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PROTECTION OF CROPS FROM ANIMALS AND PROPER USAGE OF RAIN WATER USING IOT AND ML

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Abstract: Agriculture is the primary occupation in our country for ages. In order to increase the productivity of the crops and to minimize the expenses of agricultural practices, various IOT methods have been adopted. This paper proposes an integrated solution for agriculture crop protection by the combination of advanced technologies. The system incorporates Arduino-based automation with a range of sensors coupled with responsive mechanism such as relay, water pump, H-bridge and DC motor for protection. The system restricts the entry of animal to the crop through IR sensor using a Laptop camera employing YOLOv5 algorithm. Just when an animal is detected, an alarming sound along with light is used to divert the animal. The system extends its capabilities to ensure proper usage of rainwater collected during heavy rainfall which can further be used for all the agricultural practices thereby conserving water, an essential resource. The system also promotes the use of renewable energy by collecting solar energy and using it as the major source of power. The implementation of NodeMCU in the system ensures seamless wireless communication with the farmer. This multi-purposed approach aims to mitigate losses caused by both environmental factors and unwanted wildlife interference.

Index Terms **- Relay, H-bridge, IR sensor, DC motor, NodeMCU, YOLOv5, Arduino.**

I. INTRODUCTION

Agriculture is the backbone of our country. It is India's most important economic sector. India is mainly depended on agriculture and 70% of India's income is from agriculture. In this project we are developing the model which prevents damage to crops caused by heavy rainfall and animal interference. This system is developed with the help of embedded System design using WIFI technology. The main aim of this project is protecting the crops from heavy rainfall by covering the field from double coated polythene sheet automatically with the help of rain sensor and also to store the collected rain water. The saved water can be used for other purposes such as feeding animals, washing, drinking, cooking etc. Though maximum population of India depends on agriculture, there are many problems faced by farmers. Problem caused by wild animals is a major problem which is rapidly increasing. So this zone is to be watched continuously to prevent entry of the animals or any other unauthorized entry. Human animal conflicts arise due to encroachment and illegal hunting. Humans enter into the forest to satisfy their livelihood, for claiming of land for agricultural practices and rapid industrialization thereby reducing forest area and animals enter the nearby villages for water during the summer due to scarcity of water body. Elephants or wild boar enters agricultural field in search of nutritious food. Need of the animal or human imposes the real danger, thereby which the crops are spoilt and sometimes leads to death. Human-elephant conflict is more in south Asia and in Africa. Usually the technique used to protect farm is painful to the animals which makes animals behave abnormal and causes serious damage to resources.

Agriculture, as the backbone of our society, faces the critical challenge of meeting the ever-growing demand for food due to climate change, resource scarcity, and environmental uncertainties. To address these challenges and optimize agricultural practices, there is a crucial need for innovative technologies that can enhance efficiency, minimize resource utilization, and protect crops from various threats. In response to this, we propose a comprehensive agricultural crop protection system that integrates cutting-edge technologies such as Arduino, LCD, soil moisture sensor, humidity sensor, rain sensor, relay water pump, DC motor for protection mechanisms, laptop camera for animal detection, and NodeMCU for wireless message intimation. This paper proposes an integrated solution for agriculture crop protection by the combination of advanced technologies. The system incorporates Arduino-based automation with a range of sensors coupled with responsive mechanism such as relay, water pump, H-bridge and DC motor for protection. Soil moisture and humidity sensors enable real-time monitoring of environmental conditions, ensuring optimal irrigation for crops. A rain sensor acts as a preemptive measure, adjusting irrigation schedules based on precipitation levels. The integration of a relay water pump and DC motor facilitates an efficient and automated crop protection mechanism. Furthermore, the system extends its capabilities to animal detection using a laptop camera. Employing machine learning algorithms, the camera detects and identifies potential threats to crops, triggering protective measures. This approach aims to mitigate losses caused by both environmental factors and unwanted wildlife interference. The implementation of NodeMCU in the system ensures seamless

wireless communication. Farmers receive timely notifications and updates on the status of their crops.
The purpose is to prevent the damage of crops due to heavy rainfall and extreme weather conditions, rainwater harvesting, to protect the crops against animals, detect the intrusion of the animal and taking suitable actions and notification will be sent to the farm owner and forest officials using NodeMCU.

