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Implementation Of Artificial Intelligence In Crop Monitoring For Agriculture

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ABSTRACT

Farmers have stopped cultivation in present days due to not being able to get the facilities which would help them in the process. On top of this, animals are causing other issues that frustrate the farmers and drive them to abandon crop cultivation; You can get our paper immune to the latter. Paper aims to scare the animal involving our fields to destroy. Wildlife intervention often leads to destruction of locally owned crops. This creates protection of yield and to protect the yield, those organisms need to be terrified — which is the only way of saying that the farmer is a worry to those organisms." Farmers cannot constraint the entire fields and guard it. Due to time and resource constraints, it is impractical for farmers to monitor and guard whole fields by hand. Thus, there is an urgent requirement for novel, automated systems that can effectively deter animal poaching in a safe manner.

The use of such technologies allows farmers to protect crops, improve productivity, and minimize the need for real-time human intervention. This article describes an everyday application that can be used to prevent crop-damage on agriculture farms by animals. To address this problem, this research utilizes Global System for Mobile Communication (GSM) and Short Message Service (SMS) technology to present a useful, automatic system for the farmers. The proposed system approach depends on mobile telecommunication technology to send instant notification to inform farmers of a possible animal attack in their farms. This method gives instant responses by applying detection techniques along with GSM based alerts, which reduces the level of crop loss and yield security. The study endeavours to adapt the existing mobile communication infrastructure that is readily accessible, affordable, and conducive to a range of farmers in diverse locations, maximizing usability and cost efficiency. This Research paper it helps the concept of identification of a specific target by an image processing system and generating intolerable frequency than the targets audible range frequency.

Keywords: *cultivating crops, farmers, Robot, frequencies.*

1. INTRODUCTION

It is not possible for the farmers to constraint the field and to guard it at all times. In present days, most of the farmers stopped cultivation due to lack of facilities favourable for the process. In addition to this, animals are creating another problem, which stimulating the farmers to stop cultivating crops. The latter can be solved with the help of our paper. This can be achieved by installing a robot which will monitor the farm continuously. It will compare the frames of the camera with the earlier one. The captured image is examined as it is trained for two different datasets (eg: Monkey and Dog) and respective intolerable frequency sound will be generated. Animals are annoyed by this sound, and they leave the place instantly.

Although animal attacks are a serious public health issue in rural India, with devastating impacts on human life and agriculture, they mostly go unrecorded. The attack, primarily caused by wild animals, such as elephants, wild boars and tigers, leads to both destruction of crops and agricultural lands, as well as lives in some areas. These attacks occur due to the absence of a considerable detection and prevention system to alert farmers or communities of imminent threats.

One without a proper alert system in place leaves farmers and residents vulnerable, making it difficult for them to protect their crops and families. It is often a futile effort to stop large movements of animals or a sudden attack with traditional methods such as a fence or deterrent, leaving communities powerless, limited and powerless on the ground.

To mitigate these risks, there is a growing need for implementing modern technologies, such as sensor-based detection systems, motion detectors, and mobile communication alerts, that can offer real-time notifications of animal movements. By providing early warnings, such systems can help farmers take preventative measures, safeguard their crops, and prevent human-animal conflicts, thus reducing the devastation caused by animal attacks

Fig.1. Animal Attack in the crops

These individuals are vulnerable to their destiny because they lack adequate safety measures. Consequently, an effective detection system could help to save both their lives and the crops. The interference of animals often leads to the destruction of crops belonging to the villagers.Artificial Intelligence (AI) has revolutionized traditional farming practices. This innovation has also fueled the rise of precision agriculture, which maximizes crop yields with minimum resource wastage and optimizes farming practices. AI empowers farmers to make data-driven decisions, optimize resource allocation, and enhance productivity sustainably through advanced technologies like machine learning, computer vision, and data analytics. Crops and paddy fields cannot always be fenced, making them prone to be eaten and destroyed by animals like cows and goats. Commonly this leads to serious waste of their harvests leading to big loss for farmers.

