BLAZE A TRIAL 2.0

S.P.O.T

Sensor-based **P**redictive **O**perations **T**racker

Presented by TEAM BLUERTONICS

INTRODUCTION

PROBLEM STATEMENT: (PS-3) Real-Time Tool Health Monitoring in CNC Using AI & Sensor Data

Fix-It-Bot is an IoT-based predictive maintenance assistant that monitors CNC machines in real time using an ESP32 microcontroller and multiple sensors (temperature, vibration, sound, and current). It leverages AI and machine learning to detect anomalies and predict failures, enabling proactive maintenance. The system provides real-time alerts via a dashboard , UI and local indicators (buzzer, LEDs), helping reduce downtime, lower maintenance costs, and boost productivity.
Innovation: Combines IoT, AI, and edge computing for a scalable, cost-effective, and easy-to-deploy solution.

COMPONENTS

HARDWARE

- ESP32
- DS18B20 (Temperature Sensor)
- ADXL345 (Accelerometer Sensor)
- LM393 (Sound Sensor)
- Stepper Motor
- Scrap DVD
- Buzzer and LEDs

SOFTWARE

- Arduino IDE (ESP32 programming)
- Random Forest (ML Model)
- Google Colab
- ThinkSpeak
- Apps Script with G-sheets
- FireBase

BLOCK DIAGRAM

IOT SENSORS

- DS18B20 (Temperature Sensor) : Measures temperature with ±0.5°C accuracy.
- ADXL345 (Accelerometer Sensor) : Detects acceleration and vibrations.
- LM393 (Sound Sensor) : Detects machine noise variations.
- ACS712 (Current Sensor) : Monitors current consumption
- A model of CNC Machine is developed using scrap DVD and stepper motor.

DATA ACQUISITION

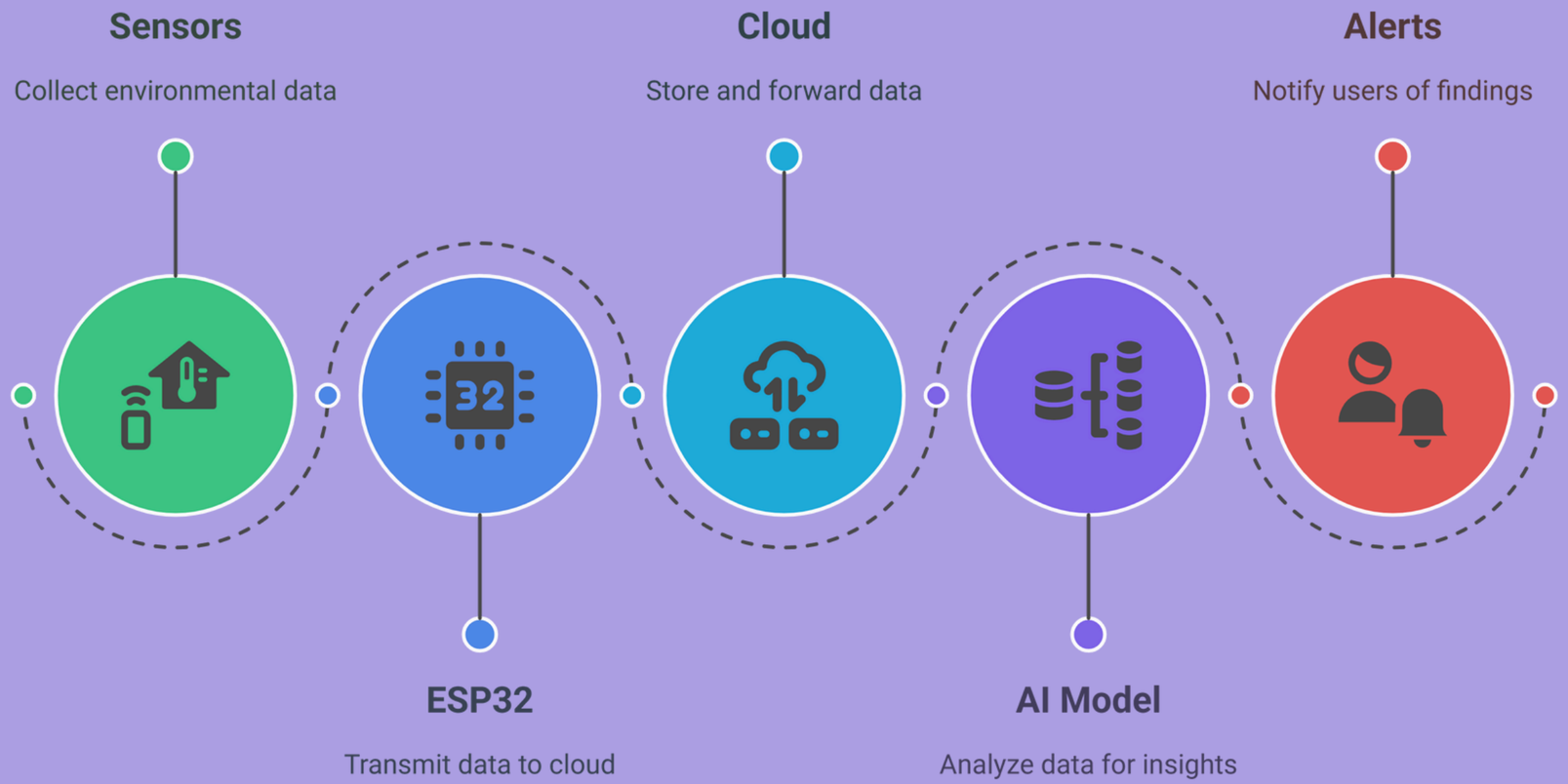
- Collect data from multiple sensors simultaneously.
- Store data in accessible training data set using ESP 32.
- Feed data into Random Forest ML model.
- Generate waveforms and predictions.
- Send the results to mobile device via ThinkSpeaks.
- Graphs and %of integrity can be accessed through the UI