II. LITERATURE SURVEY

Smart Intrusion Detection System for Crop Protection by using Arduino[1] Agriculture is still one of the most crucial sectors of the Indian economy. It is important for human survival as well as economic growth. Traditional systems like humanoid scarecrows are used even today in an agricultural field to stop birds and animals from disturbing and feeding on growing crops. There are many loopholes in such ideas and so enhancing agricultural security has become a major issue these days. Thus, this paper focuses on proposing a system which detects the intruders, monitors any malicious activity and then reports it to the owner of the system. It acts as an adaptable system which provides a practicable system to the farmers for ensuring complete safety of their farmlands from any attacks or trespassing activities. Published in 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA) Published by IEEE Conference and the authors are Srushti Yadahalli , Aditi Parmar, Amol Deshpande.

Crop Field Protection from Animals Using Convolutional Neural Networks[2] Animals such as buffaloes, cows, goats, birds, and others have caused agricultural damage in recent years, resulting in significant losses for farmers. Farmers are unable to safeguard entire fields or remain on the field 24 hours a day to do so. As a result, this paper suggests an automated crop security system that will protect crops from animal attacks. The system is trained utilizing datasets that can automatically filter photos and identify animals using Convolutional Neural Network (CNN) architectures. When an animal is discovered in the field, it emits an alarm sound. This sound irritates the animal, and it flees. Published by IEEE and the authors are Karthikeyan P, Paul Nishanth R, Valarmathi R.

Image Processing based Protection of Crops from wild animals using Intelligent Surveillance[3] Surveillance plays a major role in home, hospitals, schools, public places, farmlands etc. It helps us to monitor and prevent theft. To prevent unauthorized peoples, surveillance is important in farmlands. Traditional methods like human itself monitoring the whole field for long time to prevent the animals and it is difficult.

So there is a need for specialized detection of animals particularly like include segmentation and object detection process. Main intruders of agriculture are birds and animals, but most of the work is based on human intruders. So, object recognition based intrusion detection is proposed in this work. Already predefined images and features of some animals are stored in image processor. When animal is intruding to the land the camera fixed at various places will capture it and send it to the processor for further processing. Feature extraction and matching of predefined and new image will be done through yolo based regression algorithm after that alarm will be produced and also SMS will be sent to the owner of the land. So this proposed system will really helpful for the agriculture to increase yield. Published by IEEE and the authors are A. Sathesh, K. Vishnu, A. Yuvaneshwar, V. Vellaisamy, K. Gowthami.

Intelligent Secure Smart Crop protection From Wild Animals[4] Farmers have faced numerous issues in agricultural regions throughout the years, including unexpected rainfalls and a shortage of rainfalls. Animal threats are the second most serious challenge for farmers in agricultural fields. Some of the places that are closer to the forest area are affected by wild animals. So, to avoid these issues, they have worked hard to build a low-cost, environment-friendly project that farmers can afford. To reduce the constraints and improve the security of crops against wild animals. The technology offered is designed in three steps. The first stage is intended to sense/detect the animal using a PIR sensor and generate a digital output. The second stage is aimed to determine whether it is an animal or not by utilizing a Pi camera to capture the region and record animal video. The third stage is intended to offer farmers information on animal entry by providing video. As a result, proposed methodology assists farmers in removing animals from agricultural lands. When farmers are aware that a specific animal is entering a field at a specific time, they may easily employ their regulated methods to remove animals from agricultural grounds. Project is carried out using IoT (internet of things) technology. Published by IEEE and the authors are Mahammad Firose Shaik, Ravipati Mounika, A. Durga Prasad, Inakoti Ramesh Raja, B.Prajakatha Sekhar, D. Sampath.

Smart Crop Protection System from Wild Animals Using IoT[5] Crops in the farms are many times devastated by the wild as well as domestic animals and low productivity of crops is one of the reasons for this. It is not possible to stay 24 hours in the farm to sentinel the crops. So to surmount this issue an automated perspicacious crop aegis system is proposed utilizing Internet of Things (IOT). The system consists of esp8266 (NodeMCU), soil moisture sensor, dihydrogen monoxide sensor, GPRS and GSM module, servo motor, dihydrogen monoxide pump, etc. to obtain the required output. As soon as any kineticism is detected the system will engender an alarm to be taken and the lights will glow up implemented at every corner of the farm. This will not harm any animal and the crops will stay forfended. Published by IEEE and the authors are Priyanka Deotale, Prasad Lokulwar.