In this regard, an effort has been made in this study to explore how to make best use of mobile communication technology, utilizing the Global System for Mobile Communication (GSM) and Short Message Service (SMS). This model helps farmers identify intrusion of animals in real-time and save their crop from destruction. The incorporation of GSM technology in the system allows farmers to be conscious even if they are far away from the farm and it becomes accessible and practical along with the affordability of the farmers as well as the system ensures the betterment of agricultural production. Application Of Wildlife and Animal Detection system on Edge node This device serves a dual-purpose application, as it helps to stop the entry of wild animals into rural areas, as well as providing surveillance. Farmers would have to spray a mixture of rotten eggs over their crops. Alternatively, wild pigs and deer stay away from the crops due to the strong smell of the solution. Also firecrackers are used to drive away wild elephants, which create havoc in farming fields. The loud noise and sudden flashes create a terrifying environment that prevents elephants from coming near the area.

By selecting crops with less nutritional value while combining traditional practices with new age surveillance tech, these organizations have ensured that damage to crops done by wild animals can be closely monitored, managed, and mitigated with zero human risk to farmers in the area. All of these studies are based on field-based surveillance using animal ward off system to reduce crop loss by wild animals.

In addition to providing security, this system uses RFIDs to distinguish between an invader and an authorised person. Multiple Passive Infrared (PIR) sensors are strategically positioned throughout the area to detect any motion. Consequently, when movement is identified, a camera is activated, enabling live surveillance. It involves the mechanization of different methods to deter wild animals from encroaching on fields and damaging crops, including the utilization of an electronic explosion.
In 2013, Suryawanshi created and evaluated a solar-powered device that emits sound to scare away birds. The study also investigated the specific sound frequencies used in the bird scarer system; a device designed to protect crops from bird-related damage. This system consists of several key components that work together to generate and broadcast predator sounds, which are intended to scare birds away from agricultural fields. The main components of the bird deterrent system include:

The photovoltaic (PV) panel acts as the main power supply for the whole system, thus improving the energy saving and carbon footprint of the system by using solar energy.

The dry-cell battery pack acts as an energy storage device, contributing to the overall operation of the device, when solar energy is not available, namely at night.

The electrical converter is the most significant component in the energy conversion, as it converts the energy that is generated from the light energy from the photovoltaic (PV) panel into an efficient format that can power the different elements of the system.

The MP3 player serves as an archiving and playing device for selected predator calls or distress sounds. The amplifier is used to boost the audio signal, so the predator sound reaches a volume loud enough to be heard over a large area.Speaker: The loudspeaker is used to broadcast the predator sounds effectively across the agricultural field.

Camouflage: The system is designed to blend into the environment, minimizing its visibility and reducing the likelihood of birds becoming accustomed to it.

The basic idea is to play predator cries, carefully chosen to imitate the natural predators that birds would find threatening. These noises are designed to scare away birds, preventing them from destroying crops. This system works well because the predator calls are very scary for birds, and the loud, surprising presence of a predator can ask-issomething birds do to disrupt their normal behaviour.
This bird scarer is capable of protecting crops from damage caused by birds by harnessing the energy emitted from the components it is composed of, while the solar panel gives it independence as it does not require a power outlet to operate. Additionally, during tests, birds have been reported to visually validate the existence of a bona fide predator versus a fake object before flying away. The Falcon (Buteolagopus) sound was the best out of the 22 soundscapes. The camouflage, sound quality and volume of these bird scarers were all deemed critical.

Muminov et al. (2017) created a solar-powered device that keeps the birds at bay by emitting highly effective sounds that scare them away. The primary components of the repelled system include a 7W, 12V solar panel, a sophisticated PWM solar charge controller, a 12V battery, an MP3 player, a Stereo 20W Class D Audio Amplifier (MAX9744), two 20W speakers, three sonar or PIR sensors, and an Arduino UNO controller. By utilizing a personal computer, the individual who preys on others within a household transferred phone conversations and specific auditory cues, such as the sound of gunshots, onto an SD Card in MP3 format. The amplifier amplifies the loudness of the signal transmitted to the speakers. The underlying principle of this bird deterrent device is to utilize a stimulus to control feral avian species. The birds can take flight by responding to various forms of sound stimuli.

