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IDENTIFICATION OF INSECTS USING AN AUDIO ANALYSIS-BASED MACHINE LEARNING TECHNIQUE

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Abstract — The longstanding interaction between insects and humans has been valuable and lethal. Each year, insects transmit diseases that inflict property damage, but they also fertilize a significant portion of the global food supply. Similarly, new technology is necessary to reduce the number of harmful insects without damaging populations of beneficial insects. In the scope of this study, we offer an intelligent insect catcher that uses a sensor and sound analysis to capture and classify insects. We utilize audio research and machine learning technologies for the insect identification competition to assess many feature sets and create individualized training programs for each participant. We evaluated our classifiers in linear discriminant and binary class settings and discovered that a class labels classifier detecting mosquito species has near-perfect accuracy. It proves that the proposed trap is effective.

Keywords — ***Agriculture, Audio-analysis, Insect catcher, IoT, Machine learning.***

1. INTRODUCTION

Given the increased population, agriculture must be less damaging to the environment than ever before. As a result, agricultural monitoring has become increasingly important in the modern world[1][2]. Machine learning has also become a popular study topic in recent years, with applications in various fields such as image processing, cyber security, metric science, etc.[3][4][5][6][7][8][9][10][11]. The dataset is essential for machine learning techniques. When we have all the data, we can determine what is wrong with crop growth, photosynthesis, severe weather, and greenhouse adaptation. No longer can farmers boost crop yield by using excessive pesticides, insecticides, and fertilizers. Its alteration precludes people from engaging in that behaviour. Hence it was inevitable that the outcome would occur. The machine would examine the farm and inform the farmer when it was safe to apply chemicals to his field by telling him when to do a check. Additionally, the device informed the farmer when to use pesticides on his property. The farmer's efforts would save time, money, and the environment. The buzzing of bees may be detected by flowers, which makes their nectar more appetizing. Too many pesticides, insecticides, inorganic fertilizers, and chemicals that cause cross-pollination hurt insects, which make up 90% of all living

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things[12]. Insects constitute 90% of all life on Earth. It is a problem because 90% of all living organisms are insects. We frequently forget It. It is problematic given that 90% of all organisms on Earth are insects. Commonly, farmers use chemical fertilizers and pesticides to increase crop output and quality. On the other hand, we tend to ignore that excessive pesticide usage causes insects to lose interest in specific plants or die from exposure to poisons and pollutants. Excessive pesticide use produces an abundance of both. If nothing is done to preserve the last 500 species of pollinators, they will become extinct like the dinosaurs. If they are not safeguarded, it will occur. The extinction of 2,000 pollinator species may have been caused by human activity. We must also swiftly identify and prevent the spread of agricultural diseases throughout the area. The first solution that sprang to mind while attempting to resolve the issue was educating farmers to use chemical treatments only when undesirable growth patterns or harmful pests are present. It was the initial thought when trying to resolve the issue. It was the initial guess of the research, and it proved correct. Honeybees and other pollinators are dying because farmers continue to apply hazardous chemicals even with no apparent disease symptoms. It may also determine the kind of pollinator present in the fields and the frequency of their visits. The data is helpful for crop management. Farmers could use This information to make better decisions about where to grow plants that look good. It could help them make more money. It is done by looking at how often animal sounds happen. It tracks animals that ruin crops. For this study, our method can tell the difference between honeybees, Aedes, Culex, and Anopheles mosquitoes [13]. The study will add bugs that do not know. If a farmer or the government can recognize early warning signs of a problem, they can take preventative actions before the issue affects many individuals. Using system data, a user may determine which device transmitted a signal. When a tree fell, sound analysis alerted the appropriate individuals. It is crucial due to illegal tree cutting. Widespread illegal logging is prevalent. Analyse the frequency and pitch of wood cutting. If we have access to data from environmental and gas sensors, we can precisely anticipate the spread of wildfires. We will avert further harm. If the plant does not receive enough light or warmth to function in greenhouse mode, we can instruct the device to take appropriate action. Its method acts as an incubator.

