iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** VIII **Month of publication:** August 2026

DOI: https://doi.org/10.22214/ijraset.2026.84482

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VIII Aug 2026- Available at www.ijraset.com

Illegal Logging Detection from Acoustic Sensors

Smitha B N[1], Divyashree K[2], Preksha M[3], Priyanka H M[4], Uma T.R[5], Zaina Shariff[6]
Information Science and Engineering, Don Bosco Institute of Technology

Abstract: ***Illegal logging is a major concern for forests such as deforestation and biodiversity loss. In this presentation, we will be introducing an acoustic-based monitoring system which detects chainsaw and tree-cutting sounds and filters out everyday forest sounds like birds, wind, rain and insects. The system uses INMP441 MEMS micros and a pre-trained model for sound classification, YAMNet. It integrates with ESP32, GPS module and the IoT communications to offer instant warnings of suspicious activity. The proposed approach intends to facilitate the forest monitoring, manual patrol and assist in the conservation of forest resources. Illegal logging is responsible for the destruction of countless square kilometers of forest land, yet the robust acoustic monitoring system is often overlooked. Illegal logging for example is destroying enormous amount of square meters/kilometers of forests, in which case, the audio monitoring system, which is robust and capable is rarely being utilized.***

Keywords: Illegal logging, acoustic monitoring, environmental sound classification, YAMNet, MEMS microphone, ESP32, IoT, forest conservation.

I. INTRODUCTION

Forests provide an important natural resource and a home to wildlife and help ecological balances, control climate and support biodiversity. However illegal logging is a threat to the forest ecosystem as it causes deforestation, habitat destruction, soil fertility loss and carbon emission. But these areas must be monitored continuously, something that is a challenge in areas of large forest size and its outlying areas.

Traditional forest monitoring is based largely on manual patrolling by forest officials. This method is widely used but requires a lot of manpower, time and money. Wherever possible, the illegal removal of trees is only spotted in the face of the damage that has already been done, leading to a time lag in taking action. The advanced use of AI technology, acoustic sensing and embedded systems opens the future of automatic monitoring of forests. Acoustic monitoring is of particular benefit in examining sound patterns made by chainsaw operation and tree cutting that can help identify them from the other forest sounds. These sounds can be detected more accurately and in time by deep learning systems and make it possible to recognize suspicious activities before the ecology is be affected.

In this work, we suggest an illegal logging detection system using acoustic means in forest environments based on an INMP441 MEMS microphone, an ESP32 development board and a previously developed audio classification-based model, YAMNet. The sounds in the audio are then analysed to discern the typical noises of the surroundings from the sounds of loggers' work." Any unusual noise is detected by the system and an alert is sent using IoT-based communication module along with the location information. The automation of the monitoring process will presumably decrease the number of forest patrol personnel needed, increase the efficiency and time for forest authorities to respond, and contribute to long-term conservation of forest and biodiversity.

II. NEED OF STUDY

Illegal logging contributes to deforestation, biodiversity loss and degradation of forest ecosystems as one of the major drivers of deforestation. Present monitoring methods are largely based on manual patrol and monitoring by forest staff, which is timeconsuming and resource intensive. The continuous monitoring of forests can be challenging as they can be large, inaccessible, and it remains difficult to see unapproved felling operations until a considerable amount of damage has been done to the environment. The alternative is an acoustic based monitoring system, which can monitor the forest continuously, without the need of constant human intervention. The system detects sounds generated during the use of chainsaws in tree cutting from an early time, allowing the concerned authorities to be alerted immediately. This is not only more efficient forest monitoring, but also essential in the timescales of sustainable forest management as it means detecting and responding to illegal logging operations quicker, and reducing the need for manual monitoring and patrolling.

III. RESEARCH METHODOLOGY

Research methodology describes the progress of steps taken in building the idea of the detection of illegal logging. The hardware components should be selected, audio data should be gathered and processed, features should be extracted from the sound to be used in the classification model, the classification model should be developed, and an alert system should be implemented for real-time alerts. The full methodology is provided in the next sections.

