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Predictive Machine Maintenance Using Tiny ML

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Abstract: Anomaly detection (AD) is detection of pattern in data in expected behaviour. In an industrial environment, any equipment and system that breaks down are affecting productivity. Therefore, Tiny Machine Learning (Tiny ML) is introduced to address this problem. Tiny ML undergo anomaly detection to detect if any equipment did not act expected behaviour and notify the user if an anomaly detection has been detected. Anomaly detection is an unsupervised learning algorithm. It has aim to identify the patterns of data that do not follow the expected behaviour.

Tiny Machine Learning (Tiny), a rapidly evolving edge computing concept that links embedded systems (hardware and software) and machine learning, with purpose of realizing ultra-low-power or low-cost and efficiency and privacy also brings machine learning inference to battery-powered intelligent devices.

By using TensorFlow Lite Micro, the Tiny ML can be trained to undergo anomaly detection. How is the machine learning process has exported for TensorFlow, then TensorFlow and final TensorFlow L Micro order to upload the machine learning algorithm with Tiny ML.

The paper highlight the state the art of the current work on Tiny Machine Learning.

Keywords: ESP32, Accelerometer, Temperature, Buzzer, LED, etc.

I. INTRODUCTION

Reliability, Which is the main attribute of safe operation in any modern technological system. Reliability analysis focus on incertainty in failure incidences and the aftereffects. The aim shield the systems beyond the incertainties of there accidental situations. In recent years, reliability engineering has been well established as a multi-disciplinary scientific discipline that seeks to offer an ensemble of formal methods to inspect the unclear boundaries between system operation and failure. Furthermore, E. Zio is also recorded to main question focusing in reliability engineering.

These questions are the main causesof the system's failure, the procedure of measuring and testing the reliability in design, operation, and management, the ways to maintain the system's reliability such as maintenance, fault diagnosis, and prognosis, and the techniques to develop the reliable systems. Engineering maintenance is prognostics plays a critical role of modern industries such as aerospace, loco motive, manufacture, and so etc**.** The usually engineering maintenance approach is the maintain of functionality the equipment or system, such as preventive maintenance.

Tiny machine learning is rapidly growing field machine learning technologies and applications that include hardware , algorithms, and software capable of performing on-device sensor (camera/colour vision, audio, IMU, biomedical) data analytics of extreme low power, typically the mw range as below, enable the variety of a always-on use-cases of targeting battery-powered devices.It is delivering low-latency, low-powers, and low-bandwidths model inference at edge devices.

The typicaly microcontroller consumes electricity the milliwatts the microwatts range, whereas a typical consumer CPU consumes in range 65 and 85 watts and a typical consumer GPU consumes between 200 to 500 watts. This equates a thousand-fold reduction in power use.

II. METHODOLOGY

In this proposed system we have proposed a new concept through tiny ML, in which we are implementing Predictive Machine Maintenance in which an ESP-32 Microcontroller is used to control the flow of the Accelerometer.

Through this, we can read Accelerometer Data and Then Tensor flow lite Interpreter which runs the model. Then it classifies the model which is Trained to Normal or Abnormal Activity.

Whenever the model is in the normal state then Interpreter sends the message to the Model and glows Green Led Light and Buzzer off, and if the model is in an abnormal state, then the model shows Red LED and Buzzers.

