International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 4, ISSN No. 2455-2143, Pages 133-138
Published Online August 2020 in IJEAST (http://www.ijeast.com)

AUTOMATED REAL-TIME LOCUST MANAGEMENT USING ARTIFICIAL INTELLIGENCE

Akshatha Pramod
Department of ECE
BNM Institute of Technology, Bangalore
Karnataka, India

Deeksha.R
Department of ECE
BNM Institute of Technology, Bangalore
Karnataka, India

Neha H.C
Department of ECE
BNM institute of technology, Bangalore
Karnataka, India

Dr. Jyoti R Munavalli
Department of ECE
BNM institute of technology, Bangalore
Karnataka, India

Abstract— **Locust Invasion is a major problem to crops and also vast unused fields in many parts of the world. This paper proposes an idea to make use of Artificial Intelligence for real time locust management. Artificial Intelligence Drone has the ability to identify and kill the locust swarms in real time. This paper explains about locust, their life cycle, various other locust management techniques used across the world and we propose a methodology for real time locust management by using AI techniques like CNN (Convolutional Neural Network), drone, mechanism to spray the pesticide and real time object detection.**

Keywords: **Locust Management, Artificial Intelligence (AI), Drone, Object Detection**

I. INTRODUCTION

Locusts (derived from the Vulgar Latin locust and are called Schistocerca Gregaria meaning grasshopper) are a collection of grasshopper species belonging to the Acrididae family. Normally they live and breed in semi-arid or desert regions. These have a swarming phase that is commonly called the locust swarm phase in these species (Zhang Long, Lecoq Michel Latchininsky Alexandre, 2019). In the early stages the species appear similar to the common grasshopper and this stage is called hoppers. Later they develop to winged locusts that travel in groups often called swarms (Locust swarm). As these require green vegetation for their development, in order to achieve this, these migrate with an attack and feed mechanism (Michel Lecoq,2001). These enormous swarms spread across regions devouring crops and damaging agricultural lands. An adult locust can eat upto 1.984467g of vegetation per day, which is its own body weight. These locusts swell up to 70 billion insects which can destroy a ton of crops every day. According to an estimation, around 40 million locusts can eat as much as 35,000 people eat in a day (Latchininsky Alexandre V.,2013).

Locusts have the capability of long-distance migration. This attribute makes the locusts as straddling pests. It is observed that about 30% - 40% of agricultural crop yield is lost every year because of all pests' attacks. Around 0.2% of the total crops are destroyed by locusts worldwide (José A. Sánchez-Zapata et al, 2007). But, recently the increase in the locust population has led to the destruction of crops in summer 2020 in India especially in parts of Rajasthan, Uttar Pradesh and Madhya Pradesh. 50,000 hectares (125,000 acres) of cropland had already been destroyed by locust. This is a clear indication that the loss of vegetation may also result in soil erosion (Zhang Long et al, 2019).

In this paper, we put forward an AI based solution to tackle the locust problems. We propose locust spotting and spraying the pesticide, using drones. The paper is organized as follows: Section 2 describes the life cycle of locust. Section 3 highlights the present locust management methods. Section 4 presents the proposed methodology and Section 5 is the conclusion.

II. LIFE CYCLE OF LOCUST

Locust undergoes four stages in its life as shown in Fig. 1.

1. EGG: Eggs are laid by female locusts and are set down into ground in groups. The eggs hatch after 3 weeks.

NYMPH: After the egg stage they become nymph. Over one or two months after hatching they undergo molting for about five times called as "instar", the locust develops wings.

FLEDGLINGS: After the fifth month, nymphs turn into fledglings. But still they cannot fly yet. It takes around seven days for their body to get hardened and they become capable of flight.

ADULT: After two weeks of fledgling state, they become adults. Adults group into millions of locusts termed as swarms. They typically live around 10 weeks (Wang Xianhui, et al, 2014).