2. DESIGN

Design of the Rover/Robot

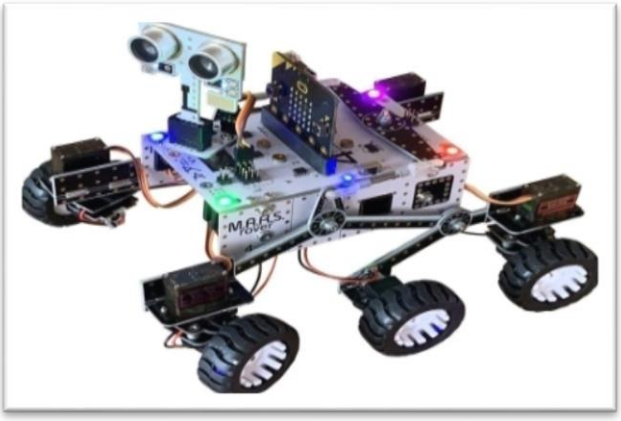

Fig.2. Rover Robot

Many industrial sectors are moving towards flexibly, reliable and scalable system and component-wise architectures in their business process with e-services that help in automation of processes and reduction of more costs due to integration, maintenance and development. It is from the need to become more efficient; to improve operations and better meet an ever-changing market need that this transformation is taking place. create dynamic process-based applications for global business in the E-Industry 4.0 era, turn business processes into e-services and a component-based architecture to enable industrial sectors to provide a potent and versatile instrumentation to bring enhanced operational flexibility, reliability, scalability and cost-efficiency. By doing this, companies not only encourage innovation, reduce their time to market, but also quickly adjust to the constantly transforming business landscape. ANother dynamite, high-growth field is robotics, which is focused on creating machines capable of operating independently, and used in manufacturing, space exploration, armament, lab research and more. The kind of robot that is most common in space exploration research is a planetary rover, which intuits a planet's surface and executes a thorough geological examination of it. This kind of rover system is still ad hoc because it integrates its software into its basic hardware. As a result, the entire system is more coherent, coupled, brittle, not extensible, high maintenance, and impossible to re-purpose.

A robotic rover is a type of unmanned ground vehicle (UGV) that can walk, roll, or fly over rough terrain. Des developed

for cell exploration by NASA before do the organized explore and gather information in annuated and inaccessible destinations these were are designed.

Despite the challenges posed by the extreme environment in which they operate, most traditional space exploration rovers are expensive to produce as they entail the use of advanced materials, sophisticated software systems, and strong engineering to ensure that they can endure the harsh conditions of the extraterrestrial environment they are designed for. Moreover, they are generally quite large and complex and thus not easily transferable to everyday applications.

Efforts are ongoing to develop more cost-effective, compact, and versatile rover designs for a broader range of uses, including agriculture, search and rescue, and environmental monitoring. These advancements aim to make robotic rovers more accessible for various industries while maintaining their reliability and functionality. Robotic rovers serve as a critical tool for bridging the gap between challenging tasks and human safety, minimizing the need to place workers in potentially fatal or hazardous situations. These versatile machines can navigate dangerous or inaccessible environments, performing tasks that would otherwise put human lives at risk.

Rovers can be instrumental in assisting safety authorities by gathering real-time data and insights in scenarios such as disaster response, hazardous material handling, and environmental monitoring. Additionally, they play a significant role in search and rescue operations by accessing hard-to-reach areas, locating survivors, and delivering essential supplies, thereby enhancing efficiency and safety during critical missions.

By leveraging robotic rovers, organizations can ensure both the well-being of workers and the success of operations in unpredictable or perilous conditions. In order to meet requirements for carrying out a range of tasks, such as hazardous identification, site surveillance, and monitoring, the design, functions, specifications, and applications of the robotic rover that has been developed in previous years are reviewed.Several analyses follow in relation to the design and development of the proposed robotic rover.