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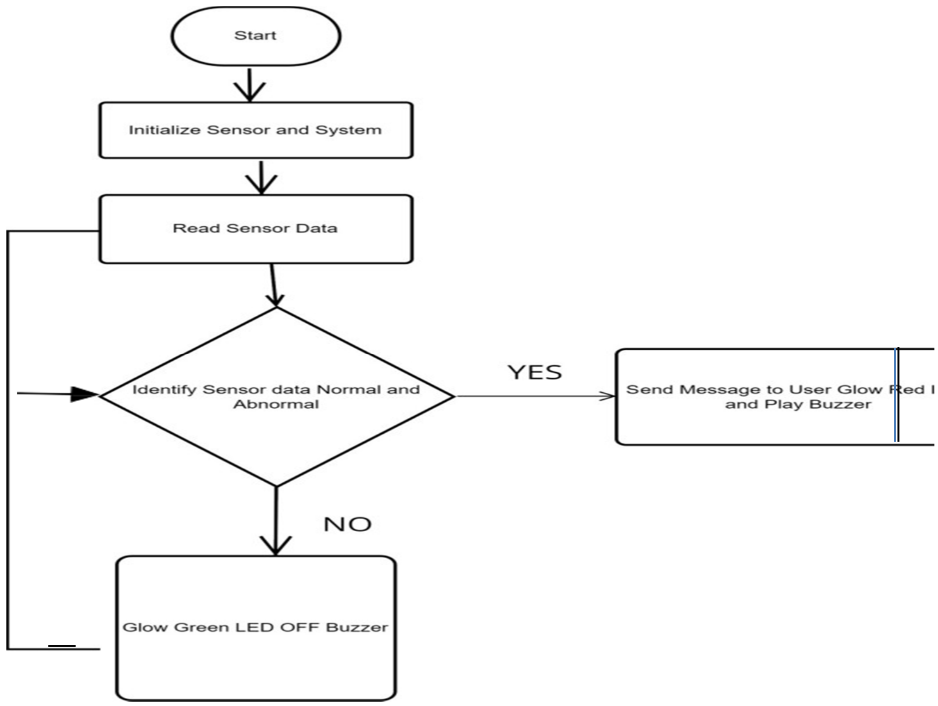

Fig 1. Data Flow Diagram

III. PROPOSED SYSTEM

To build predictive machine maintenance system using tiny ML. In this system we are predict machine maintenance by a sensing vibration of machine. we are using accelerometer sensor to collect data , then build and optimize ML model to deploy to edge hardware.

A. ESP32

ESP32 would be a series of low-cost, low-power systems with on-chip microcontrollers in integrated Wi-Fi or dual-modeBluetooth.

B. Piezo Buzzer

The Grove Buzzer module has piezo buzzer as it is main component. The piezo element makes a clicking sound every time when it is pulsed with current. If we pulse it at the correct frequency, these frequent clicks will run together to develop a little melody.

C. Accelerometer

An accelerometer sensor is the tool that measure the acceleration of anybody or an object in its instantaneous rest frame. It is not a coordinate acceleration. Accelerometer sensor is used in many electronic devices, smartphones and wearable devices, etc. Accelerometers is used in biomedical applications, biomedical field accelerometer sensors is mainly operated in step counting or activity monitoring.

D. Male Female Wire

This cable is an electrical device or wire and group of the cable with a connector and also with pins at every last stage, which is normal for interconnecting t componentsof a breadboard and other prototype and test circuit, internal with other equipment are components which is without soldering.

E. LED

LED adjust with brightness as well as adjustable orientation. Then, Grove LED is perfect for your need. The Grove and Red LED are designed for monitoring controls from digital ports. It is very helpful for beginners of Arduino and Seeding. The PCB of this module is mounting hole, so can you mount it with the required surface on a box or the desk and a prototype.