IoT solutions for crop protection against wild animal attacks[6] Technology plays a central role in our everyday life. There has been a surge in the demand of Internet of Things (IoT) in many sectors, which has drawn significant research attention from both the academia and the industry. In the agriculture sector alone, the deployment of IoT has led to smart farming, precision agriculture, just to mention a few. This paper presents the development of Internet of Things application for crop protection to prevent animal intrusions in the crop field. A repelling and a monitoring system is provided to prevent potential damages in Agriculture, both from wild animal attacks and weather conditions. Published by IEEE and the authors are Stefano Giordano, Ilias Seitanidis, Mike Ojo, Davide, Adami, Fabio Vignoli.

Machine learning-based Acoustic Repellent System for Protecting Crops against Wild Animal Attacks[7]. The main aim of this work is to develop a device to protect crops from damage by wild animals by diverting them from the farms, without harming them physically. In this context, an Acoustic Repellent System has been designed which uses a convolutional neural network (CNN)

based machine learning model and an IR camera to identify target animals, such as wild boar, deer, etc. A Raspberry Pi (Rpi) module has been integrated with a camera and a frequency generator to recognize different animals and produce corresponding frequencies that keep them away from the farms of interest. Moreover, the architectural aspects of the proposed solution have also been detailed. Lastly, the potential impact of the proposed solution has been discussed. Published by IEEE and the authors are Devsmit Ranparia, Gunjeet Singh, Anmol Rattan, Harpreet Singh, Nitin Auluck.

Sensor based Crop Protection System with IOT monitored Automatic Irrigation[8] Agriculture assumes a significant job for advancement in nourishment creation and crop protection in India. Here, agriculture relies upon disproportionate rain which thereby affects India's agriculture. There arises a need for effective irrigation for the agricultural production. The control over how much water is to be supplied and when it is to be applied determines the uniformity which is key to maximizing the irrigation efforts. The proper irrigation management takes careful consideration and vigilant observations. It has many benefits. Keen water irrigation and protection system framework is in this way accepted to be a significant arrangement. The paper along these lines presents an effective water system framework that advances the accessible water in the water supply and in this manner giving an effective and powerful mechanism for the irrigation purposes. Irrigation framework would automatically begin/stop water siphons, on the agricultural site depending upon the dampness content obtained by the moisture sensor as soon as it senses the level of water in the reservoir. The deliberate sensor estimates are sent to the Arduino Uno microcontroller for arranging the controlled calculation. The protection is done through the voice detection and movement detection methods to enable high frequency sound, hence protecting the crops from insects, pests and small animals. Published by IEEE and the authors are Damini Kalra, Praveen Kumar, K Singh, Apurva Soni.

Automatic Farming for Minimum Water Usage and Animal Protection Using Solar Fencing with GSM[9] Food is one of the basic need of human being, food comes from cultivation of crops, leafy vegetables, fruits, etc. in agriculture land. It is necessary to develop a system for better farming and crop cultivation. A system is to be proposed which will protect the farm field from animals / birds, as most of the crops / grains are destroyed by the animals / birds which enter the farm field. A Solar / electric fence is provided around the farm to protect the farm from animal/birds, so that they should not enter the farm. A short electric pulses are transmitted through the fence, any animal intends to enter / touch the fence may get a short shock, this shock is just to threaten the animal to be away from the fence. As birds enter the field and destroys the grains, an audio generator is used which emits definite frequency which tends animals / birds to stay away from the field and those frequencies are not audible to human being. For agriculture, water is needed for the growth of crops, somehow the farmer needs to monitor the crops for the water needed to be supplied, thus by designing an automatic water supplier to the crops by sensing the moisture content of the soil. If any of the harms / problems happens to the farm field a text message is sent to the farmer's mobile by the use of GSM, and alarm / buzzer is ranged to indicate any rare attempts in farm field. This research offers harmless and user friendly farm field for better agriculture. Published by IEEE and the authors are Gopika Nair, Mayuri Chawla, Narendra Bawane.

