TECHNOLOGICAL INSTITUTE OF THE PHILIPPINES – MANILA

ANITU: A MACHINE LEARNING BASED DEVICE WITH SOUND RECOGNITION AND NOTIFICATION SYSTEM FOR FOREST CONSERVATION

ADVANCED EMBEDDED SYSTEMS
MEMC 122-MCPE11S1

SUBMITTED BY:

CEZAR, ALQUIN
GALVEZ, JOHN ROY

SUBMITTED TO:

ENGR. RUFO I. MARASIGAN JR.

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1 Introduction

1.1 Background

During the pre – colonial period in the Philippines, the Filipino ancestors, or the *Ninuno*¸ worships gods and goddesses of nature. The *ninuno* perform rituals for different things such as winning wars, having a bountiful harvest, even protecting their homes. The ancestors create human-like figurines that resembles a little human being, or what they called *taotao*. These little human like figures are also called *Anito*. *Anitu or Anito* is part of the Filipino Folklore which refers to the ancient or nature spirits. It is said that these spirits are inhabit the figurines, and serves as protector of shrines, forests, or sacred places.

The Philippine land is covered by dense forest. It is one of the main sources of living and protecting the homes of the Pilipino people for many centuries from natural calamities such as landslides, flood, and devastating typhoons. The Philippines has abundant forestry, but also has a rapid population growth. Thus, the increase in demand of material for building houses.

Throughout the years, Philippines has been greatly affected deforestation. In 1900, the forest covered 70% of the land area, that is approximately 21 million hectares. By 1999, the forest covered 5.5 million hectares, and only 800kha of this is primary forest. In an article published by (Rhet Buttler, 2014), the widespread logging was responsible for much of the historical forest loss in the Philippines. Some of the contributing factors in the deforestation includes illegal activities such as illegal logging and *Kaingin* wherein a total of 19 illegal logging hotspots where recorded in the entire Philippines including municipalities in Region 1, Region 3, MIMAROPA, Region 11, and Region 13 in a publication of Philippine Forestry Statistics 2020.

Despite government bans on timber harvesting following severe flooding in the late 1980s and early 1990s, illegal logging continues today. Deforestration in the Philippine forest is growing on an alarming rate which affects communities near mountains, and forest, even taking the lives of man wherein people affected perhaps thinking on going back to tradition; praying on spirits for divine intervention.

Instead of praying to the spirits, which the *Ninunos* used to do, a device will be placed on the forest to lessen the illegal activities especially Illegal Logging. The ANITU will identify the illegal activities using sound recognition, and it will notify the registered authority on it. The authority can get its approximate location on where the activity taking place by looking at the device number. To cater the geography of the Philippine forest where in majority of the remote location doesn't have a signal capable of having an internet connection, the device will use the SMS for the notification, and will use sets of microphones and sensors for Sound Recognition.

As recorded by globalforestwatch.org, in the Philippines, from 2001 to 2019, 86% of the tree cover loss occurred in areas where the dominant drivers of loss resulted in deforestation. With this, the proponents came up with the ANITU to lessen the illegal activities that will result to deforestation, and risk for the *forest rangers*.

1.2 Problem

1.2.1 General Problem

There has been an increasing report on illegal activities in the forest of the Philippines and authorities are having a hard time monitoring, recording, and tracking down different group. Furthermore, the illegal activities cannot be easily identified. In addition, forest rangers and authorities cannot secure the forest 24/7 which give the illegal loggers time to execute their activities.

1.2.2 Specific Problem

There are machines and technologies available in the market but they are not readily available locally and the cost is too expensive. With this, the authorities and forest rangers continue to monitor illegal activities physically. Also, the existing approach in recording and monitoring is very ineffective as some illegal loggers work in groups and they can easily avoid rangers as they approach their location.

1.3 Objective of the Study

1.3.1 General Objective

The goal of this project is to aid the authorities to cracked down illegal activities in the forest using unmanned device through sound recognition, also to reduce the risk of the *Forest Rangers* in patrolling forest.

1.3.2 Specific Objective

The objectives that the study ought to achieve are listed below:

1. To design and develop a machine learning device that will help the community in protecting the forest.
2. To test and analyze different signal processing for sound recognition
3. To utilize the ISO 17025:2005 standard to evaluate the ANITU in terms of:
    - 3.1 Functionality
    - 3.2 Device durability
    - 3.3 Usability
    - 3.4 Component Effectivity
    - 3.5 Longevity of Battery power

1.4 Significance of the Study

The significance of this study is to help the community to lessen the illegal activities in the forest that will result to deforestation. Thus, this study is beneficial to the following:

Authorities. The study will help the authorities to track down illegal activities in the forest that will result to the loss of tress.

Forest Ranger. The study will reduce the risk for the forest rangers in patrolling the dense forest. The study will also help the forest rangers in protecting the forest from illegal activities.

Community. This study will help the community to monitor the condition of the forest and to avoid calamities due to deforestation.

Environment. This study will help the conservation of the environment by lessening the increasing number of forest loss.

Future Researchers. Future researchers can use the proposed device as a basis for improvement for further enhancements.

2 Requirements Analysis

2.1 Requirements

Based on the client, the physical process on monitoring and recording illegal activities in the forest is very tedious and unnecessary. The client's requirements are as follows:

1. The device should be able to send a notification via SMS in less than a minute when it records an illegal activity
2. The device must be able to identify accurate reading of illegal activities in the forest
3. The device effective range of sound detection is within 3-5 m range.
4. The device should have a reasonable cost without compromising its overall quality and functionality.
5. The device can provide a log report and type of illegal activities along with the time, date, and location. (database)

Based on the gathered requirements from the client, design criteria were derived and their corresponding constraints are presented in the table below.

Design Criteria	Constraints
The device should be able to send a notification via SMS in less than a minute when it records an illegal activity	Response Time
The device must be able to identify accurate reading of illegal activities in the forest	Accuracy
The device should have a reasonable cost without compromising its overall quality and functionality.	Economical

2.2 Specifications

1. The device uses a Raspberry Pi 4 Model B as the microcontroller processor with 1.5 GHz speed amounting to Php 3,900.00 and 3000Mah Battery
2. Using SIM800L V2 5V Wireless GSM GPRS Module
3. 3.3V/3.5V LM393 Microphone Amplifier Sound Sensor MIC Voice Module
4. Using Google Firebase for Cloud Storage

2.3 Software Requirements

1. Windows 10 x64
2. Python 3.0
3. Microsoft Excel 2019
4. Matlab / Simulink
5. Proteus 8.13

2.4 Hardware Requirements

1. Desktop / Laptop Computer

   Specification:

   Processor: Intel Core i7 – 8700k @3.70 ghz or Higher
   Ram: 16GB DDR4 3200MHZ
   Graphics Card: Nvidia Geforce GTX 1050ti or Higher

2. Raspberry Pi 4

Specification:

Processor: Broadcom BCM2711 Quad core Cortex-A72 (ARM v8) 64-bit SoC - 1.5GHz

Ram: 4GB LPDDR4 3200MHZ

3. Microphone module / Audio Sensor
4. SIM800L V2 5V Wireless GSM GPRS Module12v Solar Panel
5. 3000 mah Battery

2.5 Data Requirements

Source:

1. Environmental Sound Classification – 50 (ESC-50)
2. BDLib2 Environmental Sound Data Set
   2.1 Bountourakis, V., Vrysis, L., & Papanikolaou, G. (2015). Machine learning algorithms for environmental sound recognition: Towards soundscape semantics. In Proceedings of the Audio Mostly 2015 on Interaction with Sound (pp. 1-7).
   2.2 Bountourakis, V., Vrysis, L., Konstantoudakis, K., & Vryzas, N. (2019, June). An Enhanced Temporal Feature Integration Method for Environmental Sound Recognition. In Acoustics (Vol. 1, No. 2, pp. 410-422). Multidisciplinary Digital Publishing Institute.
3. AudioSet

3 System Architecture

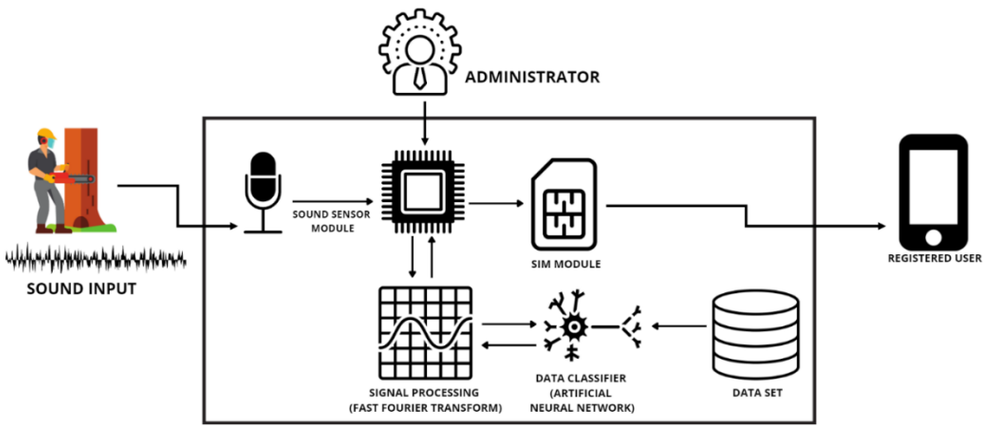

Figure 1: System Architecture

Figure 1 depicts the system software architecture for the classification of sounds in a forest area. A sound sensor will be used for the sound acquisition which will then be processed by the Raspberry Pi 4 Model B to classify whether there is illegal activity or not. In addition, the sound will be stored locally for further improvement of the algorithm. After the classification of sound, the Raspberry Pi will then send a notification via GSM or Sim module to users whether the detected signal is positive of illegal activity or not. Lastly, the Administrator will be the one to deploy the machine in an identified illegal logging hotspot and download the sounds stored locally on the device. The administrator will also be responsible for the maintenance and user registration.

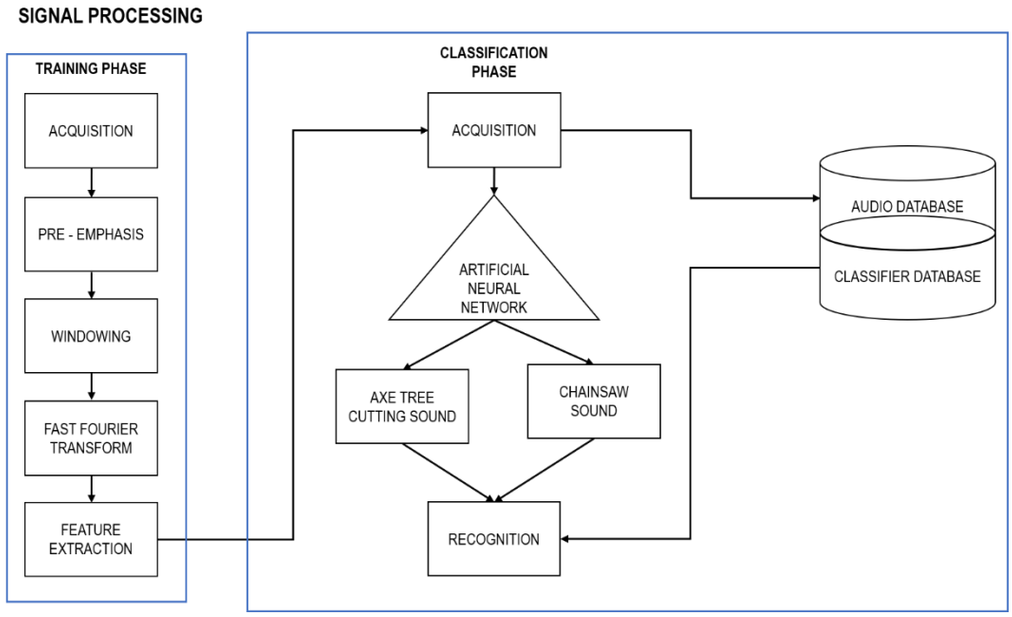

Figure 2: Signal Processing and Classification

Figure 2 shows the techniques that the researchers uses. For the Signal processing, the researchers use fast Fourier transform (FFT) to the acquired data. It will convert the time domain to frequency domain to filter out the needed or “applicable” frequency, then will revert it back to time domain. The extracted data from signal processing is the input for the Machine Learning technique, Artificial Neural Network (ANN) that will classify the extracted data into two (2), the Axe Tree Cutting sound, and Chainsaw Sound.