2. LITERATURE REVIEW

After analysing smallholder production practices, the researcher developed a monitoring and control system geared toward rural areas. We investigated this answer, and the results are shown here. Then this transpired. Coverage is provided for data processing, networking, and sensor integration. Few scientists have developed AI-IoT software (IoT). Since each IoT module functions as a neuron, the network may be converted into an artificial neural network. It altered by Maximizing power transfer between nodes, prolonged the network's lifespan, and prevented the power hole. The objective was to see if data could be processed locally without accessing the cloud. No cloud-based uploads are required. These studies investigated whether network data could be managed without the shadow. Agricultural monitors based on LoRa are uncommon. We failed. Now we know. ZigBee "fails miserably" over long distances but performs admirably at medium and short distances. Despite its average distance performance (more than 1 km), it is true[14]. Sensor data was collected using a mini-PC and an app with a new set of sensors and Microphones made of mesh and powered by a battery. Three leading authorities about low-cost tracking all endorse this idea. Data is spread through edge computing, FFT audio streams, and mesh networks. 110-meter nodes limit range and power. Academics made an IoT mesh network for farms. They keep an eye on Earth, the air, and the sun. Electrical and thermal testing of the sensor. Sensors were checked. Sensors. Mesh WiFi has not been tested. The WiFi range is untested. A.N.T./LoRa is backed by universities (IoT)[15]. TDMA-related. TDMA-synthesis. Coverage, reliability, and efficiency are all improved by 200 nodes. Few researchers favour using Bluetooth mesh IoT devices to monitor crops. Uncommon professors. The novel concept Requires citations. Using Qualcomm's C.S.R. mesh enabled communication between network nodes. The one-hectare testing area is equipped with thirty sensors. It is correct. Few academics favour monitoring airport cargo terminals using mesh networks connected to the Internet of Things. Such a system would be tough to implement. Developing such a system is complicated[16]. A group formed a device to monitor and track aviation cargo automatically, reducing loss and theft. To monitor farms with Edge Computing and LoRa sensors, only a few researchers have developed Smart Fields. Wireless sensors send data. A LoRa mesh network built nineteen stations spanning 800 by 600 meters. Stations. Star and mesh network comparison Seldom utilized IoT mesh networks. Each application comprises agriculture, industry, and urban technology. There are three technologies. The writers assert that any circumstance presents both challenges and opportunities. Protocols, degrees of performance, costs, and coverage vary per technology. Universities develop mesh wireless networks. Government institutions build wireless mesh networks (W.M.N.s). Infrequently IoT applications over long distances employ mesh networks. Management of mesh networks is challenging[17][18][19].

3.METHODOLOGY

As an introduction, we have compiled a brief collection of sounds that show the wing-flapping behaviour of several insects, including honeybees, mosquitoes, and others. Even though the File is enormous, we do not require a large dataset because our device has limited RAM. Therefore, we will only accept 200 audio recordings for each class, with each recording limited to one second in duration. It is valid for both internal and external data. If there were no noise in a room full of insects, the results would be more accurate and intriguing. Suppose we immediately attempt to load the audio data downloaded during Training. It will not operate since the microphone architecture is changed, and the device will not recognize what it hears. If we attempt to load the data immediately, it will not function. Re-record the downloaded files using Artemis' microphone to train on the precise inference data. It will allow us to utilize Artemis' microphone. To obtain the audio sample, we follow a specific procedure. The procedure is as follows:

From File->Examples->Spark fun Redbeard Artemis Example->PDM->Record to wav, choose the Artemis ATP board. One must execute a procedure to capture audio from the board's built-in microphone. It is crucial because the sound files originate from several microphones, and if the board did not have this information, it would not be able to discern the frequencies correctly and conclude that the sound is merely noise. To alter the recorded air column, shift the sound source back and forth while recording. It will create the illusion that an insect is approaching the microphones, allowing for more exact readings. Our precision increased as a result of our accomplishments. After recording, we use an audio splitter to make audio files precisely one second in length. Before using our previously downloaded audio recordings in editing, we cleaned them up with Audacity. Using an audio spectrogram, the procedure may detect whether the sound is clean. We will be able to instruct Artemis after segmenting the audio recordings. However, we will need some adjustments to function well as the data may be noisy owing to the enclosure or the environment in which it is used. Consequently, we advise that the model train the background dataset to perform well even if there is constantly unexpected noise in the data. The background contains all of the Audacity-split sound pieces and some audible noise.

The following stage is Training the audio data. For audio training steps are

- Audio Instruction Number One: Labels = mosquito, bee, chainsaw

After Training is complete, the model must be frozen and converted to a lite model for usage in the Edge device.

- Labels = Aedes, culex, anopheles, bee, chainsaw

Download all the files created in the preceding stages, and make a microfeature file for each class audio file.