An Investigation on Smart Crop Protection System Utilizing Internet of Things[10] Agriculture is the foundation of Indian society and provides over 20% of the country's economic output. But currently, farmers are having various issues in agriculture and the outcomes are dropping year by year. The goal of this research is to examine the effects of better agricultural techniques on agricultural production and protection. The key difficulty is protecting crops from harm due to crop diseases, an endless supply of water, pests and animal attacks. By considering the aforesaid challenges experienced by the farmers, a system is proposed for monitoring the conditions such as weather, soil, and crop protection. This approach provides the essential measures to be taken for improved crop production by supplying the images of the plants. Any animal attacks, diseases, and pests can be seen in the image of the plants. And also, it notifies the producers by delivering alerts from buzzers. This strategy offers the producer an incentive to encourage better crop yield. It also describes the functioning of machine-learning and artificial intelligence using IoT in crop-protection systems. Different sorts of sensors are employed to notify their distinct movements. Published by IEEE and the authors are M. Siva Sahitya, L. Vinay, Bindeshwar Prasad Sah, P. Srilatha, B. S. Kiruthika Devi.

III. SYSTEM ARCHITECTURE

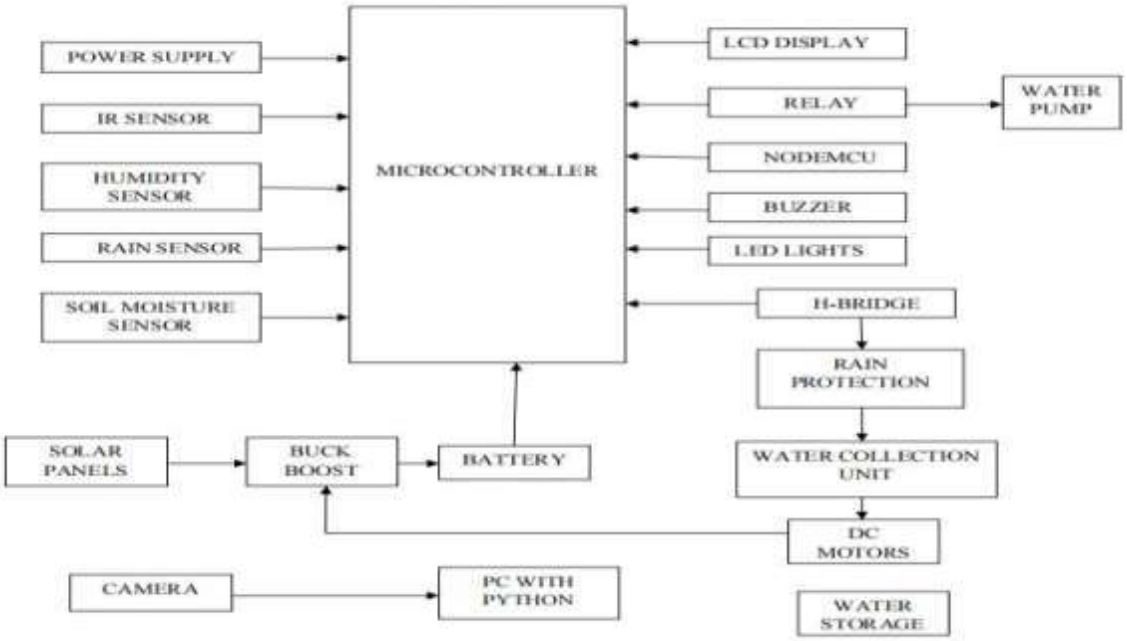

Fig: System architecture

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. In animal detection, a camera serves as the input device to capture images or video footage of the environment where animals are present. The camera provides visual data that is then processed by algorithms, such as YOLOv5, to detect and identify animals within the captured frames. Through this process, cameras play a crucial role in enabling real-time or offline animal detection and monitoring applications, aiding in various fields such as wildlife conservation, agriculture, and animal behavior research. LCD displays serve as convenient interfaces for showcasing real-time data in various applications. By connecting these displays to IoT devices and leveraging appropriate libraries, developers can seamlessly present crucial information such as sensor readings, system statuses, or alerts. Rain sensors for irrigation systems detect rainfall and prevent unnecessary watering by interrupting scheduled watering cycles. They measure rainfall intensity and communicate with the irrigation controller to adjust watering schedules accordingly, conserving water and preventing overwatering. Humidity sensors for irrigation monitor soil moisture levels to optimize watering schedules. They measure the moisture content in the soil and transmit data to irrigation controllers, allowing for precise irrigation adjustments based on real-time conditions. The soil moisture sensor is used to detect the moisture level of the soil and based on the data which necessary actions will be undertaken.

Buck-boost converters regulate voltage levels to ensure efficient battery utilization. They step up or step down voltage as needed, accommodating fluctuating battery levels for consistent device performance. A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smart phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. Power supply devices are crucial in IoT projects, ensuring continuous operation of connected devices. They provide stable power to sensors, actuators, and communication modules. A relay is an electrically operated switch. It is used to control the flow of electricity in the model. Water pumps are used to spray the water by detecting the moisture level of the soil during the farming.