There are two types of rover vehicles: The first type is human-controlled rovers, which are remotely operated and generally instructed to perform a specific task. Each of the communications between the rover and the earth control is carried out via the Deep Space Network (DSN), a worldwide interoperability protocol for the connection with spacecraft communications. Currently DSN is made up of three deep space communications facilities located south of Canberra, Australia, west of Madrid, Spain and in the Mojave Desert in California. Autonomous rovers are the second kind, capable of carrying out specified duties without continual human guidance. The ability of space exploration rovers to adapt to their changing environment, automatically learn about landing sites, survive a disaster or failure, work for extended periods of time, and carry out predetermined tasks without human assistance sets them apart. The cost of developing, testing, and deploying robotic rovers can reach hundreds of millions or perhaps billions of dollars.

Conventional rover systems employ the Web to contain two fundamental components: a software program that manages the rover's hardware and offers all necessary features, and a high-end digital computer capable of doing calculations at extremely high speeds. In contrast, a service-oriented architecture would separate the software from the rover's web page and install it on a server, either on Earth or in a space station in low earth orbit, that could connect to the rover remotely to provide the required features.

Design considerations

To suit The two wheel drive robot chassis is attached with the L293D driver which is guided by Arduino uno that controls the path by a c program that follows a black line on the ground as there should be artificially designed environment to run the device also this idea is adaptable like if the crop height is more than the rover then the same phenomenon is added to a drone which is manually operated or fixed to a longitudinal pole at the centre

Hence we can come to the conclusion that the design may or may not change but the photo processing is the key process, though the rover with L293 driver chassis rolls well in any terrain of crops

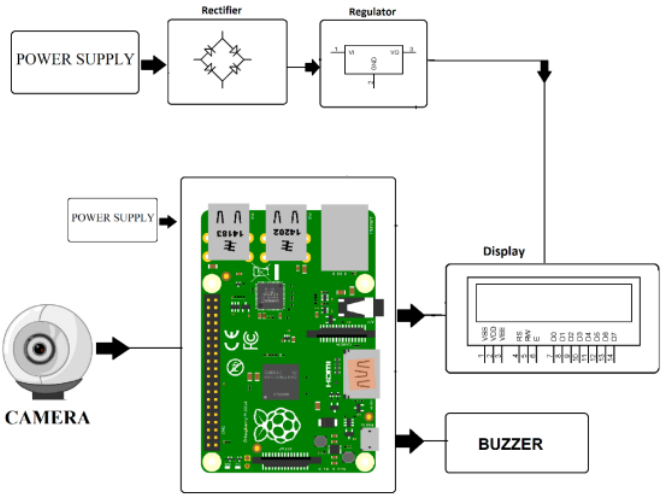

Fig.3. Arduino uno with L293D driver

3. SOFTWARE REQUIREMENT ANALYSIS

These days animal repellents are being used in crop production to save fields from the animals. one of the ways is to use ultrasonic sounds when an animal approaches the field. however, animals having different audible ranges, the same frequency range doesn't work for all the targets.

unlike the present repellents in the market which are having low visibility range, our device captures multi-directional visibility by moving around the field, to run a robot on the embankment of the field there should be a proper atmosphere around it like plain surface, proper track

the operating system used for doing this is raspberry pie 3 provided with a python code that captures the images of the crop and compares with the data sets given in the program and detects the presence of animals and responses through the speaker with the respective frequency, this entire process is done through particular time constraint more like a surveillance camera, following with this the motion of the device is controlled by the Arduino UNO that uses a sensor to detect the path.

There are two software mainly used here

(i) C programming language

(ii) Python programming language

C programming

The Arduino programming language is nothing more than a set of C/C++ functions that you can call from your code. Your sketch is modified somewhat (e.g., automatic production of function prototypes) before being sent straight to a C/C++ compiler (avr-g++). All of the standard C and C++ constructs that avr-g++ supports should function with Arduino. Though the Arduino uno is configured with a code that makes the L293D driver spin the wheels motor suitably, the Arduino build process delivers the brief information.