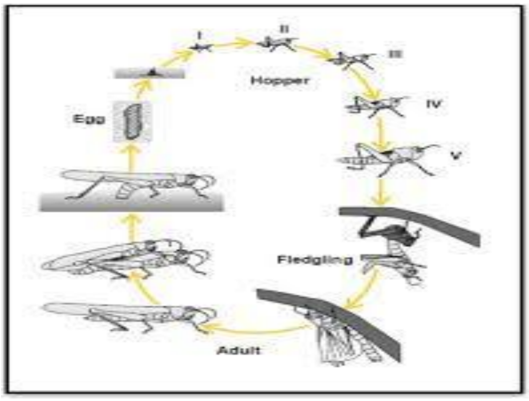

Fig. 1: Life Cycle of Locust

III. LOCUST MANAGEMENT METHODS

It is observed from literature that there are many ways in which locust problems have been solved in many parts of the world in the past (Michel,Lecoq,2001). The past locust management strategy included burning of tyres to scare the swarm or catching locusts in nets (YatesChristian,2015). Improvement in the knowledge of pests may help to curb this problem easily. Efficient implementation of monitoring and controlling of locust swarms help to manage them. We should be able to locate the rapid invasion of locusts (Zhang Long, et al,2019).

Locust management is part of Food and Agriculture Organization (FAO). They maintain DLIS (Desert Locust Information Service). They update the information such as status of locust population, the amount of vegetation destroyed, soil erosion caused. This information helps to give warning if the outbreak of locust is predicted in near future (Waldner François, et al,2015).

However, at present the preliminary method deployed is applying organophosphate chemical in small concentrations by vehicles mounted and aerial sprayers (Michel Lecoq, 2005). Another solution may be by using swarm management strategy. In this method, low flying planes are used to create atmospheric disturbances to disrupt locusts (Sharma Anil, 2014). In the recent locust attack in India, the government deployed fire brigades for pesticide spray, control vehicles with spray equipment and tractor mounted sprayers to control locusts.
Another locust management technique used in various countries is a quality-controlled spraying technique (Miche,Lecoq,2005). Modeling and understanding locust swarming can also be a method of locust management. Modelling in other organisms with respect to the coordinated movement would be helpful in locust management (G Ariel, et al,2015).

In Kazakhstan area, combined satellite and ground data has been used to build a locust monitoring system. Statistical analyses show that the locust outbreak is more when the level of water in the lake is less and Reed grass is found more during the dry hot season. They had also come to another conclusion that lower temperature and higher water levels decrease the outbreak of locusts (P Propastin ,2012).

IV. PROPOSED METHODOLOGY

We propose methodology for recognizing locusts and then sprinkle the pesticide on the locusts. For this we use the Convolutional Neural Network (CNN), Drone, Camera and software.

A. Convolutional Neural Network-

Convolutional neural network also known as CNN is an artificial neural network that is mostly used for classification of images. Convolution layers are the most important part of CNN model. convolution can be described as a simple method of application of a filter to an input that will lead to an activation .The process of repeated application of the same filter to an input will result in a map activation and this map is termed as a feature map that will indicate the location ,strength of the detected feature of the input image.

With respect to (CNN) convolutional neural network, a convolution can be described as a linear operation. This involves multiplication of input to a set of weights similar to a traditional neural network. For two-dimensional input, the multiplication is performed between an array of input data and a two-dimensional array of weights, called a filter or a kernel as shown in Fig [2].

Thus, to summarize we have an *input*, such as an image of certain pixel values, and we also have a *filter*, that is a set of weights, and the filter is systematically applied to the input data to create a *feature map*.

Images can be considered as a matrix with values where these values correspond to the intensity of light. where white is for highest intensity, black for lowest intensity at each of the pixel values. Grayscale images will have single value for each pixel however a colored image is represented by light intensity value of RGB (red, green, blue) for each pixel value. Thus, for a gray scale image the dimensions are a 400 by 400-pixel image has the dimensions [400×400×1] [400×400×1] and [400×400×3] [400×400×3] for colored images. Images used for machine learning models, are rescaled so that the light intensity values to be bound between 0 and 1.

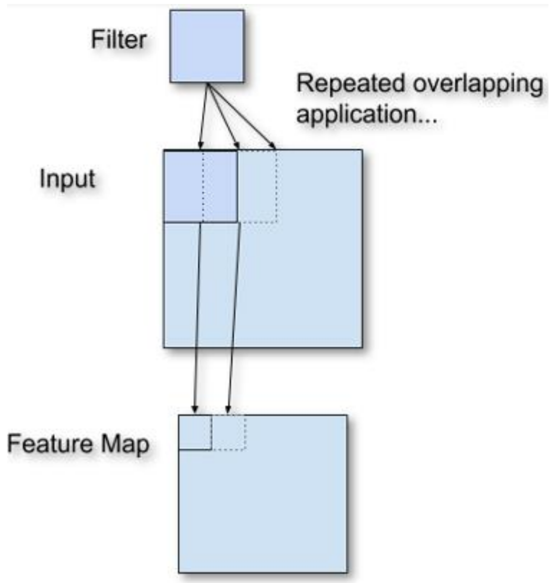

Fig 2: Example of a Filter Applied to a Two-Dimensional Input to Create a Feature Map

Convolutional Neural Network is very efficient in image processing. An Image is given as Input to the Convolutional layer followed by nonlinearity and Pooling layer. Pooling acts as a filter and involves selecting a Pooling operation. The size of feature map selected should always be greater than the size of filter or Pooling operation. The precise size is always 2x2 pixel which is applied to a stride of 2 pixels. The size of feature map is always reduced by a factor of 2 by a Pooling layer. Let s pooling layer be applied to a feature map of size 6x6 i.e, 36 pixels. The output is a 3x3 i.e, 9 pixels pooled feature map (Saqib Muhammad ,et al,2017).

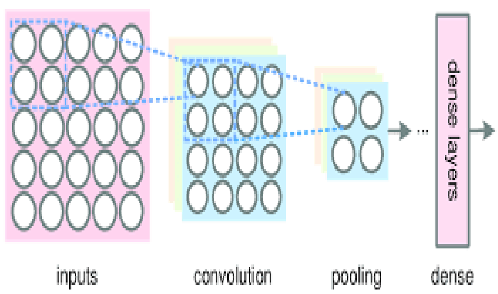

Fig. 3: Layers in the model

ReLu (Rectified Liner Unit): ReLu always maintains positive values and maps all the negative values to zero. The operation is to be repeated on hundreds of layers so that each layer will learn to detect new and different features. Classification is to be performed after feature detection. The next step is FC (Fully Connected) layer with the output as a vector of k dimension where k represents the number of classes a network can predict. The last layer of the architecture of a CNN includes a SoftMax function. This function helps to provide the classification output (Fred M Abien, 2019,).

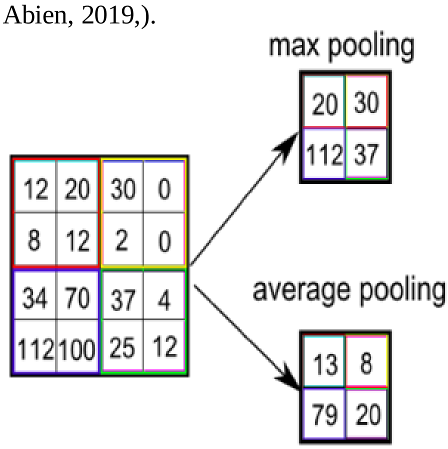

Fig. 4: Matrix Representation of Max and Average Pooling

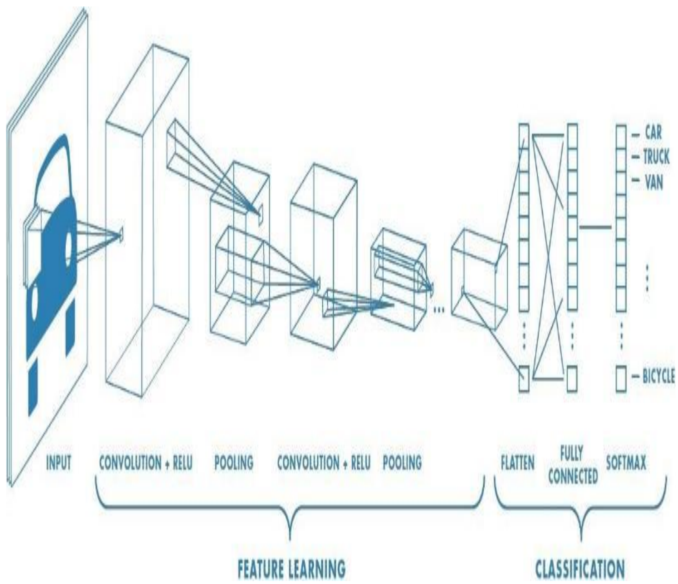

Fig. 5: Various stages in CNN model

B. About the drone-

AGRAS MG-1S is an agricultural UAV drone. It allows a total weight of 8.8 kg (without batteries). It has a DJI designated power battery (MG 12000). The drone has a foldable propeller made-up of high performance engineered plastic material. The operating voltage is 12S LiPo. It allows a motor of 280 g including a cooling fan. A liquid tank spray system that can withstand a payload of 10 kg is also present. The remote controller operates at 2.4-2.483 GHz which has a maximum transmission range of 1Km.The maximum operating speed of the drone is 8 m/s and the maximum flying speed is 22 m/s.

C. Mechanism to spray the pesticide-

Locust detector is a device that has been designed for spot and spray mechanisms. Artificial Intelligence drone acts as a detector consisting of a real time image capturing drone along with a completely natural spray that only affects the locust swarm consisting of caraway, orange peel and wintergreen oils that are natural and tested to reduce the mortality of locust by approximately 80%(Filho Iost ,et al,2020). In these systems, an overhead camera is often used to detect the locust swarm and spray that helps farmers in protecting their farms from the devouring attack of locust (Maski Devanand,et al,2017).

D. Object detection by drone-

Artificial Intelligence is of great use in Drone Industry. Drones emerged to help the general public as well as the Defense research for which it was primarily built. Today Drones help public in delivering the essentials, in farming and AI has made the process easier. Today, even the general public can use the drones which can fly as high as 2kms.These drones have high resolution cameras attached to them that are capable of capturing high quality images which can be used for different applications in wildlife photography, geological survey, monitoring the crops and its maintenance, land development, disease control, defect localization, surveillance, etc(Gordon Michael S ,et al,2017).

To completely capture landscapes and water bodies, the process of acquiring aerial images can be categorized into two steps:

Photogrammetry**:** When an unmanned vehicle i.e., Drone's flight, several images have to be taken at regular intervals to get an overlapped image. This is very important as the final image is used to measure and calculate the exact distance between two objects like two hills and this process is known as photogrammetry.

Image stitching: Once the acquisition of data in the form of image and videos has been completed, the next process is to combine individual images into a map by using a special form of photogrammetry to stitch the images quickly and accurately together. This special form of photogrammetry is called Structure-from-Motion software which stitches images of the same scene that have been captured from different angles, together by comparing the two images based on some features, and matching them and measuring angles between those objects (like hills) in each image. Apart from matching the images are also named as per their geographical information availed by using GSM model in Drones while flying in those areas. The map can be used for various kinds of applications.

E.Camera Specifications-

The resolution of camera is the number of pixels that the sensor will map from that of the real object. The estimated range that cameras of Unmanned aerial vehicle have varies between 2–50Mp. Higher-resolution cameras have greater Ground Sample Distance as compared to lower resolution camera of equal size. High MP resolution with small sensor size will result in images diffraction effects that is sharp images cannot be processed.

Camera aperture

The aperture defines how much part of sensor or the lens is exposed to light. If the aperture value f is fixed it will affect quality of images captured by a camera and increase the

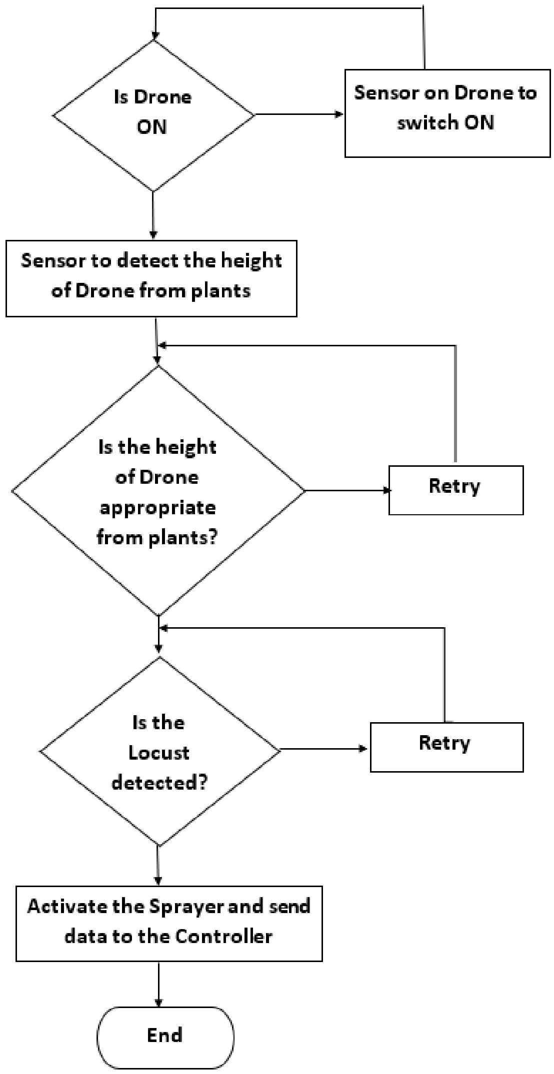

Fig. 6: Flowchart

exposure time resulting in blurry images. The images will be darker and blurry at night compared to daylight. UAVs cameras usually have low aperture values (f= 2.0), which is fixed which keeps all objects which are few meters away from the camera in an infinite focus area or region. Low resolution cameras can't differentiate two adjacent points apart on the ground when captured too far away from ground.

Adjusting the aperture value in the camera helps in matching lighting of the surrounding to which helps to expose the sensor to capture the sharpest images of the swarms and detect their body colour, wings, essential features to discriminate them from normal grasshoppers and other insects. You should also consider the diffraction effect which in-turn affect the sharpness of the image which in-turn result in misclassification. Hence, Camera plays an important role in locust swarm detection.

F.Software-

The various software that can be used to implement the CNN model for classification and recognition of locust swarms are

1. TensorFlow is an open source end to end deep learning software it can be used in neural network
2. Keras is an open source neural network library written in python running on top of machine learning platform TensorFlow.
3. OpenCV is a library of programming functions mainly used in real time computer vision.
4. Matlab and Simulink is a Matlab based graphical programming environment
5. The cloud that can be used to get API is Thing speak

Steps:

1. Collection and formation of the image dataset from various local and regional sources
2. Preprocessing of data includes removal of noise using various filters and resizing the image.
3. Build a program to train and test the model to recognize the images
4. Real time extraction of the data from the drone camera that captures the video and preprocessing this data.
5. The data is sent to the machine and then classifies as swarms or not and the final result is sent to cloud
6. The predicted value is compared with the actual value and if the value exceeds the threshold the command to switch on sprinklers is sent.
7. The timer is set to sprinkle the pesticide.
8. The drone will navigate to different locations to repeat the same process, from step four.

V. CONCLUSION

Our proposed Artificial Intelligence Drone has the capability to capture the real time image of the locust swarms through the high-resolution camera embedded in it. The image captured is processed by use of Matlab. The images have noise which is filtered out by use of special filters. After preprocessing is done the image is recognized as Image of Swarms or other insects by the use of Convolutional neural network algorithm and Max pooling method. The feature of Swarms is matched with already available data set of Swarms collected at different areas and at different time of the day. After proper detection and recognition of locust swarms by the computer, the computer sends the signal to the drone to spray the pesticides on the swarms immediately. The sprinkler is activated and the drone moves to the higher altitude to spray in the swarms. After the required swarms stop to fly or the number of Swarms detected by the camera is less than 10-20 the spraying action is terminated and if there are other insects the spraying action is not required. All these should happen in real time and need high speed drones and accurate sprinkles along with real time processing. Our proposed solution is this. To capture image, we need good sunlight and it is difficult in night light.

VI. REFERENCE

[1] Latchininsky Alexandre V.(2013). Locusts and remote sensing: a review. J. of Applied Remote Sensing,7(1), 075099

[2] Zhang Long, Lecoq Michel, Latchininsky Alexandre v, Hunter D.M. January 2019., "Locust and Grasshopper Management. Annual Review of Entomology 64(1):15-34,

[3] YatesChristian,2015,how-can-we-control-locust-swarms

[4] Waldner François, Mohamed Abdallahi Babah Ebbe, Cressman Keith, Defourny Pierre, (2015) Operational Monitoring of the Desert Locust Habitat with Earth Observation: An Assessment, ISPRS Int. J. Geo-Inf., 4, 2379-2400

[5] Sharma Anil, Locust Control Management: (2014) Moving from Traditional to New Technologies – An Empirical Analysis, Entomol Ornithol Herpetol , 4:1.

[6] G Ariel , A Ayali (2015), Locust Collective Motion and Its Modeling, PLOS Computational Biology, , 11(12): e1004522.

[7] P Propastin, (2012), Multisensor monitoring system for assessment of locust hazard risk in the Lake Balkhash drainage basin. Environ Manage.; 50(6):1234-1246.

[8] Miche,Lecoq,2005, Desert locust management: from ecology to anthropology 14[179:DLMFET]2.0.CO;2

[9] Michel Lecoq,2001, Recent progress in Desert and Migratory Locust, management in Africa. Are preventative actions possible?

[10] Saqib Muhammad, Sharma Nabin ,Daud KhanSultan ,Blumenstein Michael,2017. A Study on Detecting Drones Using Deep Convolutional Neural Networks IEEE AVSS , Lecce, ITALY

[11] Jose A. Sánchez-Zapata, José A. Donázar, Antonio Delgado, Manuela G. Forero, Olga Ceballos And Fernando Hiraldo,2007, Desert locust outbreaks in the Sahel: resource competition, predation and ecological effects of pest control, Journal of Applied Ecology (2007) 44, 323–329.

[12] Fred M Abien, 2019, Deep Learning using Rectified Linear Units (ReLU) ,arXiv:1803.08375v2 [cs.NE]

[13] Wang Xianhui ,Fang Xiaodong,2014,The locust genome provides insight into swarm formation and long-distance flight. Nature Communications.

[14] Maski Devanand,Kumar Palled Vijaya, 2017, Development and evaluation of drone mounted sprayer for pesticide applications to crops. Global Humaitarian Technology Conference

[15] Filho Iost , H Heldens Fernando , B Kong Wieke, Zhaodan, 2020, Drones: Innovative Technology for Use in

Precision Pest Management,J Econ Entomol. 2020 Feb 8;113(1):1-25

[16] Gordon Micheal S,Heights Yorktown , 2016, Pest Abatement Utilizing an Aerial Drone, 15 / 045 , 285 ,Patent Application Publication

[17] Zhang Long, Lecoq Michel, Latchininsky Alexandre,2019, Locust and Grasshopper Management, 2019.64:15-34. Annual review of Entomology.