A. Study Area and System Deployment

The integrated system is expected to be installed in protected forests, wildlife forests, reserve forests and other ecologically sensitive areas where exploitation of wood by non-legitimate people is a prominent issue. These areas can be hard to continually monitor due to their size, and inaccessibility. To tackle this challenge, acoustic sensor nodes are deployed here and there in the monitored area. All the nodes will capture the surrounding sounds in real time and assess them for suspicious sounds. The system does not broadcast what it has picked up unless it thinks it may have heard illegal logging. This technique can result in less power usage and unnecessary communication.

B. Data Collection and Sources of Data

The sounds used in this study are from publicly available environmental sounds data set as well as manually recorded forest sounds. All recordings are divided into two headings. The first group consists of the normal sounds of the forest, like birds' song, beetles' noise, water flowing, wind blowing and again, the animal noises. The second set of sounds is associated with illegal logging practices, such as a chainsaw, axe blows, human movements (such as vehicles), and other sounds usually associated with unauthorised intrusion on the forest. All audio recordings are carefully labelled before they are trained in the model based on their type of sound, and converted into a common format. The prepared dataset is further split into training, validation and testing sets to assess the performance of the classification model.

C. Theoretical framework

The proposed system is based on acoustic system approach to detect possible illegal logging activity in forest environment. Analysed sounds from the classification model are continuously processed sounds captured by the MEMS microphone. The initial step of the process on the recorded audio is pre-processing to remove noise and enhance sound quality. Processed audio is then fed as input to our pre-trained YAMNet model for intelligent audio embedding for sound classification. The last classification layer is then retrained by using the labelled forest audio data by transfer learning to enable the model to distinguish between the normal sound of forests and the sounds associated with forest activity. The system considers the occurrence of such sounds, or the probability of such sounds to be suspected when the probability of detection is greater than a predetermined level of confidence. The ESP32 controller then fetches the GPS position, and conveys an alert message to concerned forest authorities using the GSM or WIFI communication module. The alert contains the detected sound category, time of detection and where it is detected. The proposed methodology combines acoustic sensing, artificial intelligence and IoT technologies to allow continuous monitoring of forest, and to minimize reliance on manual surveillance. Expected enhancements to early detection of illegal logging and to respond quicker by forest management authorities. Technical Suggestion If your project utilizes YAMNet, don't make any statements about the extraction of features (as MFCC) and feeding them to YAMNet. The model internals compute the desired audio representations out of the audio waveform in the standard YAMNet pipeline. It is technically incorrect and might be subject to discussion up in the viva by saying “MFCCs are inputted to YAMNet”. The updated version above is the standard YAMNet workflow.

D. Performance Evaluation and Model Validation

This section describes how an illegal logging detection system (IWDS) was evaluated after training the model. To assess the system performance, forest sound marks will be used, with both the environmental sounds and illegal logging forest sounds being marked. Multiple indicators, such as accuracy, reliability, and overall effectiveness, are used to evaluate the proposed monitoring system. Evaluation of the effectiveness of the proposed classification model is performed with standard classification evaluation metrics that are used to assess the performance of classification models in most cases.

1) Performance Metrics: Evaluation of the effectiveness of the proposed classification model is performed with standard classification evaluation metrics that are used to assess the performance of classification models in most cases. The accuracy is defined as the ratio of samples classified accurately over all test samples. It provides an overall idea of its classification performance. The percentage correct among sounds identified as 'illegal logging' that are actually 'illegal logging' activities. The

larger the precision, the smaller the number of false alarms produced by the system. Recall is an indicator of the model's ability to correctly classify all real incidents of illegal logging. If you have a greater recall, there is a lesser likelihood of suspicious activities going undetected. The F1 Score combines precision and recall to get a comprehensive view by calculating the harmonic mean of both values. It provides invaluable overview of the model, particularly when there are both significant false/true negatives and false/true positives.

2) Audio Classification Model: The system uses the improved pretrained audio classification model, YAMNet, which was gained by transfer learning, to detect different sound classes. The initial pre-processing task of the INMP441 MEMS microphone is to eliminate unwanted background noise. The audio processed into meaningful texts which are then fed into the YAMNet model to obtain meaningful audio embeddings for classification. The final classification layer is adapted using a small number of labelled audio samples from forests with a range of typical environmental sounds and sounds of illegal logging, via the transfer learning technique. After training, the model then classifies received audio as either "forest activity" or "suspicious forest logging".

