



CAMERA VISION BASED ANIMAL BEAT BACK SYSTEM FOR AGRICULTURE USING MACHINE LEARNING

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ABSTRACT:

As a result of human interference with natural habitats and deforestation, crop raiding by animals has emerged as one of the most prevalent human-animal conflicts. Wild animals can assault farmers working in the fields and seriously harm agricultural harvests. Due to agricultural raiding by wild animals like elephants, wild boar, and deer, farmers experience significant crop loss. The protection of crops against assaults by wild animals is one of the primary concerns of today's farmers. There are numerous conventional methods to deal with this issue, both lethal (such as shooting and trapping) and non-lethal. (e.g., scarecrow, chemical repellents, organic substances, mesh, or electric fences). The edge computing device turns on the camera, then uses its DCNN software to identify the target. If an animal is discovered, it then sends a message to the Animal Repelling Module with information about the type of ultrasound that should be created based on the animal's category.

Keyword: Animal Recognition, Repellent, Artificial Intelligence, Edge Computing, Animal Detection, Deep Learning, DCNN.

1. INTRODUCTION:

Agriculture has seen many revolutions, whether the domestication of animals and plants a few thousand years ago, the systematic use of crop rotations and other improvements in farming practice a few hundred years ago, or the "green revolution" with systematic breeding and the widespread use of man-made fertilizers and pesticides a few decades ago.

Most farmers have challenges related to crop damage due to wildlife pests. Animal intrusion is a major threat to the productivity of the crops, which affects food security and reduces the profit to the farmers. Organic farmers have additional challenges because they cannot use chemical controls which are sometimes the most effective and efficient options. A need has been identified for alternative pest control appropriate for traditional and organic farmers. Three types of animal intrusion you might find include animal tracks, crop damage and animal scat or faeces. In the case of animal tracks, only one instance of tracks in the field carries a relatively low risk.

2. LITERATURE SURVEY

Zachar J.Ruff, Damon B.Lesmeister, Cara L.Appel, Christopher M.Sullivan
2021 "Workflow and convolutional neural network for automated identification of animal sounds" The aim of this project is automated identification of animal sounds using Convolutional Neural Networks.[1]R. Nikhil; B.S. Anisha; RamakanthKumar.P2020."Real-Time Monitoring of Agricultural Land with Crop Prediction and Animal Intrusion Prevention using Internet of Things and Machine Learning at Edge" The aim of this project is crop prediction helps the farmers to grow suitable crops depending on the soil parameters by the use of machine learning techniques and it also helps in prevention of the intruders like wild animals into the field. [2] L. G. C. Vithakshana; W. G. D. M. Samankula "IoT based animal classification system using convolutional neural network". The aim of this project is an IoT

based acoustic classification system was designed using Convolutional Neural Networks (CNN), which is beneficial for those who are interested in monitoring ecosystems such as animal scientists, zoologists, and environmentalists..[3] Henry Roberts; Aviv Segev 2020. “Animal Behaviour Prediction with Long Short-Term Memory”. The aim of this project is efficiently converting video of animals at any length into models capable of making accurate behavioural prediction using Long Short-term Memory (LSTM).[4] Loris Nanni , Sheryl Brahnam , Alessandra Lumini and Gianluca Maguolo 2020. “Animal Sound Classification Using Dissimilarity Spaces”. The aim of this project is to automated animal audio classification using clustering methods..[5] S. Jeevitha; S.Vengatesh Kumar 2019. “A Study on Sensor Based Animal Intrusion Alert System Using Image Processing Techniques”. an animal intrusion alert system is designed by employing wireless sensors for sending an automatic alert message to both the landowner and forest officials with an image.[6]

3. EXISTING SYSTEM

Wild animals are a special challenge for farmers throughout the world. Animals such as deer, wild boars, rabbits, moles, elephants, monkeys, and many others may cause serious damage to crops. They can damage the plants by feeding on plant parts or simply by running over the field and trampling over the crops. Therefore, wild animals may easily cause significant yield losses and provoke additional financial problems. Another aspect to consider is that wild animal crop protection requires a particularly cautious approach. In other words, while utilizing his crop production, every farmer should be aware and take into consideration the fact that animals are living beings and need to be protected from any potential suffering.