Python

Since then, Python, as both a programming language and a scripting language, has become essential to the vast majority of Raspberry Pi applications. Python has a very simple, readable syntax which is easy for the beginners to learn. It also has an extremely high acceptance in the programming community, having plenty of libraries, frameworks, and tools to jumpstart the programming journey for novices.

The Raspberry Pi domain's primary programming language is Python, while the Raspberry Pi Foundation also recognizes Python as its official long. Python is really sensitive to indentation, as it uses indentation for scopes. This feature forces developers to write clean and structured code from the beginning. Python enjoys widespread acknowledgment and use in the programming world, and a huge collection of libraries is among its main benefits.

Python with Deep Learning:

A class of machine learning techniques known as "deep learning" uses a collection of algorithms modeled after the composition and operations of the human brain. Artificial Neural Networks are the common name for these algorithms (ANN). Deep learning is a highly popular field within data science, showcasing impressive results in areas such as robotics,

image identification, and artificial intelligence through many case studies.

Keras covers the efficient numerical computation libraries Theano and Tensor Flow, making it One of among the most potent and user-friendly Python frameworks for creating and reviewing deep learning models. One major advantage is that you can begin working with neural networks in a straightforward and entertaining way.

Our Raspberry Pi can only keep 3 to 4 data sets due to limited storage and RAM capacity, as the CPU will take a long time to decode if the number of datasets is more.

Implementation Difficulties

High Initial Investment: Setting up and maintaining AI systems can be costly.

Availability and Verification of Data: Accurate predictions require complete and reliable datasets.

Technical Expertise: Farmers need training to use AI tools effectively.

Connectivity Issues: Rural areas may not have the infrastructure needed to support real-time data transmission.

4. HARDWARE COMPONENTS

1. Two wheel drive robot chassis
2. Arduino UNO
3. Motor driver Shield
4. Raspberry pi
5. SD card
6. Buzzer
7. Webcam C270
8. Ultrasonic sensor
9. Line array sensor

Output screens

The full coding part can be checked through connecting the raspberry pi to the computer and required editing can be done there, and there is no display screen here the only output is by detecting the creature and produce its set of intolerable frequencies from the respective datasets given ,as there is no digital screen or display needed

Two wheel drive robot chassis:

The ideal mechanical base for your robotics projects is this do-it-yourself two-wheel drive robot chassis. All of the mechanical and hardware parts needed to assemble your robot are included in this kit, including wheels, motors, chassis, nuts, and bolts. All you need to do is add your Arduino/Raspberry Pi and motor driver to begin programming your robot. It provides a sizable area with pre-drilled holes for mounting electronics and sensors in accordance with your needs. With this robot chassis, you can expedite the robot manufacturing process and have your mechanical platform ready in a matter of minutes. enables you to focus your time and energy on programming your robot instead of creating a unique platform from scratch.

Arduino UNO:

Additionally, it was Arduino's first USB board. It is regarded as a strong board that is utilized in many different tasks. The Arduino UNO board was created by Arduino.cc.

The ATmega328P microprocessor serves as the foundation for the Arduino UNO. In contrast to other boards, like the Arduino Mega board, etc., it is simple to use. Shields, additional circuits, and digital and analog input/output (I/O) pins make up the board.

Six analog pin inputs, fourteen digital pins, a USB port, a power jack, and an ICSP (In-Circuit Serial Programming) header are all included in the Arduino UNO. The Integrated Development Environment, or IDE for short, is the basis for its programming. Both offline and internet platforms are compatible with it.

Motor driver Shield:

Based on the L298 dual full-bridge driver, the Arduino Motor Shield can drive inductive loads like solenoids, relays, DC motors, and stepping motors. With your Arduino board, you can use it to drive two DC motors and independently regulate their speed and direction. Other characteristics include the ability to measure each motor's motor current absorption. Due to the shield's compatibility with TinkerKit, you may easily develop projects by connecting TinkerKit modules to the board.