3) Model Validation:

o The trained model is tested on a separate set of audio recordings which are not used for training.
o Validation process consists of Classification of normal forest sounds.
o Recognizing the noise of chippers, sawmills, and logging of trees.
o Evaluation of performance over different environmental stimuli.
o Assessment of false detections of signs of positivity and negativity.
o The outcomes of the predicted labels are compared to actual labels to check the system's effectiveness and reliability.

4) Comparison with Conventional Monitoring: The following criteria are used to evaluate the proposed acoustic monitoring system in this thesis against the traditional manual forest surveillance. The proposed acoustic monitoring system is evaluated in this thesis not only by the traditional manual forest surveillance but also by the following criteria:

o Detection response time. o Coverage monitoring.
o There's a need for human effort.
o Operating expense.
o Ability to track continuously.
o The skills of detection of illegal logging.

The comparison is expected to demonstrate the capability to monitor in real time of the proposed system, as well as its ability to detect suspicious activity faster and with less need for manual forest patrolling.

5) System Reliability: The proposed system's reliability is evaluated by the continuous monitoring of the forest sounds over different time periods. When the system is tested, the stability of the system is assessed, taking into consideration factors such as variable weather, changing ambient noise and a range of forest environments. The proposed system is expected to achieve a stable detection capability, decrease false alarms, and provide timely alert when suspicious logging activities are detected.

6) Overall Performance Analysis:

The following metrics are used to evaluate the performance of the proposed illegal logging detection system:

o Detection Accuracy
o Precision
o Recall
o F1-Score
o False Alarm Rate
o Detection Response Time
o Communication Reliability
o Power Consumption

Based on these assessment criteria, it is expected that the system will provide reliable and accurate identification of illegal logging operations and be able to distinguish them from regular forest sounds.

The system combines the technologies of acoustic sensing, deep learning, and IoT communication, allowing for continuous monitoring of the forest, reducing the need for manual patrols, and supporting forest authorities in the protection of forest resources and biodiversity through timely notifications.

IV. EXPECTED RESULTS

Based on the observations of the proposed system, the following are the expected performances: The proposed acoustic monitoring system is to successfully separate the sound of illegal logging from the normal sounds of the forest such as birds, wind, rainfall, insects, and animal calls. The system aims to efficiently classify environment sounds with a high level of accuracy using the pretrained model of YAMNet with transfer learning method. Overall, the use of the INMP441 MEMS microphone, ESP32 development board, GPS module, and IoT communication will enable continuous monitoring of forest environments. The system is designed to automatically alert the relevant authorities of suspicious activity, such as chainsaw or chainsaw-like noises, within certain areas through location-based alerts and send them to the relevant authorities for immediate action. The proposed approach is also likely to save on the need to continuously patrol forests manually and make forest monitoring more efficient. The system has potential to help in protecting forest resources, preserve the biodiversity and support sustainable forest conservation through early detection and timely notification of illegal logging activities.

Table I: Anticipated Performance of the Proposed System

Performance Metric	Expected Outcome
Detection Accuracy	High (>95%)
Precision	High (>94%)
Recall	High (>93%)
False Alarm Rate	Low (< 5%)
Detection Time	Near Real-Time (within 25 seconds)
Power Consumption	Low (Suitable for long-term deployment)
Communication Reliability	Stable and Reliable

V. CONCLUSION

In this study, an illegal logging detection system based on Acoustic technology and IoT is proposed, which will be integrated with Environmental sound classification technology, to enhance the forest monitoring system. The system can detect the sound of chainsaw and tree cutting and differentiate the sound of the chain saw and tree cutting from the forest noises, such as birds, wind, rain and insects. The proposed system is designed to send alerts in real-time whenever the presence of suspicious logging is detected by incorporating the pretrained YAMNet model with an INMP441 MEMS microphone, ESP32, GPS module, and wireless communication. This can help lower the need for constant manual patrolling of the forest, facilitate quick identification of illegal logging activities, and enhance the effectiveness of forest surveillance. Proposed system can potentially enable sustainable forest management and help conserve forest resources and biodiversity with future field testing and further improvements.