- Wire fences

constructed of metal wires woven together forming a physical barrier. The fences are effective, long lasting, and require relatively little maintenance. However, they are expensive and recommended only for the protection of high- value crops.

- Plastic fences

polypropylene fences are generally less expensive and easier to install and repair than

other types. Additionally, these fences are widely acceptable and meet various regulations. Their disadvantage includes their short lifespan (up to 10 years) and questionable effectiveness in areas with a higher possibility of wild animal crop damage.



Fig:3.1 wire and plastic fences

- Electric fences

These are constructed to inflict an electric shock to animals that come in contact with the fence, thus preventing animals from crossing the fence. These fences are long lasting and an effective crop protection measure. Costs vary depending on specific type and size of an area. Before purchasing electric fences, it's very important to make sure they are allowed for use in the specific area, and for protection against endangered animal species. Additionally, it's recommended that electric fences are marked with a warning sign to prevent any possible human contact.

Its disadvantages include the potential for the entire fence to be disabled due to a break in the conducting wire, shorting out if the conducting wire contacts any non-electrified component that may make up the rest of the fence, power failure.

4. PROPOSED SYSTEM

AI Computer Vision based DCNN for detecting animal species, and specific ultrasound emission (i.e., different for each species) for repelling them.design, deployment and assessment of an intelligent smart agriculture repelling and monitoring IoT system based on embedded edge AI, to detect and recognize the different kinds of animal, as well as generate ultrasonic signals tailored to each species of the animal.This combined technology used can help farmers and agronomists in their decision making and management process.

Deep learning in the form of Convolutional Neural Networks (CNNs) to perform the animal recognition.

- DCNN

CNNs are a category of Neural Networks that have proven very effective in areas such as image recognition and classification. CNNs are a type of feed-forward neural networks made up of many layers. CNNs consist of filters or kernels or neurons that have learnable weights or parameters and biases. Each filter takes some inputs, performs convolution and optionally follows it with a non-linearity. A typical CNN architecture can be seen as shown in Fig.3.1. The structure of CNN contains Convolutional, pooling, Rectified Linear Unit (ReLU), and Fully Connected layers.

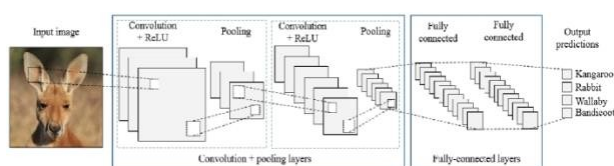


Fig:4.1.CNN

The detection system recorded the date and time of each detection. In addition, there were cameras and a video recording system that recorded all animal movements within the enclosure. The detection log was compared to the images from the cameras, which also had a date and time stamp, to investigate the reliability of the system. A message alert is sent to the registered mobile number.

Animals generally have a sound sensitive threshold that is far higher than humans. They can hear sounds having lower frequencies with respect to the human ear. For instance, while the audible range for humans is from 64Hz

- 23KHz, the corresponding range of goats, sheep, domestic pigs, dogs and cats is 78Hz - 37KHz, 10Hz - 30KHz, 42Hz - 40.5KHz 67Hz - 45KHz and 45Hz -

64KHz. Generating ultrasounds within the critical perceptible range causes animals to be disturbed, thus making them move away from the sound source. At the same time, these ultrasounds are not problems to the human ear even when the frequency range is beyond the human.

5. SYSTEM REQUIREMENTS

HARDWARE REQUIREMENTS

- Processors: Intel® Core™ i5 processor 4300M at 2.60 GHz or 2.59 GHz (1 socket, 2 cores, 2 threads per core), 8 GB of DRAM

- Disk space: 320 GB
- Operating systems: Windows® 10, macOS*, and Linux*

SOFTWARE REQUIREMENTS

- Server Side : Python 3.7.4(64-bit) or (32-bit)
- Client Side : HTML, CSS, Bootstrap
- IDE : Flask 1.1.1
- Back end : MySQL 5.
- Server : Wampserver 2i
- OS : Windows 10 64-bit or Ubuntu 18.04 LTS “Bionic Beaver”

5.2.1.SOFTWARE

Python 3.7.4

Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language. It was created by Guido van Rossum during 1985- 1990. Like Perl, Python source code is also available under the GNU General Public License (GPL). This tutorial gives enough understanding on Python programming language.