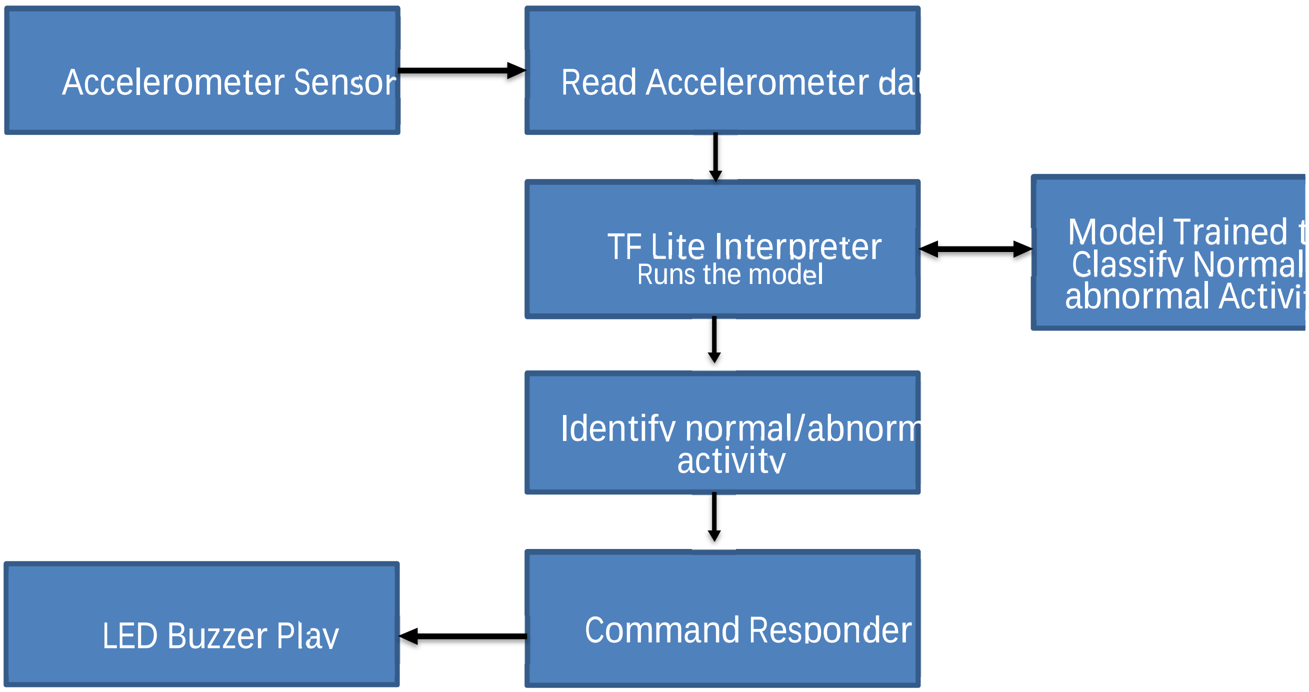

Fig.2 System architecture

In this proposed system we have proposed a new concept through tiny ML, in which we are implementing Predictive Machine Maintenance in which ESP-32 Microcontroller is used to control the flow of Accelerometer. Through which we can read Accelerometer Data then Tensor flow lite Interpreter which runs the model. Then it classifies the model which is Trained to Normal orAbnormal Activity. Whenever the model is in normal state then Interpreter sends the message to Model and glows Green Led.

IV. RESULTS

Implementation of tiny machine learning era in predictive platform growth contributor's confidentiality whilst contributing to machine learning. This is because of the character of tiny ML is easy. Predictive Maintenance techniques detect anomalies in equipment first which are turn in the system-critical failures, allowing maintenances which can be schedule first the equipment actually break down. The increase equipment uptime do less of all the maintenance costs and allow optimization of the part inventor by enablepreventivemachine maintenance based on the equipment's which needed. After having prove it has benefit in context of Industry. the data-driven maintenance strategy is adopted in the Smart Buildings of tomorrow. Especially in infrastructure critical assets which has HVAC, Predictive machine Maintenance offers high benefits. Condition monitoring use the sensors which is to provide meaningful insights in the current health of different devices and items of equipment of the buildings. The sensor is collecting the data of monitor crucial operating parameters which as vibrations, sound anomalies, airflow, and current. The various parts of predictive machine maintenance takes condition-based maintenanceto the nextlevel.

V. CONCLUSIONS

We presented a deep learning-based approach for the detection of anomalies in time series data. Since the approach is unsupervised, it requires no labels for anomalies. Instead, the method models the regular data distribution and marks data points which don't conform to this model as anomalous.

