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Asset Monitoring of Railroad Switch using IoT

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Abstract - *The contribution of Railways play an major role in day to day life of public all over the world. In which to handle the traffic and to change the tracks of train, Point machines are there on certain distances. To operate this system smoothly and flawlessly continuous monitoring and maintenance is required. But it is done on manual basis once in a week. Unfortunately if there is sudden failure in the system it takes a lot time to recognize the problem and to solve it. So in this research work, we are investing the structural health of cross over point positions, the health of point machine by monitoring its vibrations and current supply provided to the system. These things are covered under the manual maintenance every week so by exploring IoT we are developing the system under Internet of Trains and monitor position of actuator, Current supply to point machine and the vibrations of point machine with the help of Thingspeak cloud.*

Key Words: Internet Of Things(IoT),Railway Track Switch, Point Machine, ESP32-Wover,Thingspeak,Ultrasonic Sensor, Current Transformer Sensor, Piezo-Electric Sensor.

1. INTRODUCTION

When it comes to public transport Railways is the first thing came in our mind as it is a part of daily routine of many people. As we see there are almost 2400 suburban trains run daily in Mumbai only where as almost 12600 trains in all over India, in which about 23 million passengers travel every single day. The Indian Railways covers length of 67,360km and 7083 stations. Almost all countries across the world are making the great efforts to achieve the demand for fast, safe and constant rail services. where in some areas rail industry struggles to fulfill increasing demands of passenger transportation due to lack of optimized use of rail network and inefficient use of rail assets. But Nowadays Railway industry is at that position where it grabs the opportunities which helps them to make their tasks easier with the help of IIoT. There are main five ways in which Iot can and has started redefining the railways bringing in increased efficiency and enhanced passenger experience: Greater Reliability and Safety, Fewer Maintenance Delays ,Advanced Analytics for Streamlined Operations ,Restructured and Optimized Passenger Experience, Better Product Development in the Industry So In this research work we are Introducing the system which will reduce the time taken for weekly maintenance of Point machines at railway tracks and help to reduce accidents happened due to failure of working of actuators. This web based system compatible with mobile phones also to know status of parameters from remote locations as the monitoring of main parameters will be done online 24/7 in a control room. This paper aims at improving the Railway management system which will be useful for railway stuff as well as passengers by solving the main issues for railway tracks happened during the switching of tracks as well it will be a benchmark for mission Internet of Trains.

1.1 Existing System

The Existing method provides a point machine which is use to operate railway turnouts especially at a distance. Earlier they were operated manually by leavers but nowadays they are operated Electrically from the control room. The Point machine consist of Motor gear, Clutch system and it is attached to the linear actuator. The Railway authorities pays a strict attention in maintenance of rail-Tracks every week to avoid further problems. In this maintenance work health checkups of point motor, actuator and current supply to the motor as well as the oiling of the parts also be done on manual basis.

1.2 Proposed System

In this research work we are focusing on three important features for switching of Rail-Track which will be helpful and overcome the existing system used. With the help of ESP32-800siml we will detect the exact position of Linear actuator which is attached to the point motor with the help of ultrasonic sensor, The major part done in the weekly maintenance work is to check the proper current supply to the point machine we will monitor this exact current supply with the help of Current transformer sensor And we will monitor the vibration range of the point machine with the Piezo electric sensor. The data received from the sensors will be uploaded on the Thingspeak cloud with GSM/Wi-Fi as the separate port is there available in ESP32-800siml.All these parameters will be visualized on the server in control room as the specific dashboard is there.

By implementing this system at railway tracks the main advantage will be the less maintenance delays and helps in extending the life of rail infrastructure. However, recent developments in preventive and predictive maintenance practices promoted by IoT have helped to revive the reliability of even the oldest assets and trains become more sensitive to their operations for more efficiency.

2. LITERATURE REVIEW

In[1] Implemented an system which monitors the health of tracks by finding the cracks on track with Piezo sensors.

In[2] The author is implemented IoT based rail track health monitoring and information system, in which readings

of Bogie and car body acceleration measurements are taken and information is send with IoT.

In[3] The author implemented an Smart Railway Management System, with the help of IR sensor, Fire sensor and PIC microcontroller.

In[6] IoT based Track joint monitoring system using cloud computing technology is developed for the continuous inspection of tracks using accelerometer and simultaneously data is updated in cloud.

3. SYSTEM DESCRIPTION

3.1 Block Diagram:

The Following Fig.1 shows a block diagram of hardware used in system.

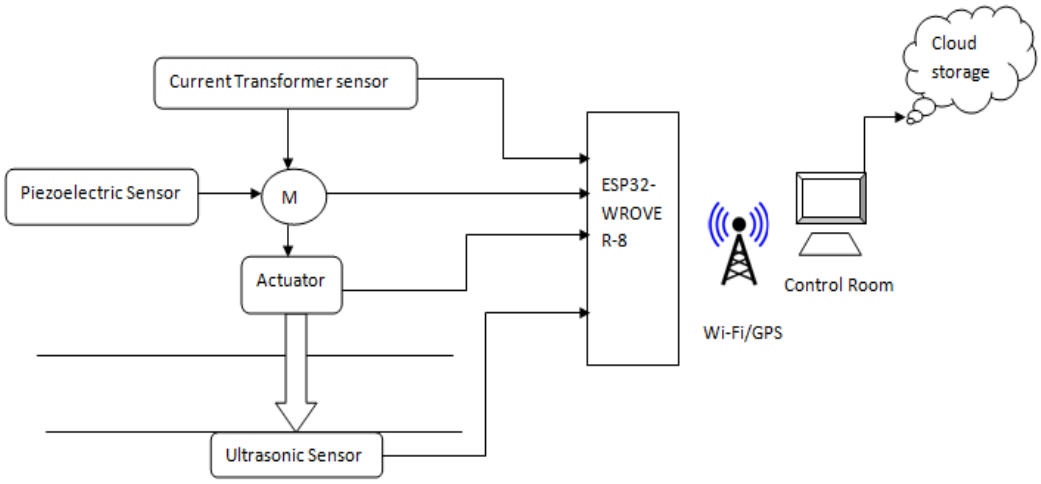

Fig.1 Block Diagram of a system

System consist of ESP32-wrover 800SimL,Ultrasonic sensor, Piezoelectric Sensor, Current Transformer Sensor, Electric Actuator, Control Room, Cloud Server.

3.2 Flow Chart:

For this project, ESP32-WOVER 800simL used to collect the data of position of Actuator, Current supply provided to the point machine by current transformer sensor which is used for energy monitoring and vibrations of point machine. As the microcontroller is Wi-Fi and GSM enabled we can send the collected data to our control room and Cloud Server by any of them.

Figure 2 shows, a process of our system. So when the operator starts the power supply it will be given to the point machine and the current supplied will be checked by the current transformer sensor if there is a insufficient supply the alert will be given in control room and if it ok the further position of actuator will be sensed by ultrasonic sensor and after that vibrations of point motor will be checked by the sensor this data will get collected by ESP32-WROVER 800simL and It will look for Wi-Fi connection or the data will be send via GSM to the Thingspeak server and the process will stop here. There is time delay of 15Secs so the data will automatically update after every 15Secs.

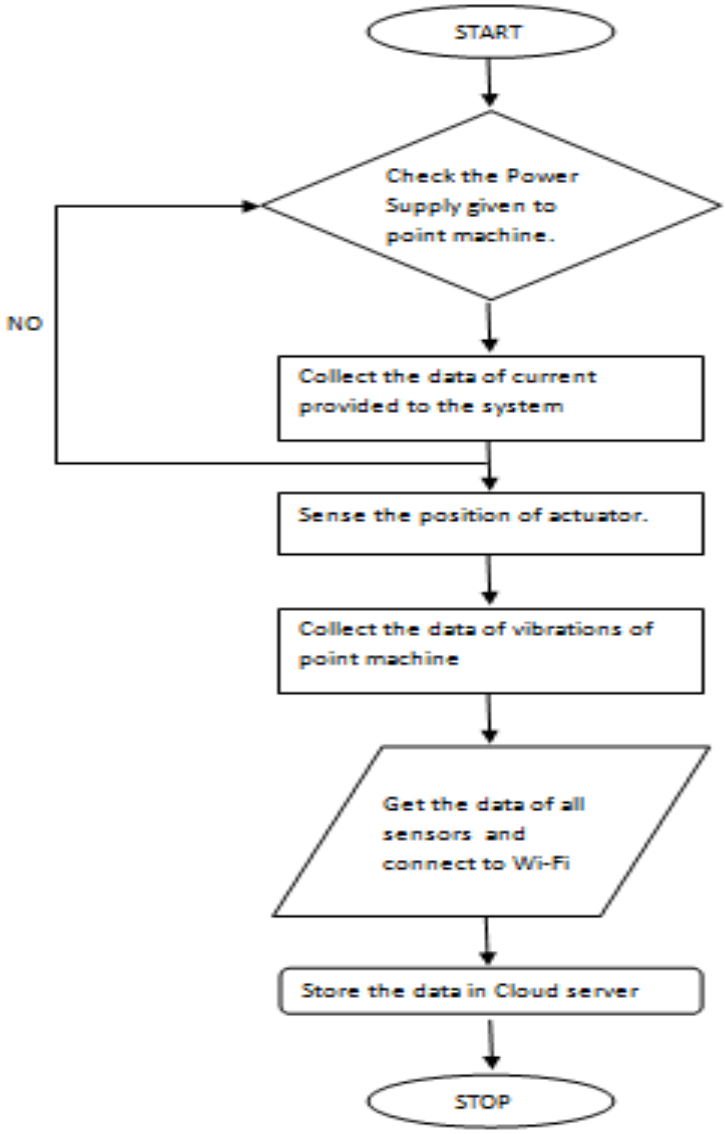

Fig.2 Flow Chart of a system

3.3 Design and Implementation:

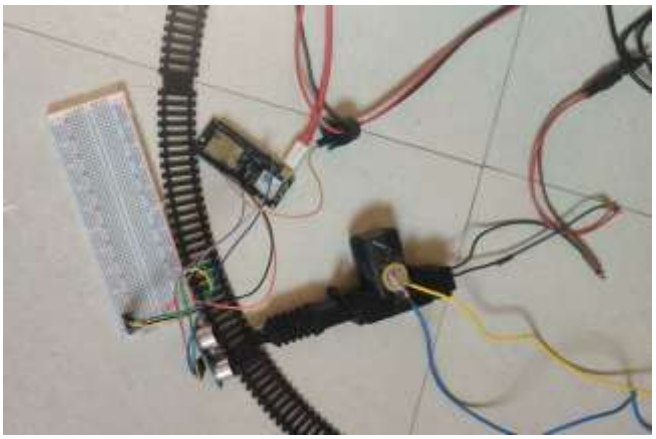

Fig3.Hardware design and implementation of the system.

Above figure3 shows a hardware of a system. All modules can be implemented on ESP32-WOVER 800SIML.Automatically monitoring of Rail track switching can be well executed by all sensors data to ESP32-WROVER 800SIML.

Following components are used in system:

1) Ultrasonic Sensor:

HC-SR04 sensor is a ultrasonic module for non-contacting distance measurement. Range from 2cm to 400cm. This senor uses sonar to measure distance with high accuracy and stable readings. This module consists of transmitter, receiver and control circuit. An ultrasonic sensor is fitted on the top of main water tank. Ultrasonic sensor works on the transmitting and receiving a ultrasonic pulse at the speed of sound from the liquid surface. This sensor works on a time

difference between transmission and reception of ultrasonic waves are calculated using formula of speed of sound, Speed=Distance/Time. Using this formula, easily measure distance between the source and target. Distance=Speed*Time/2.

Installation of this sensor is easy on other end of rail track.

2) Current Transformer Sensor:

Sensing variable current flow is a major requirement in this project. A current sensor is a device that recognize electrical current in a wire or a system whether it is high or low and creates an indicator relative to it. A current transformer sensor is a device which detects and converts current to get an output voltage, which is directly proportional to the current in the designed path. When current is passing through the circuit, a voltage drops across the path where the current is flowing. Also a magnetic field is generated near the current carrying conductor.

Current sense the voltage drop proportional to the load current across a resistor of 10R is taken and stepped up by a current transformer to feed to a bridge rectifier to generate pulsating dc for comparator to develop current sense. The comparator generates the zero crossing pulses from a pulsating DC.

3) Piezoelectric Sensor:

The ability of piezoelectric material is to convert mechanical stress into electrical charge is called Piezoelectric effect. A Piezoelectric sensor is known as piezoelectric transducer, is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain or force by converting these in to a electrical charge. It converts the physical quantity into an electrical voltage which is easily measured by analogue and digital meter.

The polarity of the charge depends on the direction of applied forces. Q=d*F where, Q is a Charge, d is a charge sensitivity of crystals and F is the force applied.

4) ESP32-WROVER-800SIML:

ESP3-WROVER is a powerful, generic Wi-Fi-BT-BLE MCU module that targets wide variety of applications ranging from low power sensor network to the most demanding task.

ESP32 integrates a rich set of peripherals, rang in from capacitive touch sensors, SD card interface, Ethernet, high speed SPI,URAT,I2S and I2C.The integration of Bluetooth, Bluetooth LE and Wi-Fi ensures that wide range of applications can be targeted and that the module is all-around. So in this project ESP32 WOVER plays the major role to achieve the desired output.

5) Internet of Things(IoT):

The inter connection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data. It has ability to transfer data over a network without requiring human to human or human to computer interaction.

In this project, Thingspeak Server is used to store a data. Thingspeak server is an open IoT platform with MATLAB an analytics. It is used to store and retrieve data from things using a HTTP protocol over the internet. It provides apps that let you analyze and visualize your data.

In this project, all sensors data are recorded to ESP32-WROVER and using IEEE 802.15-WiFinetwork protocol sending and retrieving data to cloud.

4. RESULT

After all connections are done, start Arduino Idle in Desktop and run the program. Once a command executed project starts our execution in step wise which is mentioned in a flow of project in previous section. The Thingspeak cloud server is displaying these data in a graph format.

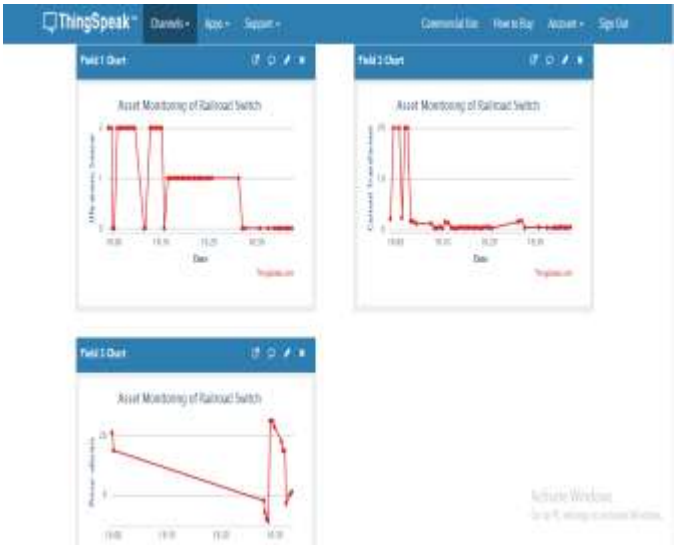

Fig.4 Thingspeak web monitor of a system

Following Fig 4 shows a Thingspeak web screen which is displaying a data of Position of Actuator by using ultrasonic sensor in Field1 chart, The Current supply given to Point machine with the help of Current transformer sensor in Field2 chart and the vibrations of the point machine in the Field3 chart are recorded in separate graphs. These graphs are used for monitoring and using these graphs further prediction is easily done.

5. CONCLUSIONS

Our Proposed system is truly based on IoT and it represents a prototype for monitoring the health of rail track switching. This prototype is still under development of various more sensors for the efficient study and monitoring purpose. But

using this system secure and continuous monitoring is possible. No need to go on field for monitoring so manual work has been reduced it makes system more efficient, reliable, low cost and accurate. The major benefit of this system is it will help to reduce the number of accidents due to failure of switching tracks. Data monitoring is easy from control room.

In future work we are trying to develop AR based app to get high precision data and improve the performance.

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