This level requires data grouping. Sensors capture both good and harmful behaviour. The height of the plant was examined. We utilized a prior experiment to assess the Measurement of rice plants once they began to grow despite it. Therefore, regardless of what we read, we determined the remaining points using Excel's mathematical and statistical skills, the regression method, and some noise. We regret that our machine learning data set is small, yet it is sufficient for our application. Using the environmental combination QUIC sensor, we collected both standard measures and fire-related signals.

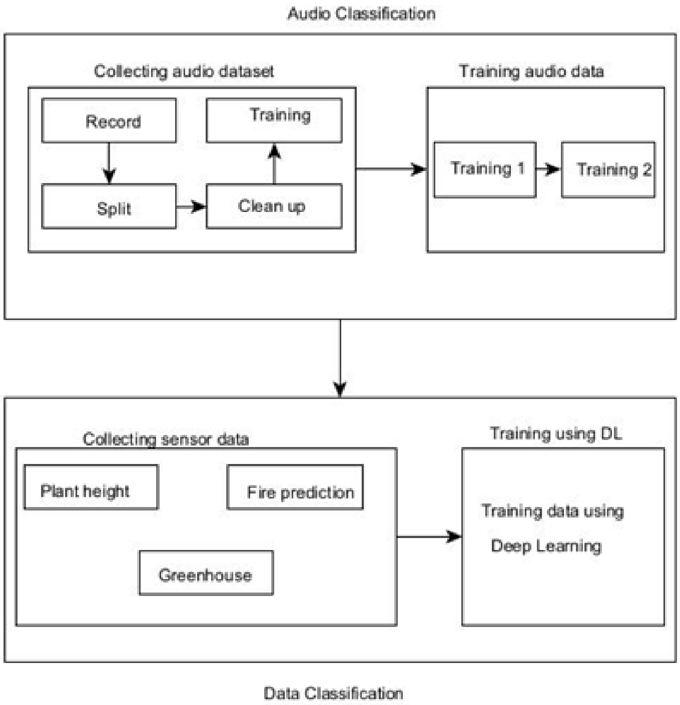

Figure 1: Methodology

Consequently, we were able to forecast when fires would start. We must monitor the fire region's temperature, humidity, total volatile organic compound, and carbon dioxide levels. Consequently, the regression method is the most used technique for obtaining predictions from a classification model. It is a crucial element needed for locating wildfires. The final step in the Classification phase of this technique is Greenhouse Adaptation. Using a Quick VCNL4040 module and an ambient combination sensor, we determined the area's light level, temperature, and CO_2 concentration. The information enables the gadget to calculate when to switch to greenhouse mode to protect the plants. It can be improved to shield the crop from hail and heavy snowfall. Figure 1 it is showing the Methodology diagram. As the last step, deep learning teaches the data what to perform. After completing all training procedures, we shall move to the device's programming.

4.RESULTS AND DISCUSSION

We obtained the best results by employing the "adam" optimizer with the "binary cross-entropy" loss. Because it operates with binary and nonlinear data, the sigmoid function is utilized as an output layer activation function. Since it is used, it performs an excellent job. The same neural network regression model used to forecast fires also predicted how effectively greenhouse plants adapt. Both models showed the possibility of fire; using sensor data, the user can assess whether the plants are receiving sufficient CO2, light, and temperature. The user will be trained on how to make a result prediction. The user is responsible for making this decision. If not, the gadget may determine how the greenhouse runs and carry out the required activities. rmsprop employs adam as the optimizer and mse as the loss function to monitor plant growth. Each option was selected. The neural network outlined below has been trained to identify the daily growth trend. The model will compute the plant's height based on the number of days. Then, we will assess whether there is a significant disagreement between the conclusions and the data from the sensor, which would indicate that the plant is not developing correctly. If the results are substantially different, it is possible that the plant is not growing correctly. There is a considerable gap in the data, suggesting that the plant is not developing usually this season. Our speech model's evaluation findings will be shown on an OLED panel. In addition, we may swiftly update it to provide data to mobile or base stations depending on sounds like a mosquito buzz. Also, we do this. The methodology can quickly determine where these insects are most numerous and block their reproduction. The model might even construct a system enabling drones to self-apply insecticides or pesticides in agricultural districts, or the study could report illegal logging while maintaining complete control. Figure 2 shows the test result images.

After training the audio analysis model, we will develop value-output models. We will use servo motors to protect plants from bad weather. Based on this data, we can assess whether the light, temperature, and CO2 levels are optimal for plant growth. Regression is limited to linear predictions only. Even though regression was utilized for training our model to determine plant height, it has one drawback. If there were no upper limit, the number would continue endlessly and represent the plant's height in kilometres. If a height restriction is established, the system shows the size of the plant in meters. We will collect daily plant measurements and compare them to our model's predictions for that day. If the expected height of the model is significantly less than the actual height of the plant, this may suggest that the plant is not receiving sufficient nutrients. If the two variables differ significantly, the model's predicted height and the plant's actual height will also diverge significantly.