VI. ACKNOWLEDGMENT

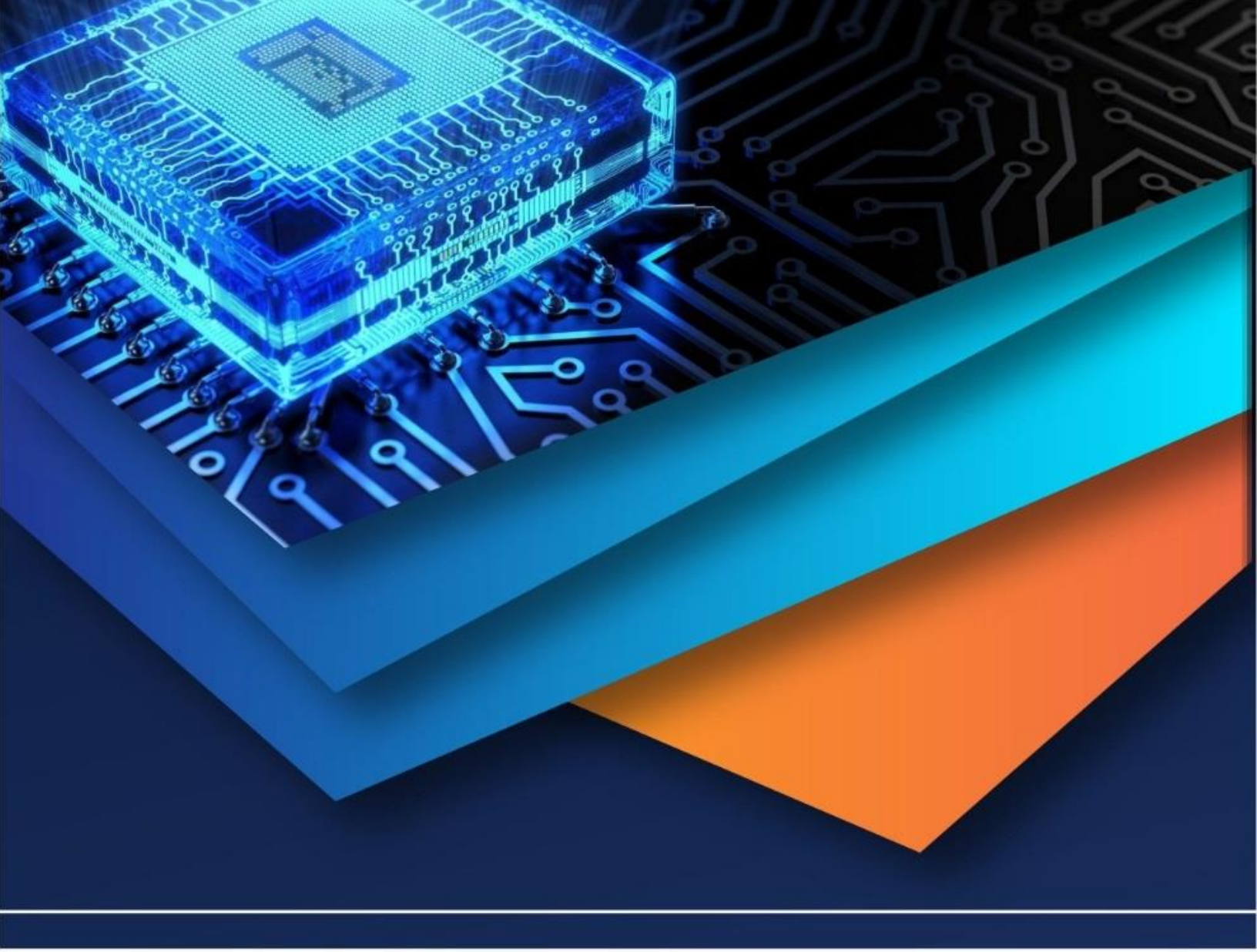
The authors would like to express their sincere gratitude to the Department of Information Science and Engineering, Don Bosco Institute of Technology, Bengaluru, for providing the necessary facilities and support to carry out this work. We are especially thankful to our project guide for their valuable guidance, continuous encouragement, and constructive suggestions throughout the course of this project. We also extend our appreciation to all the faculty members for their support and motivation. We gratefully acknowledge the researchers and organizations whose published research and publicly available datasets contributed to the development of this study. Finally, we express our heartfelt thanks to our family and friends for their constant encouragement, understanding, and support during the completion of this work.