H-Bridges play a vital role in IoT applications by controlling the direction and speed of DC motors or actuators. They enable bidirectional control, allowing IoT devices to move forwards and backwards. DC motors convert electrical into mechanical energy and they consist of permanent magnets and loops of wire inside, when current is applied, the wire loops generate a magnetic field, which reacts against the outside field of the static magnets.

NodeMCU, based on the ESP8266 microcontroller, is widely utilized in IoT projects for its ease of use and extensive community support. It enables wireless connectivity, facilitating communication between IoT devices and the internet. Buzzers are valuable components in IoT systems, providing audible alerts or notifications based on predefined conditions. They enhance user experience by offering auditory feedback in smart devices and sensors. LED lights serve as indicators or status indicators in IoT devices, conveying information such as connectivity status, data transmission, or system alerts. Solar panels are increasingly integrated into IoT (Internet of Things) devices for battery charging. These devices, ranging from sensors to smart gadgets, utilize solar panels to harness energy from the sun and charge internal batteries. This setup enables IoT devices to operate independently and sustainably, without the need for constant manual recharging or connection to the grid. Infrared (IR) sensors play a pivotal role in animal detection systems. These sensors are help in detecting infrared radiation emitted by warm-blooded animals, making them ideal for applications like wildlife monitoring, animal tracking, and even livestock management.

IV. PROPOSED SYSTEM

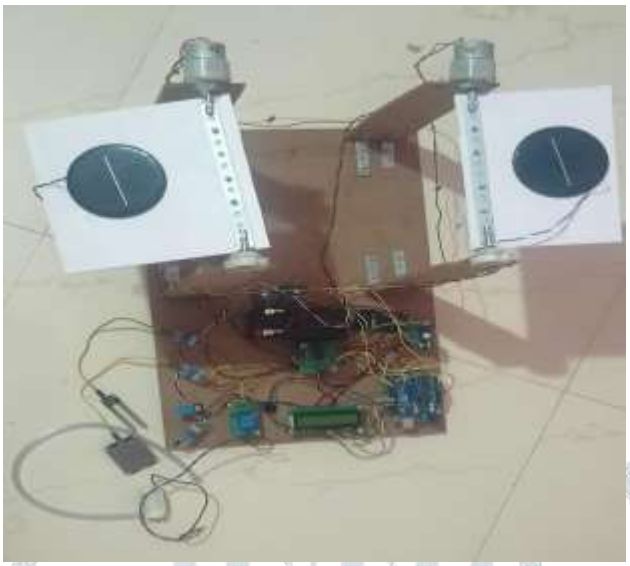

Fig: Proposed model

Component Integration: Assembled the hardware components including Arduino, soil moisture sensor, humidity sensor, rain sensor, relay, water pump, DC motor, LCD, laptop camera, and NodeMCU, H-Bridge. **Arduino Programming:** Developed Arduino code to read data from soil moisture, humidity, and rain sensors. Implemented logic to control the relay water pump based on soil moisture levels, ensuring optimal irrigation.
DC Motor Mechanism Programming: Wrote code for the DC motor to respond to adverse environmental conditions detected by the rain sensor. Implemented a protective mechanism to shield crops from heavy rain or strong winds.
Animal Detection Algorithm: Trained a machine learning model for animal detection using images captured by the laptop camera. Integrated the detection algorithm with the system to identify potential threats. **Responsive Action to Animal Detection:** Developed a mechanism for the system to respond to identified threats, such as activating deterrent devices or sending alerts thereby diverting the animals using buzzer and lights.

Wireless Communication: Configured NodeMCU for wireless communication and integrated it with Arduino to enable real-time data transmission. Established a communication protocol for sending notifications and updates to a designated user interface.
LCD Display Implementation: Interfaced the LCD display with Arduino to provide a user-friendly interface for farmers to display relevant information such as sensor readings, irrigation status, and animal detection alerts.
User Interface Design: Developed a simple and intuitive user interface for the LCD, allowing farmers to monitor and control the system easily which includes interactive features for adjusting settings or responding to alerts.

Designing an algorithm for animal detection using YOLOv5 involves several steps:

1. **Data Collection:** Gathered a diverse dataset of images containing various animals. Also included various species, poses, lighting conditions, and backgrounds to ensure the accuracy.
2. **Data Annotation:** Annotated the dataset with bounding boxes around each animal. Tools like LabelImg or CVAT helped with this task.
3. **Data Preprocessing:** Resized images to a standard size and applied data augmentation techniques like rotation, flipping, and scaling to increase dataset variety.
4. **Model Selection:** Chose YOLOv5 as the base model for animal detection due to its real-time performance and accuracy.
5. **Model Fine-tuning:** Fine-tuned the YOLOv5 model on our annotated animal dataset. This step helps the model learn to detect animals accurately.
6. **Training:** Trained the model using the annotated dataset. Monitored metrics like loss and mAP (mean Average Precision) during training to evaluate performance.
7. **Evaluation:** Evaluated the trained model on a separate validation dataset to assess its performance in detecting animals accurately.
8. **Model Optimization:** Optimized the model for deployment by reducing its size and improving inference speed. Techniques like model pruning and quantization were useful here.
9. **Deployment:** Deployed the trained and optimized model to the target platform, whether it's a server, edge device.
10. **Testing and Monitoring:** Continuously tested the deployed model and monitored its performance. Fine- tuned the model periodically with new data to maintain accuracy.

When the power supply is switched on, the model gets initialized. When IR sensor detects infrared radiation emitted by the animals it sends the command to turn on light and buzzer. The image that is sent by the camera is received by the PC for classification of animal. Database is created and the set of sample images are stored in it. The program consists of functions such as index Image, imageSet and retrieveImage. The ImageSet is used to hold a collection of images. indexImage is used to create an image search index. indexImage is used with the retrieveImage function to search for images. The captured image is given as query image to the

processing system. The retrieveImage function takes two arguments, a query image and the image stored in the database. The resultant is the indices corresponding to images within image Index that are visually similar to the query image. The image IDs output contains the indices in ranked order, from the most to least similar match. The value match range is from 0-1. If the value is 0, then the image is not matched. If it is 1, then the query image is same as that of the stored image. If the value is found between that of 0-1, then the query image falls under the category of the stored image i.e., the contents in the query image are same as that of the stored image. If the name of the image matches with that of the regular expression of the image, then the animal is elephant otherwise it is a leopard. If the score is in the range of 0.1 to 0.9, then the image is matched with that of the stored image. Once the animal is identified, the action is initiated towards scaring the animal away from the farm which is accomplished using a buzzer and a LED light. As a result, the irritating loud noise and light is used to divert the animal from crop field. Consequently, a SMS is sent to the field owner

i.e. farmer as an alert information using NodeMCU technology which enables the farmer to control the operation from the remote place. If the detected object is not a threat then no SMS is sent. By this way false alarm can be prevented. The LCD Display with Arduino is used to provide a user-friendly interface for farmers by displaying relevant information such as sensor readings, irrigation status, and animal detection alerts.

We are using rain sensor to detect rainfall and trigger automated actions, that is in case of heavy rainfall which is beyond the threshold value of water that is required by that crop, the first operation of microcontroller is to activate the dc motor in such a way that it starts rotating in clockwise direction to cover the double coated polythene sheet over the crops. Hence the crop is covered by the double coated polythene sheet over the agriculture land & crop is protected by heavy rainfall. The required protection is fabricated by four adjustable poles which enables the adjustment of height. This way the field is protected against heavy rainfall. The double coated polythene sheet over the four adjustable poles are mounted in a slope position such that, the water falling through those sheets from both the ends of the sheet can be stored and thereby implementing rain water harvesting. This stored water can be used for various agricultural activities which helps in conserving water. By using soil moisture sensor, we are able to detect the moisture levels of the soil and if the moisture level of the soil is low then water pump turns on automatically supplying water to the crops and when the moisture content is high the water pump turns off their by using the water properly without wasting water. The System also works in automated mode i.e. when farmer doesn't respond to the request from NodeMCU, it checks the moisture content of the soil using moisture sensor and initiates appropriate action required to protect crop.

