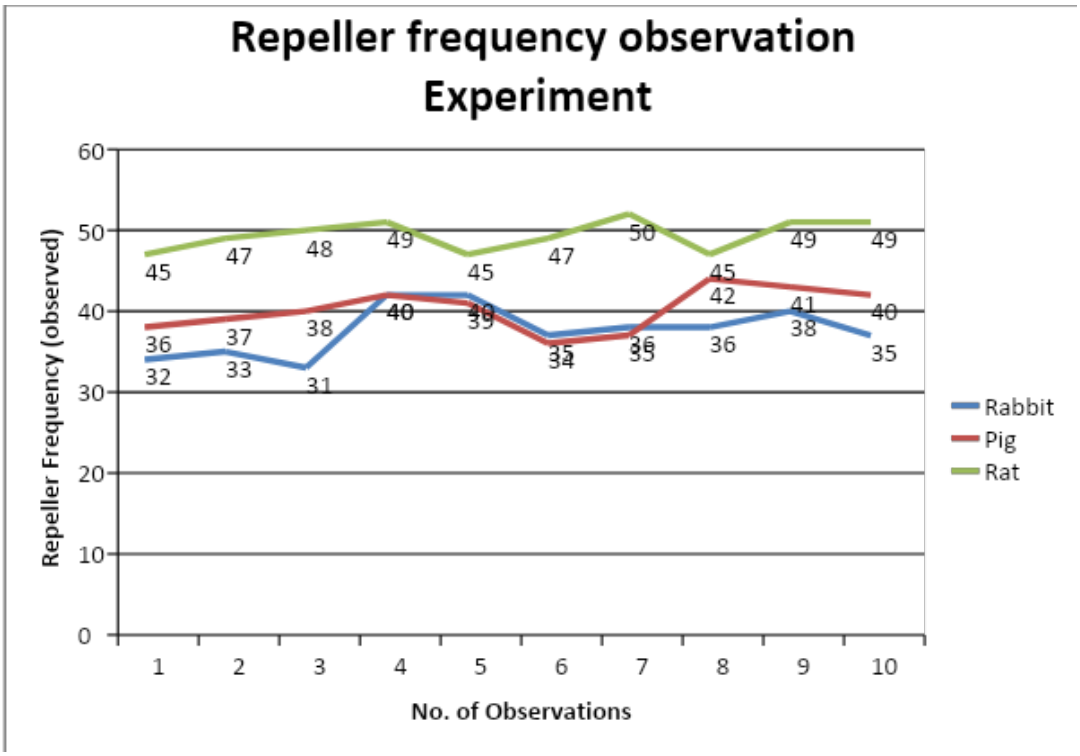

Chart2. Experimental data on Repeller Frequency of few Animals

4.1 Repeller Frequency for various Animals:

Animals	Frequency Range (Hz)
Pig	45-45000 Hz
Rabbit	360-42000 Hz
Human	31-17000 Hz
Rat	500 -64000 Hz
Dog	Up to 40000 Hz
Cat	100-60000 Hz
Bat	1000 – 100000 Hz
Grasshoppers	100-50000 Hz

Table2. Repeller Frequencies of some Animals & Insects (Fay & Popper, 1994)

Now, Figure3, Figure4 and Figure5 are showing the simulation experiment of proposed model using RED LED at output PIN instead of frequency generator Repeller device (Sonal, Shrivastava, & Mishra, 2021).

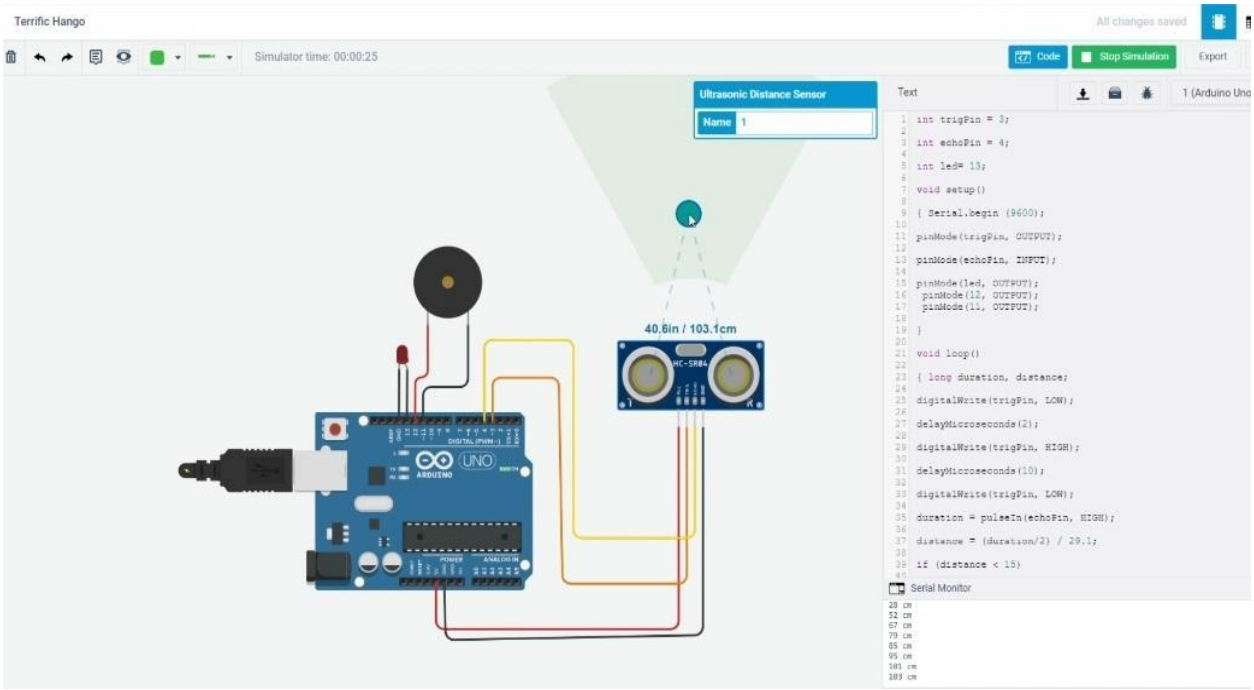

Figure 3. Object beyond the field area range (LED OFF)

