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Design and Development of GUI Based Wireless Robot for Condition Monitoring of Conveyor System

Nikhil S.Divate[1], Vikesh P.Kumawat[1], Prof S.N.Bansode[2], Amit Kumar Patel[3]

[1]Student, M. Tech (CAD CAM and Robotics), K J Somaiya College of Engineering, Mumbai, Maharashtra, India
[2]Professor, Dept of Mechanical Engineering, K J Somaiya College of Engineering, Mumbai, Maharashtra, India
[3]Lead engineer at Tata Power Company Ltd. Mumbai Maharashtra,India.

Abstract:- *In a power plants, mining, processing, and Transportation industries conveyor system plays an important role for transfer of material from one place to another. It is necessary that the conveyor system must operate at maximum efficiency without any major breakdown. The overall performance of conveyor can be increased by proper monitoring of belt, roller, and other moving parts of a conveyor system.*

This paper is based on the project which develops a self-monitoring robot which will monitor the condition of each roller on a conveyor. The project involves the design and development of preventive maintenance system which involves wireless communication which helps to monitor the condition of each roller bearing. The sensor platform measures noise level and temperature of each bearing of a roller with the frame number and generate the data file and live video output in controlling computer. The transmitted data gets updated continuously as a robot move on a conveyor system.

The implementation of a robot with real-time online condition monitoring of roller in the conveyor system of the thermal power plant will reduce the overall maintenance cost of a conveyor system.

Key Words: Conveyor system, Self Monitor robot, Roller condition, Temperature, Sound, Hardware and sensor platform, Wireless communication system

1. INTRODUCTION

For material handling and for basic transportation of the materials conveyor system performs the key role which reduces the transportation time and also increases the worker's safety. There are various types of the conveyor system which can be used to carry the material were listed below

1. Belt Conveyor
2. Screw Conveyor
3. Bucket Conveyor
4. Grab Bucket Conveyor
5. Flight Conveyors

The thermal power plant is the power station at which the electrical energy is produced by converting the heat energy. The heat energy is generated by burning coal powder which results in heat that is used to turn water into steam. This steam is used with very high pressure to rotate the turbine which is connected to the electrical generator. Generally, coal is used as the main major fuel in the plant due to its availability, low cost. The transfer of coal in thermal power plant including the carrying from one place to another and unloading the coal at site require one system out of all the transportation system the conveyor's system is the most suitable system to carry the coal. The thermal power plant normally depends on the conveyor system for transportation of coal and ash from loading point to the storage point at a site.

For the coal transportation, belt conveyors are very suitable in the large thermal power plant. The Belt conveyors consist of the belt made of rubber which is mounted over the drums or pulleys and supported by the idlers or also known as idlers which are provided at the certain interval.

1.1 Project definition

The coal conveyor has many parts like the belt, drive motors, gears, and rollers (idlers). The conveyors have the moving belt with speed of 4 to 6 m/s and idlers rollers which acts as support as well helps to carry coal. Due to a continuous moving of the parts, they require proper monitoring after the certain interval to avoid the failure of the whole system which makes the inspections and maintenance tedious as well as a hazardous.

The parts like belt drive motor, gears can be monitored from a single sensor or device but the system has many rollers which are located throughout the channel for support to a belt which cannot be monitored through single local sensor or device. In order to monitor the roller on the conveyor system, the system requires a device or sensor for each unit for monitoring.

1.2 Objectives of Project

To achieve the aims of the project and deliver the proper solution a set of objectives are specified these are

1. To build up the wireless automated system which will measure the temperature and sound level of rotating roller bearings.
2. Monitoring of the conveyor from an operation center.

3. To reduce reliance on costly manual inspections carried on a conveyor system.

4. Increased safety of personnel by reducing the manual involvement.

2. Methodology

Methodology represents the entire process for fabrication of inspection robot. From the methodology developed it is clear that complete process has been studied first and then only the inspection robot can be developed.

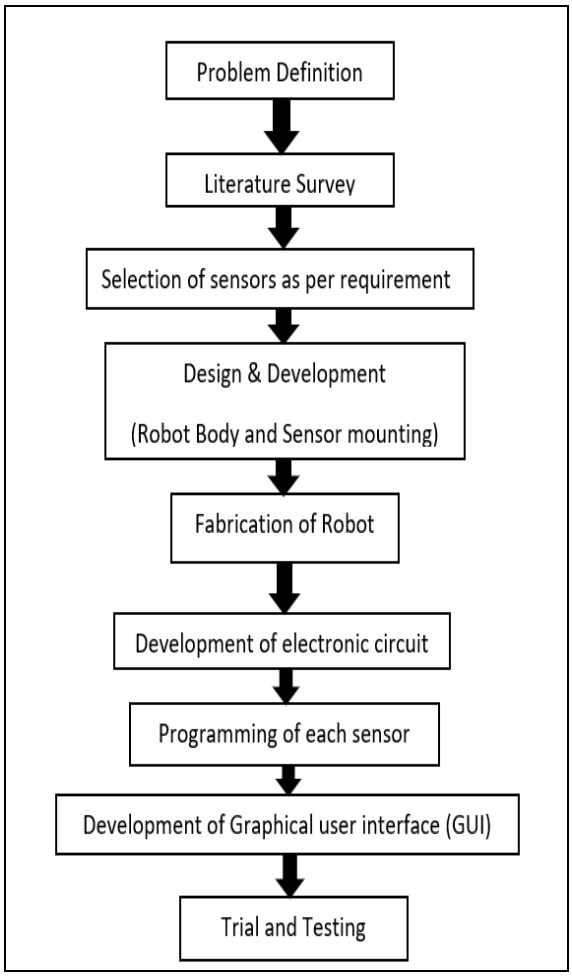

Fig -1: Methodology flow chart

The complete work starts and ends according to problem definition. On this basis systematic procedure is followed right from the research to publication of model.