V. RESULTS

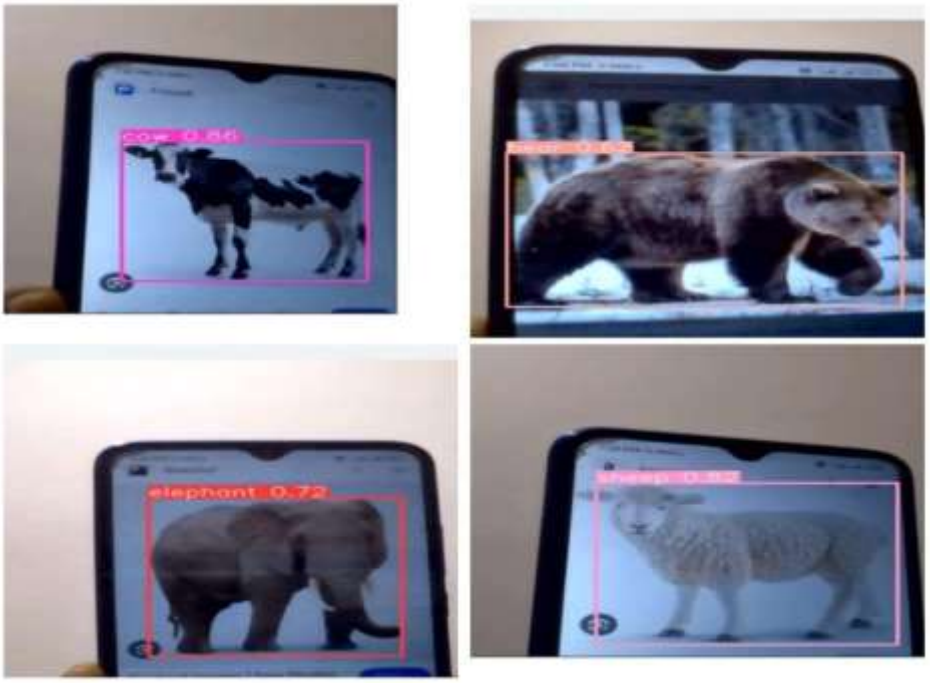

Fig: The animals detected along with their confidence ratio

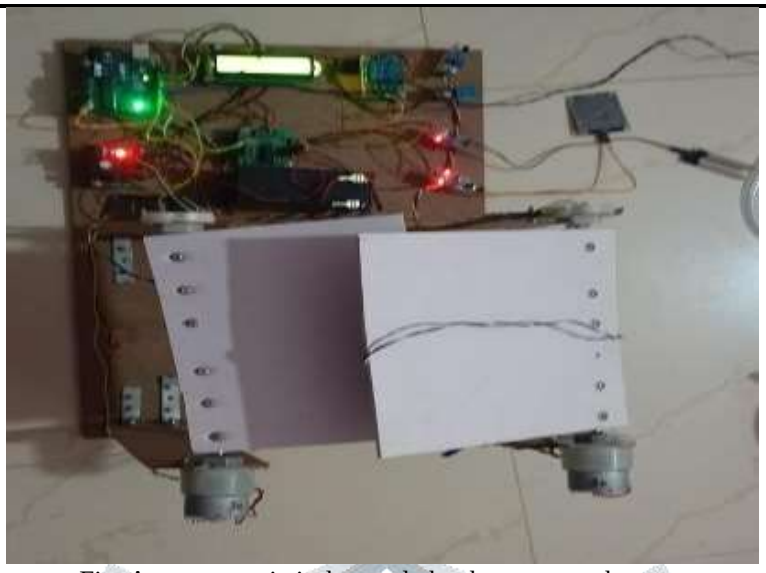

Fig: As soon as rain is detected, the sheets cover the crop

Fig: The LCD displaying the action that is being performed

Fig: Farmer receiving message on the actions take

VI. CONCLUSION

The crop protection system can be developed in many ways for various agricultural application. This system can be implemented in any environmental application where it works accurately. This system can be powered with the help of solar system which even reduces the working cost. Using IOT has made this system even more helpful for the farmer because the farm can be monitored remotely, hence it is more profitable and efficient. Smart Crop protection will create change in the way farming in India. Purest form of water that is rain water can harvest with help of this system, sensor used in this system help in collecting rain water and storing it. Rain water can be used to water the field or for drinking and many other activities. By this application, wastage of rain water can be eliminated and it can be supplied to the need. Large amount of water will be stored from this technique which is pure and does not contains any kind of salt in it. To conclude, this project met our expectations and all the features worked how exactly it should be working. It was a challenging and enjoyable experience doing this project. This technology will make the change in the way of farming in India. Farmers can access the farm remotely and can get all the information about the farm. The farm will be protected from animals, unauthorized intrusion and heavy rainfall.

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