ML MODEL

- Model Used: Random Forest
- Input Features include historical sensor data such as vibration signals, spindle load values, acoustic data, temperature readings, and corresponding tool condition labels and the output predicts faults or anomalies.
- Displays the probability of machine failure and the and the persistent spot to be checked.
- The integrated monitoring solution with CNC controls to automatically suggest to adjust machining parameters

FLOW CHART

Sensor Data Processing Sequence



WORKING

- **Hardware Flow:**
  - ESP32 and ESP8266 Microcontroller: Acts as the central processing unit, collecting and transmitting sensor data.
  - Sensors Used:DS18B20: Measures temperature.
  - ADXL345: Detects machine vibrations.
  - LM393: Monitors acoustic sound levels.
  - ACS712: Measures current flow.
  - The additional motor load details are also needed to fully configure the machine.
- **Data Flow Process:**
  - ESP32 reads sensor data at regular intervals.
  - The data is formatted into a JSON payload and sent to Google Sheets via cloud.
  - The Google Apps Script processes the data and stores it in the sheet with a timestamp.
  - The data is then fed into the Random Forest ML model for analysis.
  - The model predicts machine faults based on patterns detected in the sensor data.
- **Visualization & Alerts:**
  - The ML model output is displayed as waveforms and predictions.
  - The results are sent to a mobile device via ThinkSpeaks and the UI that is designed will provide the graphs and the details of the instruments to be replaced.
  - Local alerts (buzzer and LEDs) indicate machine faults in real-time.

DATA PROCESS FLOW

SPREADSHEET

Create and rename a new Google Sheet (e.g., ESP32_Temp_Logger) and rename the default sheet to TempSheet.

SCRIPT EDITOR

In Google Sheets, go to Tools > Script Editor and create a new Google Apps Script project.

GOOGLE SCRIPT

Paste the provided Google Apps Script and update the Sheet ID and Sheet Name.

SEND DATA

Set up ESP32 to send temperature and humidity data using GET/POST requests and handle retries for errors.

WEB APP

Go to Publish > Deploy as Web App, set access to "Anyone, even anonymous", and click Deploy.

CLOUD CONNECT

Include necessary libraries (ESP32WiFi.h, HTTPSRedirect.h, DHT.h) and configure the DHT sensor and Wi-Fi credentials.

ESP32

In the ESP32 code, enter your Wi-Fi credentials (SSID and password) to connect the ESP32

WEB APP URL

After deployment, copy the Web App URL (contains the Script ID)

MACHINE LEARNING MODEL

Algorithm Overview:

- Random Forest is an ensemble learning model that combines multiple decision trees to improve accuracy and reduce overfitting.

Dataset Collection and Preparation:

- The sensor data is collected via sensor and the values from the following sensors are stored in a Google Spreadsheet and this dataset serves as the input for training the Random Forest model.
- The data is preprocessed, cleaned, and formatted into feature vectors representing machine health parameters.

Model Execution:

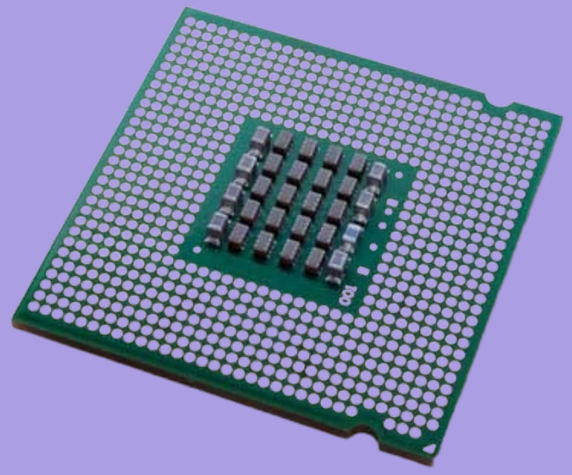
- During inference, the Random Forest model uses the spreadsheet dataset to identify patterns of normal and faulty machine behavior.
- Each decision tree makes an independent prediction, and the final result is based on majority voting or averaging and enhances fault detection accuracy by reducing the impact of individual tree errors.

Outputs and Fault Prediction:

- The model detects anomalies such as abnormal temperature, current spikes, or vibration fluctuations.
- It generates waveforms to visualize sensor trends over time, highlighting deviations from normal behavior.
- The results are transmitted to a mobile device via TinkerCad for real-time monitoring and fault prediction.
- This enables proactive maintenance, reducing unexpected failures and improving machine reliability.

USES OF THE FIX-IT-BOT PROJECT

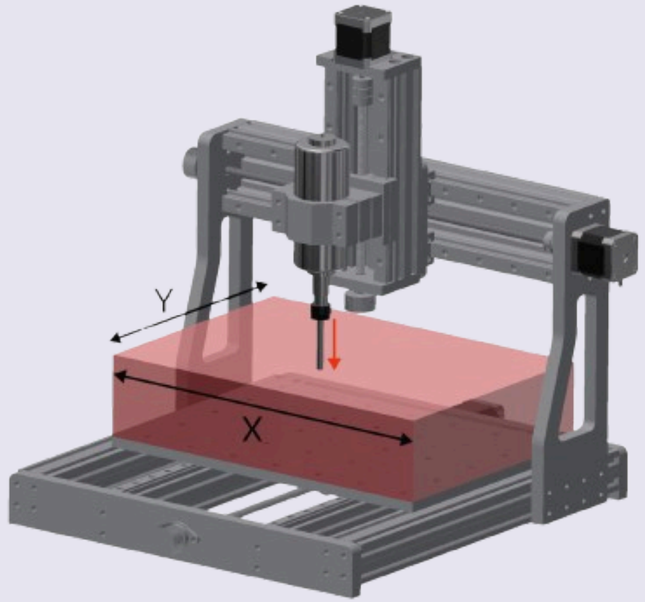
- Industrial Predictive Maintenance
- Cost-Effective Maintenance
- Data-Driven Insights
- Remote Monitoring & Alerts
- Scalable & Versatile
- Improved Safety & Reliability
- Educational & Research Value



CONCLUSION

Let’s revolutionize industrial maintenance together!

Fix-It-Bot is a transformative AI-powered predictive maintenance solution designed to revolutionize industrial operations by reducing downtime, saving costs, and improving productivity in CNC machines. By combining IoT sensors, machine learning, and real-time monitoring, Fix-It-Bot enables industries to shift from reactive to proactive maintenance, ensuring smoother operations and enhanced efficiency.



TEAM DETAILS

S.NO	NAME	DEPT	COLLEGE	REG NO
1	CHANDRA SEKARAN S	ECE	St. Joseph’s Institute of Technology	312422106031
2	HARISH S	ECE	St. Joseph’s Institute of Technology	312422106054
3	ARAVIND S	ECE	St. Joseph’s Institute of Technology	312422106013
4	BHARATH K V	ECE	St. Joseph’s Institute of Technology	312422106028
5	AZRAA NAAZ S A	ECE	St. Joseph’s Institute of Technology	312422106021
6	ASWIN K	ECE	St. Joseph’s Institute of Technology	312422106018