Dual Motor Control: Drive two DC motors simultaneously, each with independent speed and direction control.

Current Measurement: Monitor the current absorption of each motor, which is useful for detecting overloads or estimating torque.

Inductive Load Support: Besides motors, it can handle solenoids and relays, making it suitable for diverse applications.

TinkerKit Compatibility: The shield is designed to work seamlessly with TinkerKit modules, enabling rapid prototyping and expansion of projects.

Easy Integration with Arduino: Plug-and-play functionality simplifies setup and integration with Arduino boards.

Raspberry pi :

Multiple generations of each of the Raspberry Pi's three series have been made available. While Raspberry Pi Pico boasts an RP2040 system on chip with an integrated ARM-compatible central processing unit (CPU), Raspberry Pi SBCs have a Broadcom system on a chip (SoC) with an integrated ARM-compatible CPU and on-board graphics processing unit (GPU).

Webcam C270

720p video calling is possible with the Logitech C270 HD Webcam, which has automatic light adjustment. This HD webcam works with all instant chat apps and has an integrated microphone for reducing background noise.

Ultrasonic sensor:

The target object's distance is measured by an electronic device that converts the reflected sound into an electrical signal using ultrasonic sound waves propagating through air.

Line array sensor:

Sensor Tracking Module with 5 Channels Based on the infrared reflection sensor, infrared sensors are frequently employed in smart automobile tracking. The sensor's infrared emitting diode emits infrared radiation constantly. The infrared receiver receives and outputs analogue values when the emitted infrared rays are reflected by the object. The object's color and distance are related to the output analogue value. The analogue value of the five outputs is used to determine the tracking line's position.

5. FLOW CHART

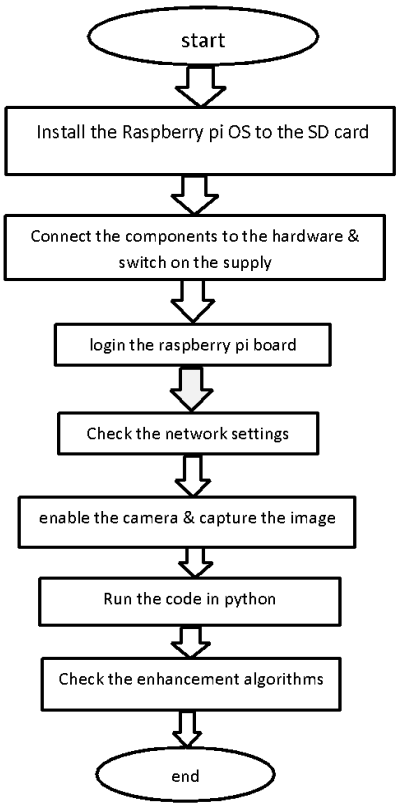

Fig.4. Flow Chart

6. TESTING

Purpose:

The purpose of testing is to check for possible faults of the system under development and allow the corrected fault to function as expected. Testing is a key part of software development, as it helps programmers detect bugs, errors, or inconsistencies in the code that might affect performance or the user experience.

Test Required: Testing is a method to check whether the inner aspect of the code (like a single function or component) or the overall functionality of the app is working. JComboBox Unit testing, Integration testing, system testing and many of these other type of testing help make sure that the software works as expected and how it behaves in different situations.

By systematically identifying and resolving faults testing improves the overall reliability, stability and quality of the application, which results in better user product. Unit testing ensures any bugs and reliable performance of the code written under various conditions. Testing allows to prevent bugs and to check if the software is working. You have two main approaches to testing which further break down into three kinds — white box, black box and grey box.

White box testing:

White-box testing is a method used to assess an application by examining its source code. White box testing is a software testing technique where the tester has knowledge of the internal structure of the software being evaluated. The development of software typically involves testing at the system, integration, and unit levels. The main objective of white box testing is to verify the correctness of an application's operational flow. It involves the comparison of a predefined set of inputs to anticipated or desired outputs, with the objective of detecting errors when one of the inputs fails to provide the intended result.