REFERENCES

[1] U. R. Prajna, P. Adhishri, M. V. Gaonkar, K. R. Prajwal, and K. Sathwik, “Acoustic Based Real Time Monitoring and Alert System for Illegal Logging Detection,” 2026.

[2] K. Sivanandam, A. Suryanarayanan, V. Tharun, K. Srisaran, and S. Vignesh, "Monitoring System for Protection of Endangered Trees Against Illegal Cutting and Smuggling Using IoT & GSM," 2025.
[3] P. R. Rajeev, M. Siddarth, V. Suresh, and A. R. Jayan, "Sensor Fusion Based Approach for the Detection of Illegal Tree Felling," 2025.
[4] A. L. Kotian, Ashritha, A. H. Shetty, Anush, A. Hafeeza, and A. V. Suvarna, "Guardians of the Green: A Review of AI, ML and IoT Innovations Against Illegal Deforestation and Wildlife Poaching," 2025.
[5] V. Singh, K. C. Ray, and S. Tripathy, "Real-time Monitoring of the Illegal Logging Events with Intelligent Acoustic Sensors Nodes," 2024.
[6] D. Simiyu, A. Vikiru, H. Muchiri, F. Gu, and J. Butime, "Chainsaw-Sound Recognition Model for Illegal Logging in Forest," 2024.
[7] J. Svatos and J. Holub, "Impulse Acoustic Event Detection, Classification, and Localization System," 2023.
[8] S. F. Ahmad and D. K. Singh, "Detection of Tree Cutting in Forest by Using Acoustic Properties Automatically," 2022.
[9] A. Andreadis, G. Giambene, and R. Zambon, "Monitoring of Illegal Tree Cutting Using Ultra-Low-Power Smart IoT Devices," 2021.
[10] G. A. Mutiara, N. Suryana, and O. Mohd, "Multiple Sensor on Clustering Wireless Sensor Network to Tackle Illegal Cutting," 2020.
[11] G. A. Mutiara, N. S. Herman, and O. Mohd, "The Use of Long-Range Wireless Sensor Network to Monitor the Illegal Cutting Log," 2020.
[12] I. Mporas, I. Perikos, V. Kelefouras, and M. Paraskevas, "Acoustic Surveillance of Forest for Illegal Logging Detection," 2020.
[13] G. Sharma, K. Umapathy, and S. Krishnan, "Trends in Audio Signal Feature Extraction Methods," 2020.
[14] M. Magno, F. Vultier, B. Szebedy, et al., "A Bluetooth-Low-Energy Sensor Node for Acoustic Monitoring of Small Birds," 2020.
[15] M. M. Faraji, S. B. Shouraki, E. Iranmehr, and B. Linares-Barranco, "Wide-Range Outdoor Sound Source Localization Based on Distributed Sensor Network," 2020.
[16] M. J. Baucas and P. Spachos, "Large Scale IoT-Based Urban Sound Classification with Cloud and Fog Computing," 2020. [17] V. Yaremenko, M. R. Azimi-Sadjadi, and J. Zacher, "Unattended Acoustic Sensor Systems for Source Detection, Classification, and Tracking," 2019.
[17] J. T. Chen, C. B. Lin, J. J. Liaw, and Y. Y. Chen, "Improvements on the Implementation of Sensor Nodes for Illegal Logging Detection," 2018.
[18] D. C. Prasetyo, G. A. Mutiara, and R. Handayani, "Illegal Logging Detector System Using Chainsaw Vibration and Sound," 2018.
[19] A. Gaita, G. Nicolae, A. Radoi, and C. Burileanu, "A Spectral Haar Coefficients Based Chainsaw Sound Detection Method," 2018. VII

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VIII Aug 2026- Available at www.ijraset.com



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY