Design of Animal Detection System usingTinyML

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***Abstract*— Nowadays, the animal signboards are usually set up to guide the visitors to recognize the current animals. Yet, the tourists cannot find the desired species because these conventional animal nameplates only give brief descriptions and introductions of the animals (i.e., their current location) immediately, which lacks of interactivity and convenience. In view of the above problem, a smart animal tracking system based on machine learning is proposed in our project. The proposed system is mainly implemented by using motiondetection, tracking techniques and ESP32 CAM. So, it can achieve the purpose of allowing the users to observe the animals which they want to look quickly and it alertsthe users when animals are near them to avoid conflicts between human and animal. The main aim of this project is to build a wild-life monitoring system using TinyML package.**

To develop the system, we are using ESP32 CAM, PIR motion sensor and Edge impulse studio. In this, the sensor node which is capable of capturing the image andclassify image in deep sleep for an event to occur. The event occurs when the PIR motion sensor detects any animal activity. Whenever the movement is tracked by the PIR motion sensor it wakes up and captures the image of the animal by ESP32 CAM. The image captured by ESP32 classifies the image with the help of TinyML model. It sends the uploaded data of the imagesto the web server and goes back to sleep again. The data can be measured by the sensor then SMS/E-mail is sent to the user so that the location of the animal can be determined.

***Keywords* — TinyML, Sensor node, Edge impulse studio, Motion detection, Web server.**

Introduction

This project aims to track the wild animals when they arriveand send alert. Monitoring wildlife is necessary to monitor animal migration patterns, habitat use, and population demographics. Future generations will be able to appreciate our natural world and the amazing animals that call it home if we continue to protect wildlife. Understanding how species interact within their ecosystems and howanthropogenic and environmental factors affect them is crucial for helping to protect wildlife.Animal tracking data enables us to comprehend how individuals and populations travel within their immediate environment, migrate across oceans and continents, and change over the course of generations. Wildlife monitoring is important for effective protection, sustainable use and scientific management of wildlife resources. More seriously, many wild species on Earth have been driven to extinction, and many species are introduced into new areas where they can disrupt both natural and human systems. Monitoring wild animals, therefore, is essential as it provides researchers evidences to inform conservation and management decisions to maintain diverse, balanced and sustainable ecosystems in the face of those changes. The core function of our project is to develop a detection systemthat is cost-effective, so we will be using the components that have effective operation and usage. The detection process of this project can be operated by using ESP32CAM and XAMPP web server to store the captured image of the animal.The main functionality of this project is to track and monitor the wild animals by their movement using PIRmotion sensor. When this happens, the sensor node that wasin deep sleep mode awakens, captures the image, and uses the tinyML model to classify it. It then establishes a connection with a web server, uploads the data, and goes back to sleep. It then connects to web server and upload the data and goes back to sleep again. The proposed system simplifies this process by using XAMPP server which is an open-source package which can be easily installed and used.The acronym XAMPP is made up of the letters X for Cross-Platform, A for Apache, M for MySQL, and Ps for PHP and Perl, respectively. It is an open-source package of web solutions that include Apache distribution for many servers and Executables for the command line and modules for the Apache server, MariaDB, PHP, and Perl. This is the web application. It contains the files and directories file contains all the functions to upload and retrieve the data

After completing all of the settings, connect the sensor nodebefore launching the web application in a browser. Open thesend Alert() method in the upload. PHP file and make the necessary changes to the email settings. The user of the application can

then view the data that has been uploaded tothe web server. The system sends an e-mail alert.

I. Methodology

This project will be implemented using ESP32 CAM, PIR motion sensor. ESP32 is programmed using Arduino IDE and here an IP address will be generated. By using this IP address ESP32 CAM starts live streaming. When PIR motion sensor detects any movement it sends wakeup signalto ESP32 and it will capture the image. That images will be classified and results will be sent to the server and alert message sent to the user.

FOMO Algorithm:

Edge Impulse FOMO (Faster Objects, More Objects) is anovel machine learning algorithm that brings objectdetection to highly constrained devices. It lets you countobjects, find the location of objects in an image, and trackmultiple objects in real-time using up to 30x less processingpower and memory than MobileNet SSD or YOLOv5.A really cool benefit of FOMO is that it's fullyconvolutional. If you set an image: heat map factor of 8 youcan throw in a 96x96 image (outputs 12x12 heat map), a320x320 image (outputs 40x40 heat map), or even a1024x1024 image (outputs 128x128 heat map). This makesFOMO incredibly flexible, and useful even if you have verylarge images that need to be analysed (e.g., in fault detectionwhere the faults might be very, very small). You can eventrain on smaller patches, and then scale up during inference. Additionally, FOMO is compatible with any MobileNetV2model. Depending on where the model needs to run you canpick a model with a higher or lower alpha, and transferlearning also works (although you need to train your base models specifically with FOMO in mind). This makes it easyfor end customers to use their existing models and fine-tunethem with FOMO to also add locality (e.g., we havecustomers with large transfer learning models for wildlifedetection).

TO BUILD FOMO MODEL:

- Create a new project in Edge Impulse.
- Make sure to set your labeling method to 'Boundingboxes (object detection)'.
- Collect and prepare your dataset as in Objectdetection
- Add an 'Object Detection (Images)' block to yourimpulse.
- Under Images, select 'Grayscale'
- Under Object detection, select 'Choose a differentmodel' and select one of the FOMO models.
- Make sure to lower the learning rate to 0.001 tostart.

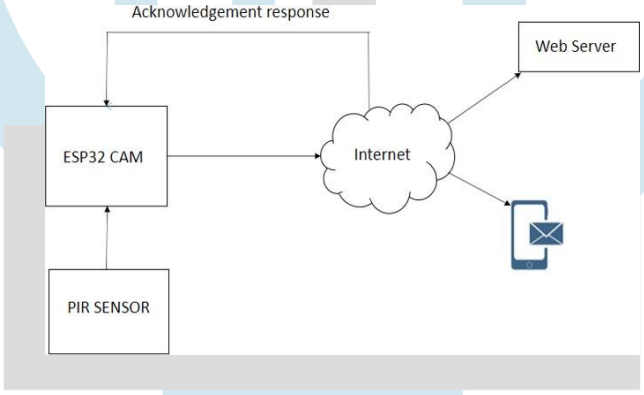

Figure1. Proposed System

III. Proposed System

The proposed system is having movement tracking system which track the movement of wild animal at the application area, identify the type of animal and report it on the webserver. The sensor node which is capable of capturing the image and classify image. System in deep sleep for an event to occur. The event occur when the PIR motion sensor detect any animal activity. When this event occur, the sensor node which is in deep sleep mode wakes up and capture the image and classify the image with the help of tinyML model. It then connect to web server and upload the data and goes back to sleep again. The data is uploaded to web server can be seen by theuser of the application. The system also send an e-mail alert.

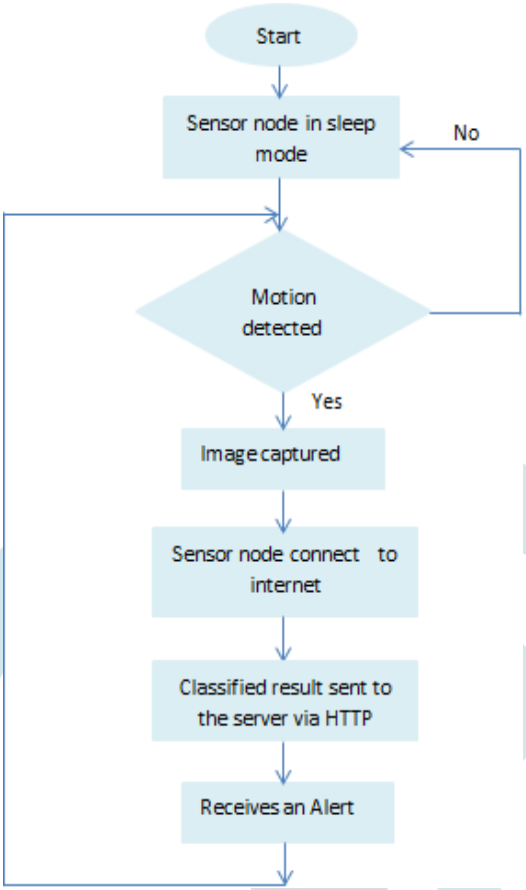

Figure2. Architecture Diagram

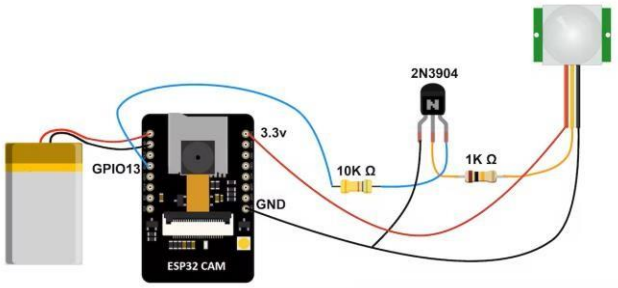

Figure 3. Circuit Diagram

V. Results

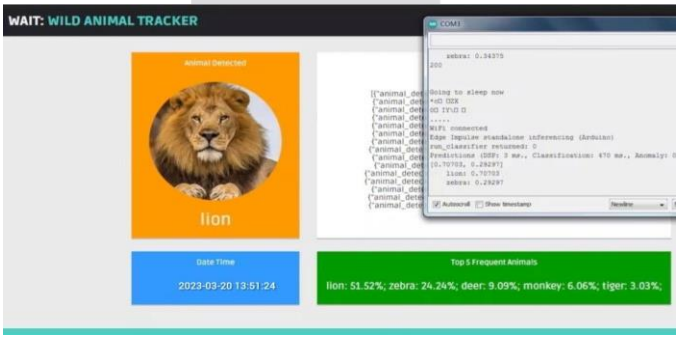

Figure 4. Output on Serial terminal and Web app

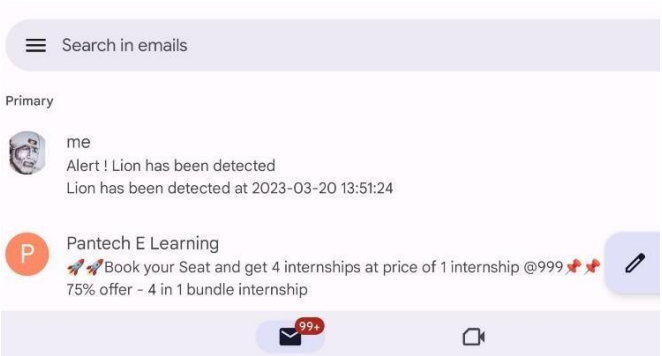

Figure 5. E-mail alert received

VI. Conclusion

Wildlife monitoring is important for effective protection,sustainable use and scientific management of wildliferesources by conserving wildlife, we're ensuring that future generations can enjoy our natural world and the incredible species that live within it. This system can be implementedin the villages or human habitant area near forests so that people are aware of the wild animal activities and take precautionary steps to avoid any human-animal conflict. To implement this TinyML algorithm used which can work with a complex dataset and produce accurate results.

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