Black box testing:

Testing the functionality of the Application Under Test (AUT) without examining the internal code structure, implementation specifics, or internal workings of the software is known as "black box" testing. This type of testing relies entirely on software specifications and requirements.

Black Box testing focuses solely on the software system's inputs and outputs, with no regard for the software's internal knowledge.

Grey box testing:

Grey box testing is a technique for testing a software product or application with only a rudimentary understanding of its internal workings. The goal of this testing is to find faults in an application caused by incorrect code structure or improper application usage.

Context-specific issues relating to web systems are frequently detected throughout this process. It expands the range of testing by specifically targeting all levels of any complex system.

Gray Box Testing is a software testing technique that incorporates the advantages of both white box and black box testing.

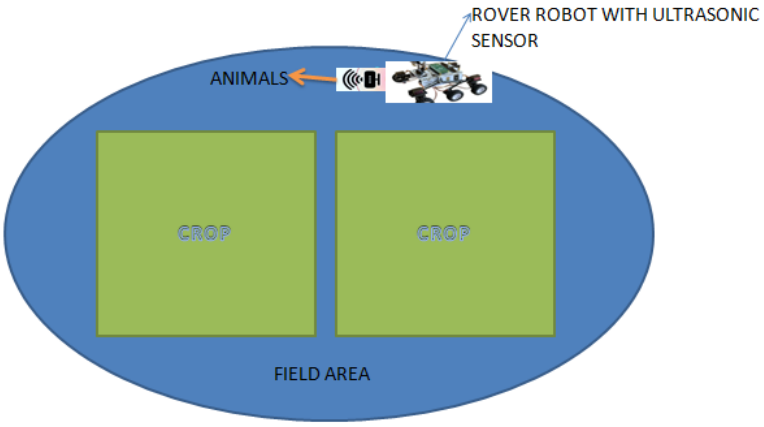

Fig.5. Model- Predicting Animals in Field

TEST RESULTS

Testing is done in the artificially created field and the functional tests are also conducted. Testing is conducted in two stages. They are:

Testing the robot

1. Ensuring its line following motion

The robot is tested for its motion around the artificial field, ensuring the robot moves in the desired path created around the field.

2. Image detection-prediction and producing the sound

The raspberry used is tested for image detection and prediction with the help of camera interfaced to it and controlling the buzzer based on the result obtained from the image prediction process.

All the above mentioned tests are conducted successfully and no defects are encountered.

7. FURTHER ENHANCEMENTS

This idea can be further developed by using a GSM module or by Ethernet (IOT) support to automate the procedure of detecting and processing along with sending the result to the respective device which can be remotely operated, so that there can be complete security and surveillance to the crop or field, we may also place a stability sensor in order to balance the device it passes through rugged surface although this idea can be employed to any of the adaptable model, based on the type of crop its height, size for example for sugarcane, paddy etc ,the device can also be made as resistant to all kind of typical weather conditions ,the camera can be used better version which is compatible with the raspberry for better results in capturing also the objects that are too small due to more distance.

Future Trends:

Blockchain is an essential piece for enhancing transparency in the food supply chain.

The integration of artificial intelligence on market platforms greatly facilitates the direct establishment of links between agricultural producers and consumers by using predictive analytics.

Deep Learning and Reinforcement Learning Techniques used in State-of-The-Art Versions of Ai Models.

Localised solutions may include development of AI tools tailored to specific soil and climatic conditions of a specific region.

8. CONCLUSION

From the experimental and analytical studies, several parameters were found to influence the performance of the image processing animal repellent as our device is just a prototype, when it comes to the real time usage better model of pi, camera range that can detect anything from a far distance and a rigid body can be designed for reliability, and the results, we obtained are accuracy in detection of the species and response of the animals is spontaneous.

Crop monitoring enabled by AI is transforming agriculture by increasing sustainability and production. The future of farming is becoming more data-driven, efficient, and environmentally friendly due to continuous developments in AI and associated technologies.

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