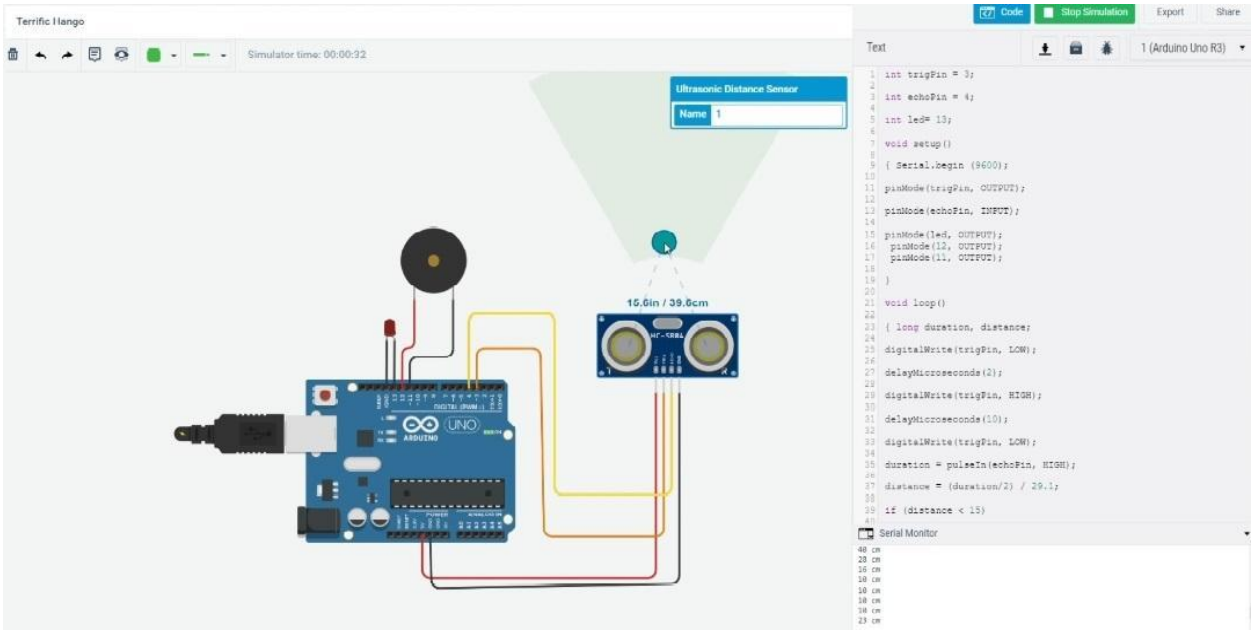

Figure 4. Object at the boundary of field (LED OFF)

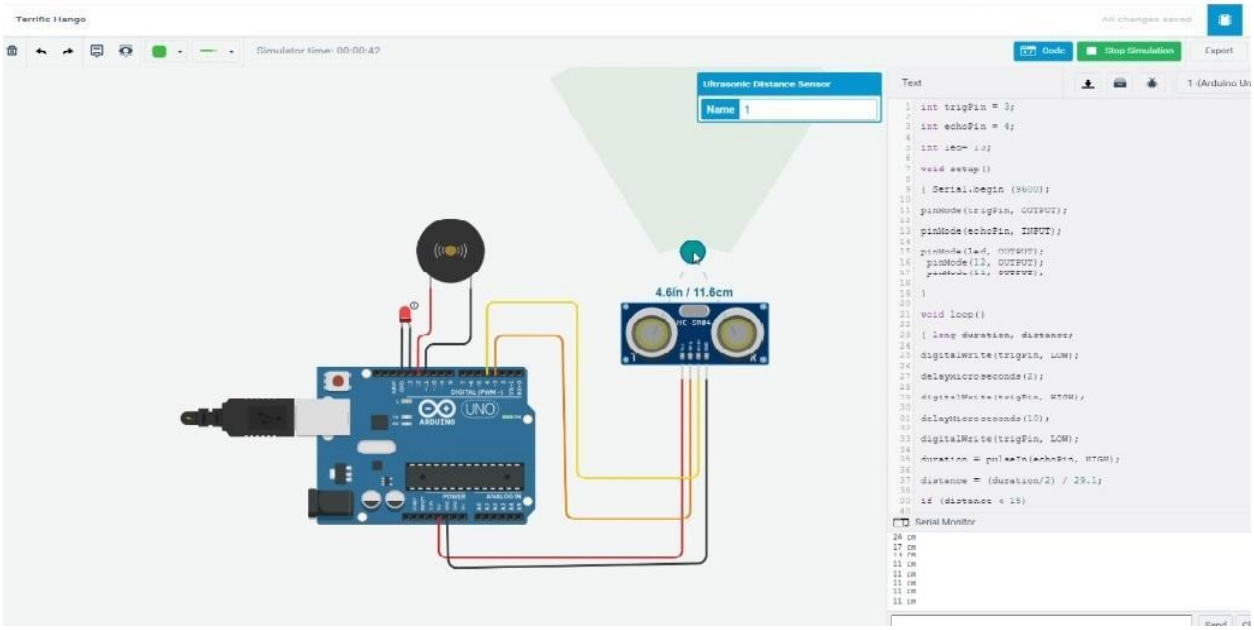

Figure 5. Object inside the Field Range (LED ON)

As a result, the above simulation of the experiment demonstrates how the proposed model works. The item does not trigger a response from ARDUINO until it enters the field range, as indicated in the diagram above. Only when the object enters the field does the red LED turn on in the experiment. As a result, the LED can be replaced with a frequency generator Repeller device, which generates frequency as the animal enters the field(Haque et al., 2021).

In our proposed model, we can also add the guarding system to the field. We can add radar software with ultrasonic sensor to visualize the field area in 180º cover vision. For this we simply have to mount the ultrasonic sensor on the Servo Motor(Samarasinghe, 2019)(Louis, 2016). As servo motor will rotate in 180º angle and can continuously guard the agricultural field especially during night. As ultrasonic sensor can work efficiently even at nights also.

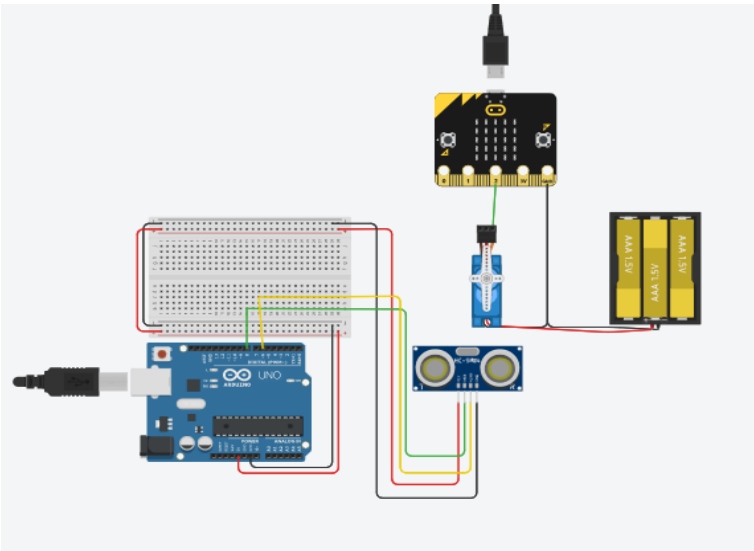

Figure 6. Circuit diagram for ultrasonic Radar coverage

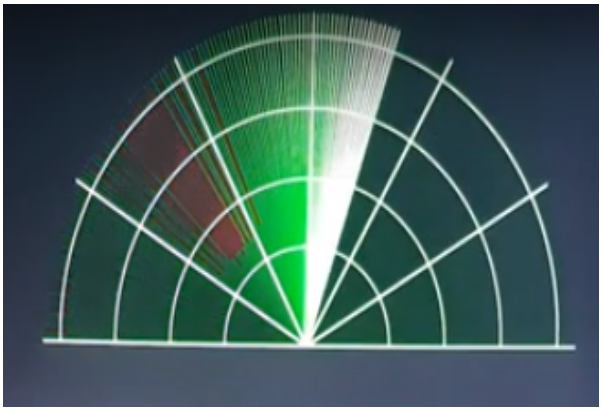

Figure 7. Agricultural field gurding using RADAR software in sensitive months

In the above Figure 6 is showing the circuit diagram for attaching the RADAR coverage with ultrasonic sensor and in given Figure 7, the additional security can be given to crop fields by showing the field condition visually using this RADAR software with Ultrasonic sensor(Haque et al., 2020). This csn be used especially in highly sensitive months when there are more chances of invasion by Animals(David et al., 2020). So the above diagram explains the Radar guarding of the crop field.

5. Conclusion

At the conclusion of this study, we can say that the proposed model is intended to safeguard crops from animals. As a result, farmers should not spend their earnings to protect their field crops. This prototype, like a scarecrow in the field, will operate as a protection against wildlife species due to its technical applicability and structural characteristics. To acquire the competitive advantage necessary to serve the population's expanding demands, agricultural farms would have to adopt cutting-edge technologies. Agricultural IoT (Internet of Things) solutions can aid the economy in improving productivity, cost reduction, waste reduction, and produce quality (Baranwal et al., 2016). Smart farming is a technique that employs sensors to track watering activities and manage crop security in the crop land, and it is centered on the Internet of Things. Farmers can keep an eye on their farms from anywhere in the world. The proposed approach's main purpose is to preserve harvests in any situation and to aid farmers in monitoring their field from anyplace.

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