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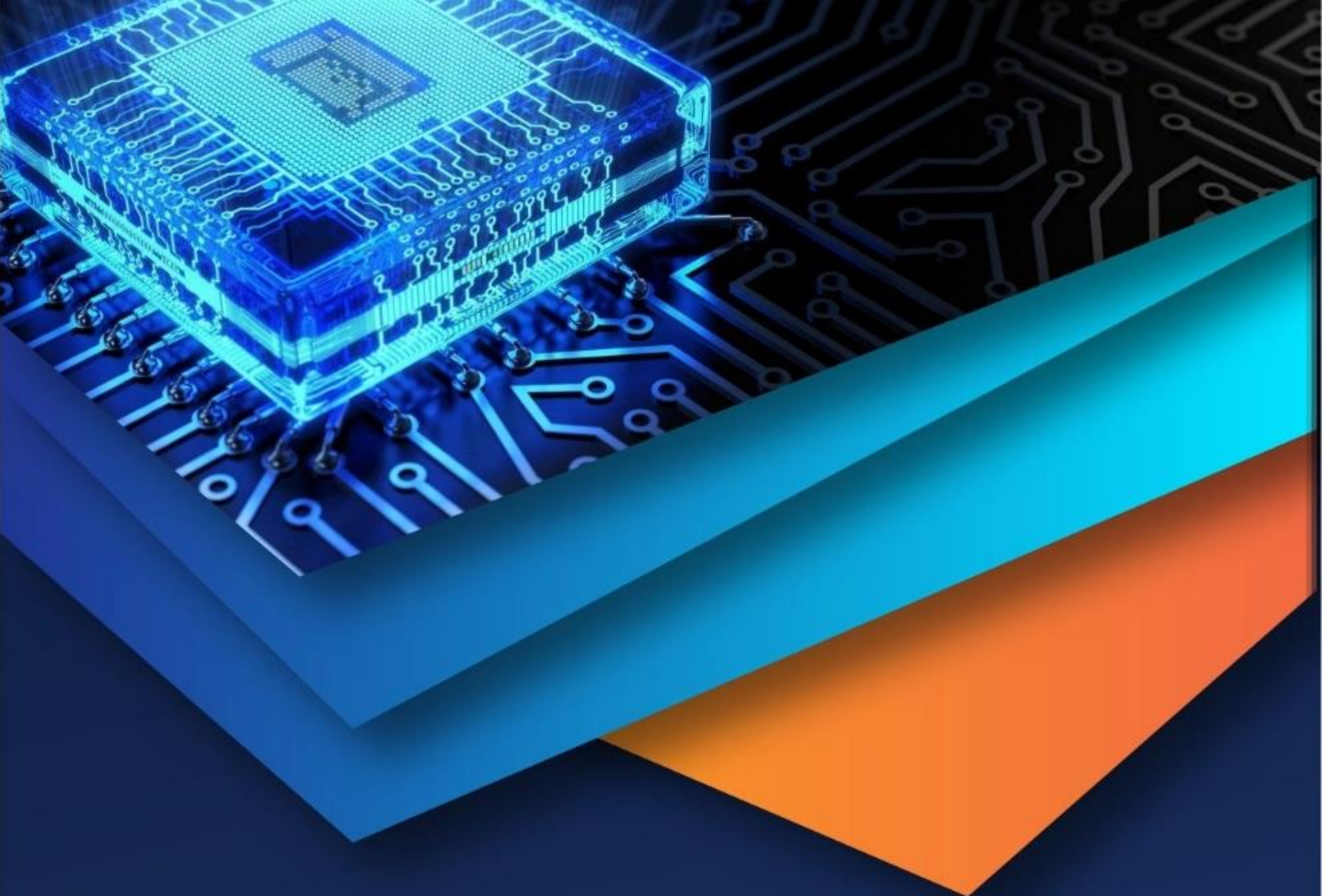

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