Python is a high-level, interpreted, interactive and object-oriented scripting language. Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages. Python is a MUST for students and working professionals to become a great Software Engineer specially when they are working in Web Development Domain.

TENDER FLOW

TensorFlow is an end-to-end open-source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, libraries, and community resources that lets researchers push the state-of-the-art in ML, and gives developers the ability to easily build and deploy ML-powered applications. TensorFlow provides a collection of workflows with intuitive, high-level APIs for both beginners and experts to create machine learning models in numerous languages. Developers have the option to deploy models on a number of platforms such as on servers, in the cloud, on

mobile and edge devices, in browsers, and on many other JavaScript platforms. This enables developers to go from model building and training to deployment much more easily.



Keras

Keras is a deep learning API written in Python, running on top of the machine learning platform Tensor Flow. It was developed with a focus on enabling fast experimentation.



Simple. Flexible. Powerful.

Allows the same code to run on CPU or on GPU, seamlessly.

User-friendly API which makes it easy to quickly prototype deep learning models.

Built-in support for convolutional networks (for computer vision), recurrent networks (for sequence processing), and any combination of both.

Supports arbitrary network architectures: multi-input or multi-output models, layer sharing, model sharing, etc. This means that Keras is appropriate for building essentially any deep learning model, from a memory network to a neural Turing machine.

PANDAS

pandas is a fast, powerful, flexible and easy to use open source data analysis and manipulation tool, built on top of the Python programming language. pandas is a Python package that provides fast, flexible, and expressive data structures designed to make working with "relational" or "labeled" data both easy and intuitive. It aims to be the fundamental high-level building block for doing practical, real world data analysis in Python.



Matplotlib

Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python. Matplotlib makes easy things easy and hard things possible



Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK.



MySQL

MySQL tutorial provides basic and advanced concepts of MySQL. Our MySQL tutorial is designed for beginners and professionals. MySQL is a relational database management system based on the Structured Query Language, which is the popular language for accessing and managing the records in the database. MySQL is open-source and free software under the GNU license. It is supported by Oracle Company. MySQL database that provides for how to manage database and to manipulate data with the help of various SQL queries. These queries are: insert records, update records, delete records, select records, create tables, drop tables, etc. There are also given MySQL interview questions to help you better understand the MySQL database



MySQL is currently the most popular database management system software used for managing the relational database.



NumPy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays.

Wamp Server

WampServer is a Windows web development environment. It allows you to create web applications



WAMPServer is a reliable web development software program that lets you create web apps with MYSQL database and PHP Apache2. With an intuitive interface, the application features numerous functionalities and makes it the preferred choice of developers from around the world. The software is free to use and doesn't require a payment or subscription.

Bootstrap 4

Bootstrap is a free and open-source tool collection for creating responsive websites and web applications. It is the most popular HTML, CSS, and JavaScript framework for developing responsive, mobile-first websites.



It solves many problems which we had once, one of which is the cross-browser compatibility issue. Nowadays, the websites are perfect for all the browsers (IE, Firefox, and Chrome) and for all sizes of screens (Desktop, Tablets, Phablets, and Phones). All thanks to Bootstrap developers -Mark Otto and Jacob Thornton of Twitter, though it was later declared to be an open-source project.



Flask

web development,
one drop at a time

Flask

Flask is a web framework. This means flask provides you with tools, libraries and technologies that allow you to build a web application.

This web application can be some web pages, a blog, a wiki or go as big as a web-based calendar application or a commercial website.

Flask is often referred to as a micro framework. It aims to keep the core of an application simple yet extensible. Flask does not have built-in abstraction layer for database handling, nor does it have formed a validation support. Instead, Flask supports the extensions to add such functionality to the application. Although Flask is rather young compared to most Python frameworks, it holds a great promise and has already gained popularity among Python web developers. Let's take a closer look into Flask, so-called "micro" framework for Python.