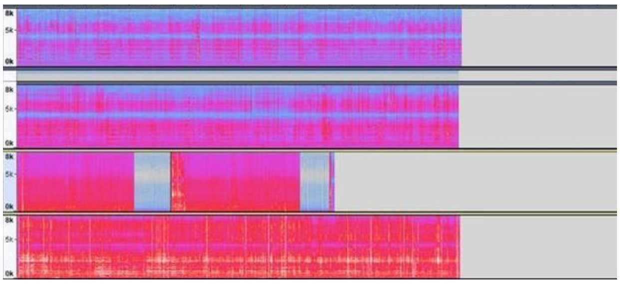

Figure 2: Audacity used for deleting audio

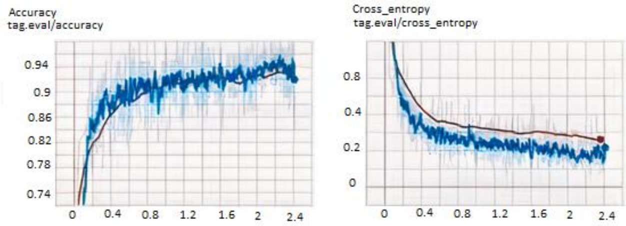

Figure 3: Training and its visualization on Tensor Board

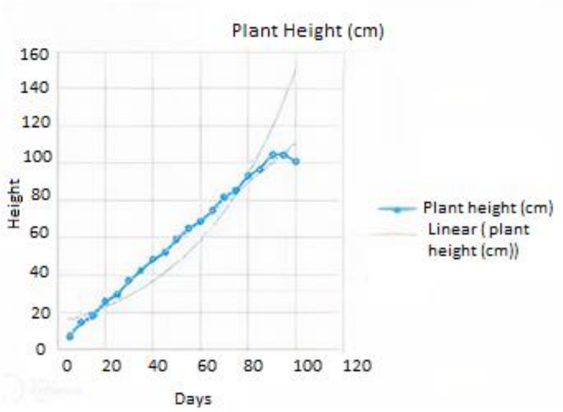

Figure 4: Normalize values

Changing the phone's mode automatically adapts it to the circumstance. We will complete our tasks quickly. Additionally, we wished to illustrate how our plants respond to varying amounts of water. We have utilized technology to warn folks of the presence of disease-carrying vectors. If we hear an insect's sound, we can save the crop. It protects the farmer for a substantial amount of time and encourages them only to use pesticides when required. It guarantees that all individuals receive wholesome foods. We may identify trees illegally cut down and report them to the Forest Service, which will take the necessary measures. As a result, we will soon no longer be allowed to cut down trees. We have also studied how to listen for gunshots, notify poachers of the authorities, and take resolute action against them. It will soon be accessible. Figure 3 shows the Training and its visualization on Tensor Board, and Figure 4 shows Normalized values.

5. CONCLUSION

Our intelligent insect detection device detects and notifies only harmful insects while leaving others unchanged. They are exclusive to our products. The sensor on the gadget can determine what sort of bug it is. It makes it easy to find folks. It makes things more accurate.

With the sensor data, we experimented with feature extraction and machine learning. After that, things got better. We could classify insects by ourselves. Without data, it was not feasible to analyse. Our study reveals that audio feature extraction leads to favourable outcomes. As proof, these tactics did work. The accuracy did not vary substantially when mixed classifier outputs with the same attributes. It suggests that there should be better grouping. We also learned this using ensemble with distinct sets of features from several signal representations improved the precision during our inquiry. It grew better at what it did. This strategy increased the accuracy of the results. We obtained 99 percent of what we wanted by restricting our aim to a yes/no bug collecting choice. Almost everything that we said was true. We were accurate 98 percent of the time. We will then be able to catch bugs. It was like 99.9 percent of the things that had happened previously. Based on what we have learned, a trap with classifiers may detect only the proper insects. It is possible to catch insects. Many individuals might get trapped on the web. The trap may acquire more than one object at once. The surprise might function since it can catch different sorts of animals. The study's conclusions are crucial and will lead to future investigation. In search of idea drifts, studying the transmission as a quasi-data stream might be helpful if environmental perturbations result in changes to specific insect characteristics.

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