6. SYSTEM ARCHITECTURE

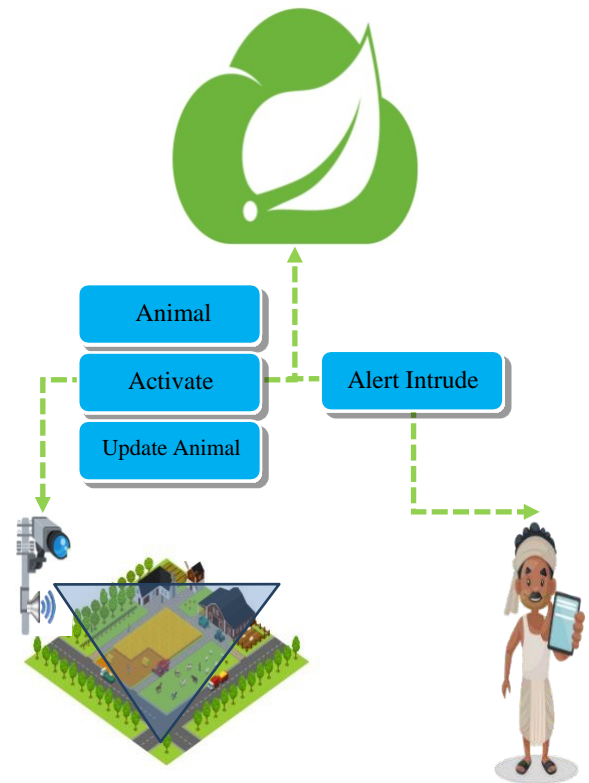
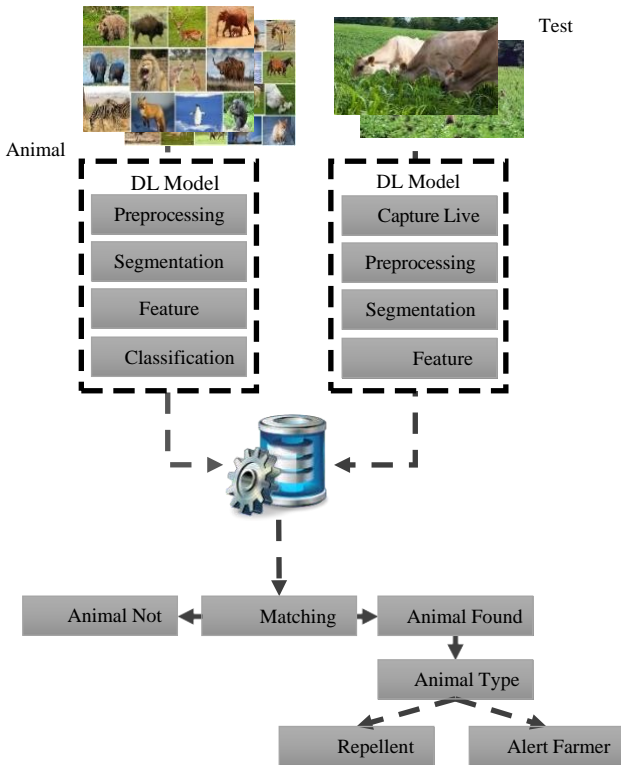


Fig.6.1 System Architecture

6.1.DCNN Model



7. MODULES

- Animal Repellent Web Dashboard
- Animal Recognition
- Animal Identification
- Repellent
- Monitoring and Visualizing
- Notification
- Performance Analysis

7.1.ANIMAL REPELLEANT WEB DASHBOARD

This system is economical as compared to many of the existing solutions like electric fences, brick walls and manual supervision of the fields. This system is very effective in driving off the animals from the fields and keeping them away. It accurately determines the presence of animals in the fields and sounds the buzzer. It does not sound the buzzer due to the presence of a human being or due to some random motion

ANIMAL RECOGNITION

Training Phase

This module begins by annotation of animal dataset. These templates then become the reference for evaluating and registering the templates for the other poses: tilting up/down, moving closer/further, and turning left/right.

Animal Image Acquisition

ANIMAL-10N dataset contains 5 pairs of confusing animals with a total of 55,000 images. The 5 pairs are as following: (cat, lynx), (jaguar, cheetah), (wolf, coyote), (chimpanzee, orangutan), (hamster, guinea pig). The images are crawled from several online search engines including Bing and Google using the predefined labels as the search keyword.

Pre-processing

Animal Image pre-processing are the steps taken to format images before they are used by model training and inference. The steps to be taken are:

- Read image
- RGB to Grey Scale conversion
- Resize image

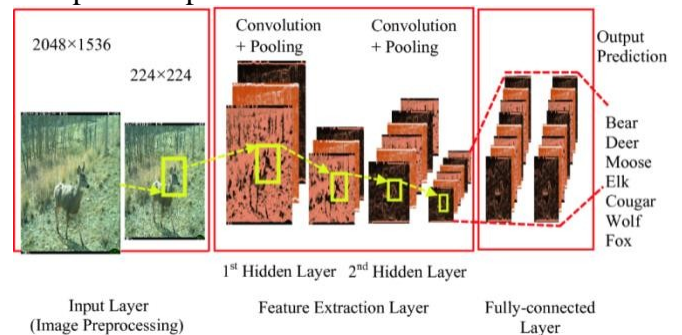
Original size (360, 480, 3) — (width, height, no. RGB channels)

Resized (220, 220, 3)

- Remove noise (Denoise)

ANIMAL CLASSIFICATION

DCNN algorithms were implemented to automatically detect and reject improper animal images during the classification process. This will ensure proper training and therefore the best possible performance.



ANIMAL IDENTIFICATION

After capturing the animal image from the Farm Camera, the image is given to animal detection module. This module detects the image regions which are likely to be human. After the animal detection using Region Proposal Network (RPN), animal image is given as input to the feature extraction module to find the key features that will be used for classification. The module composes a very short feature vector that is well enough to represent the animal image.

Prediction

In this module the matching process is done with trained classified result and test animal image with animal dataset classified file. Hamming Distance is used to calculate the

difference according to the result the prediction accuracy will be displayed. Here, it is done with DCNN with the help of a pattern classifier, the extracted features of animal image are compared with the ones stored in the animal database. The animal image is then classified as animal type. If the animal is found corresponding repellent module is called.

REPELLENT

Monitoring window detecting the presence of animals then it enables repeller module to repelling them through the generation of ultrasounds, which has recently been proven as an alternative, effective method for protecting crops against predicted animals. Animals generally have a sound sensitive threshold that is far higher than humans. They can hear sounds having lower frequencies with respect to the human ear. For instance, while the audible range for humans is from 64Hz - 23KHz, the corresponding range of goats, sheep, domestic pigs, dogs and cats is 78Hz - 37KHz, 10Hz - 30KHz, 42Hz - 40.5KHz 67Hz - 45KHz and 45Hz - 64KHz respectively.

Monitoring and Visualizing

The system works in real time detect the animals in the field, in addition the farmers can access the view of their fields remotely. Type of animal and also the count can be given. The animal recognition module will share the data over the cloud regularly through a Wi-Fi connection. The cloud setup will consist of a private cloud instance running on a machine. The data shared will be used to analyse the patterns and responses of wild animals. The farmer can visualize the errors if any, resolve them, and achieve better results.

Notification

The email and sms notification consisting of captured image is notified to the user regarding the detected motion in this phase. The email is sent to registered email id and sms is sent to the Telegram account of the user to the registered number.

Performance Analysis

In this module we able to find the performance of our system using SENSITIVITY, SPECIFICITY AND ACCURACY of

Data in the datasets are divided into two classes not animal (the negative class) and animal and type (the positive class). Sensitivity, specificity,

and accuracy are calculated using the True positive (TP), true negative (TN), false negative (FN), and false positive (FP). TP is the number of positive cases that are classified as positive. FP is the number of negative cases that are classified as positive. TN is the number of negative cases classified as negative and FN is the number of positive cases classified as negative

	True (relevant)	False (not relevant)
Positive (retrieved)	TP	FP
Negative (not retrieved)	TN	FN

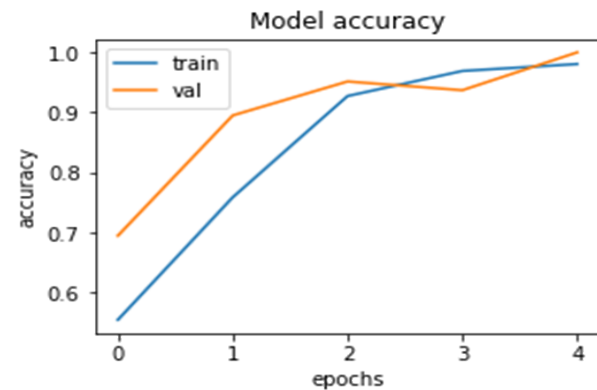
Accuracy

Accuracy is a measure that tells whether a model/algorithm is being trained correctly and how it performs. In the context of this thesis, accuracy tells how well it is performing in detecting humans in underwater environment. Accuracy is calculated using the following formula.

$$Accuracy = (T P + T N) / (T P + T N + F P + F N)$$

8. RESULT AND DISCUSSION

Fig 8.1. Training and Validation accuracy and



loss graph

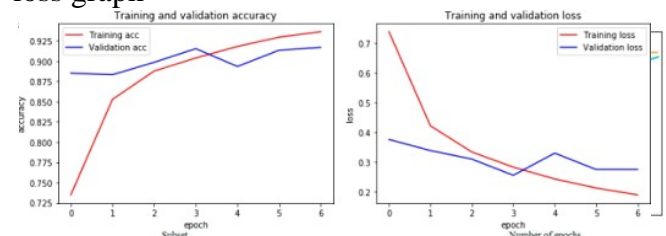


Fig.8.2. (a) accuracy of the joint CNN (Top-1 and Top-5) during training; (b) training and testing accuracy of the joint CNN (Top-5).

Table 8.3. Animal recognition results using a single branch SVM.

AP, %	MR,%	FP,%	Animals	AP, %	FP,%
78.83	12.2	11.3	Goat	76.52	16.3
80.64	9.4	14.8	Cow	81.3	12.5
73.88	15.1	18.6	Elephant	75.54	17.9
76.74	13.7	17.4	Deer	69.88	22.4
80.91	8.9	16.1	Horse	63.85	26.9
79.72	8.1	18.2	Pig	79.21	18.7

Table 8.4. Animal recognition results using the joint CNN.

AP, %	MR,%	FP,%	Animals	AP, %	MR,%	FP,%
83.37	10.7	9.7	Goat	81.93	6.9	14.4
84.29	9.1	13.2	Cow	85.69	7.1	10.8
79.13	12.4	16.3	Elephant	79.14	12.3	14.7
80.21	11.8	16.5	Deer	75.35	18.6	19.8
84.9	7.9	12.9	Horse	69.52	21.6	24.8
83.07	8	15.6	Pig	81.23	14.9	17.2

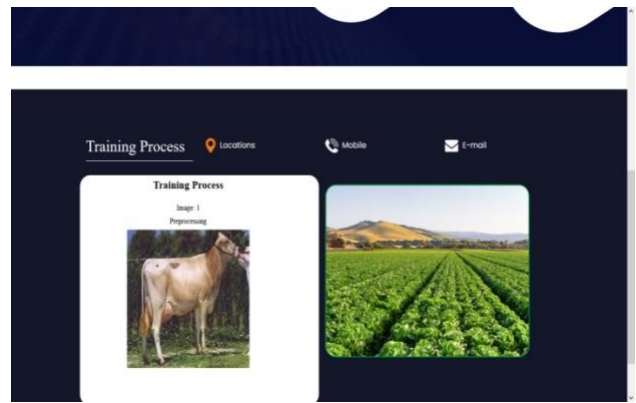


Fig.8.8.Preprocessing

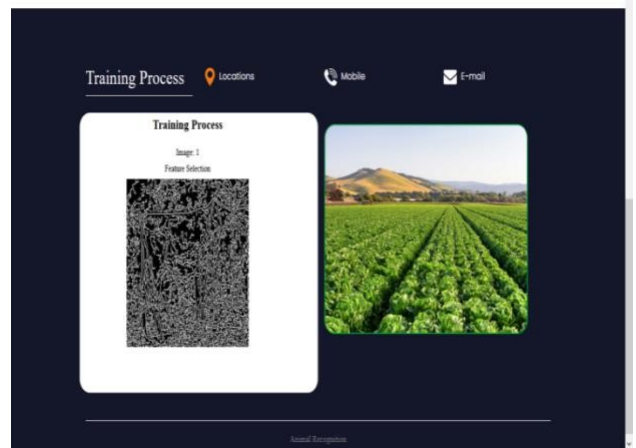


Fig.8.9.Feature Selection



Fig.8.5.Animal monitoring

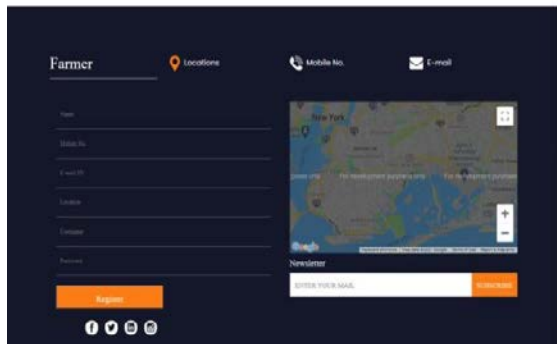


Fig.8.6.Register process

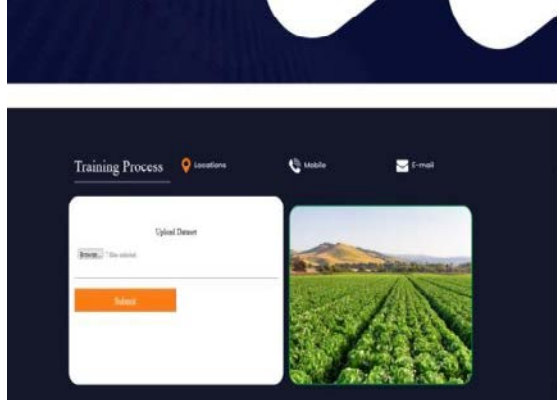


Fig.8.7.Training process

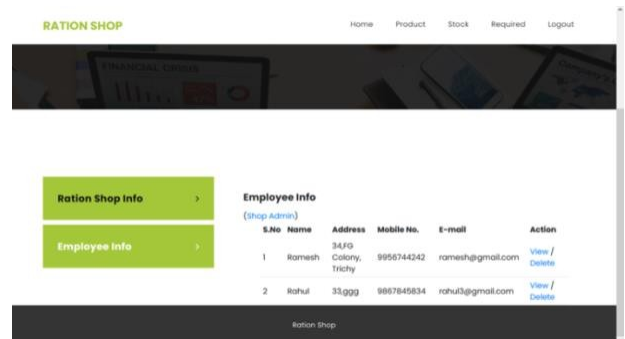


Fig.8.10.farmer Information

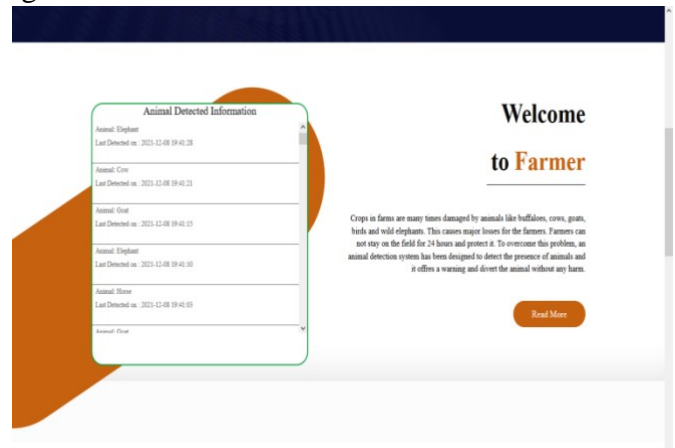


Fig.11.Animal Detection Information

9. CONCLUSION

Agricultural farm security is widely needed technology nowadays. In order to accomplish this, a vision-based system is proposed and implemented using Python and Open CV and developed an Animal Repellent System to blow out the animals. The implementation of the application required the design and development of a complex system for intelligent animal repulsion, which integrates newly developed software components and allows to recognize the presence and species of animals in realtime and also to avoid crop damages caused by the animals. Based on the category of the animal detected, the edge computing device executes its DCNN Animal Recognition model to identify the target, and if an animal is detected, it sends back a message to the Animal Repelling Module including the type of ultrasound to be generated according to the category of the animal. The proposed CNN was evaluated on the created animal database. The overall performances were obtained using different number of training images and test images. The obtained experimental results of the performed experiments show that the proposed CNN gives the best recognition rate for a greater number of input training images (accuracy of about 98 %). This project presented a real-time monitoring solution based on AI technology to address the problems of crop damages against animals. This technology used can help farmers and agronomists in their decision making and management process.

10. FUTURE ENHANCEMENT

Further in the proposed architecture, some image compression techniques can be developed to reduce the time taken for notification to reach user as described above.

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