2.1 Mechanical Design, Development and Analysis

2.1.1 Procedure

Mechanical design and development of robot include the design of body stricture of a robot on which all sensor and other hardware components are to be mounted. It includes the different steps which are to be followed during the design and fabrication of robot body.

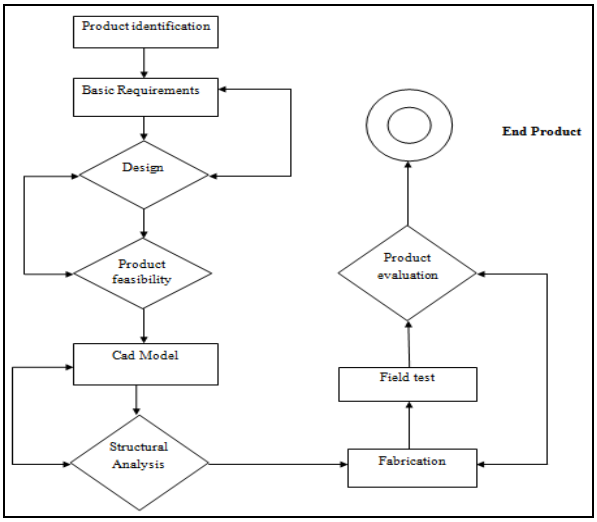

Fig -2: Design flow chart

2.1.2 Material Selection

The different material can be used for different part of robot but the material used for fabrication of robot part should be rigid. In order to use optimum power the material should be light weight and strong. Metal and plastic are mostly used material for robot, out of plastic is not so strong so metal is considered as ideal material for robot in heavy load also, the material chosen should have good ductility, less brittle, and should have high magnetic susceptibility.

2.1.3 Finite element analysis of selected part

The basic Requirement of analysis is to ensure the stability of the system. And To decide the suitable thickness of the sheet-metal parts before manufacturing so that actual structure failure can be avoided. The static load applied which act on body and direction is same as gravity.

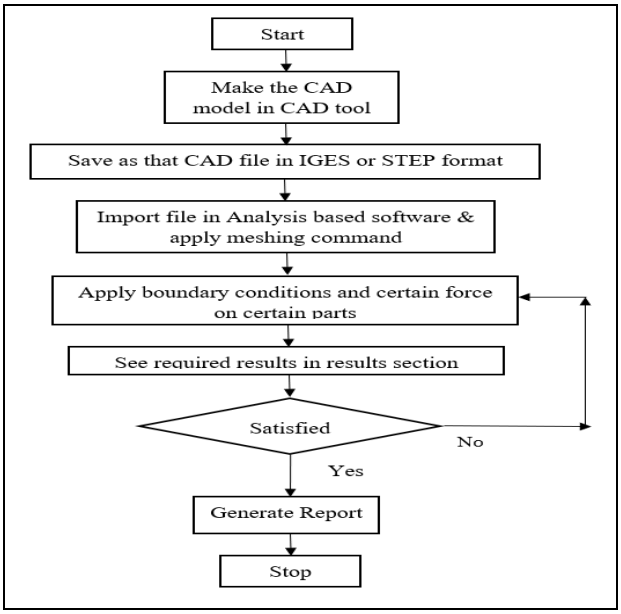

Fig -3: Analysis flow chart

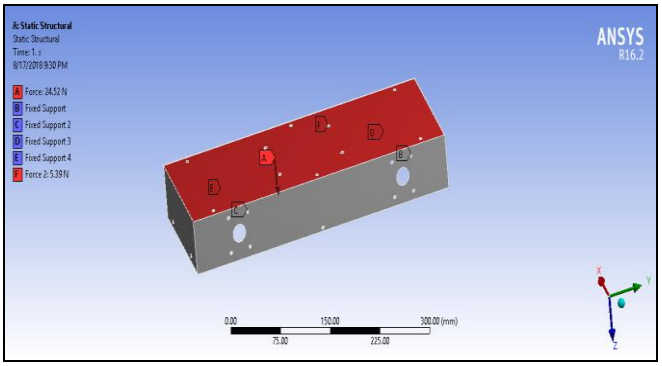

Fig - 4: Applying boundary condition

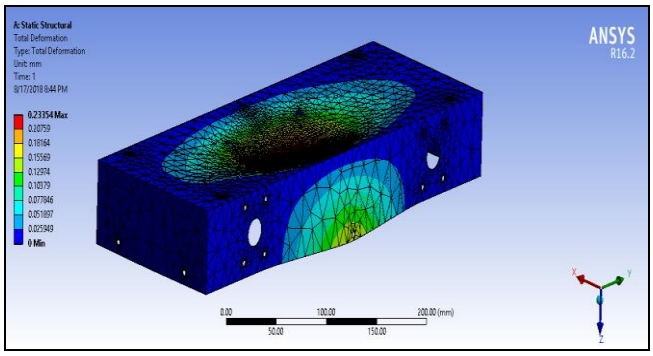

Fig -5: Final Deformation

The analysis results give the final deformation of the Sheet metal body for various thicknesses of Sheet metal parts. For the safety and stability 1.5 mm thickness selected.

2.1.4 Design and Fabrication of robot

The fabrication phase of project involves production of parts which are designed as per requirement. The various process used in fabrication of components are cutting, drilling, welding, riveting, the final product after complete assembly is shown below

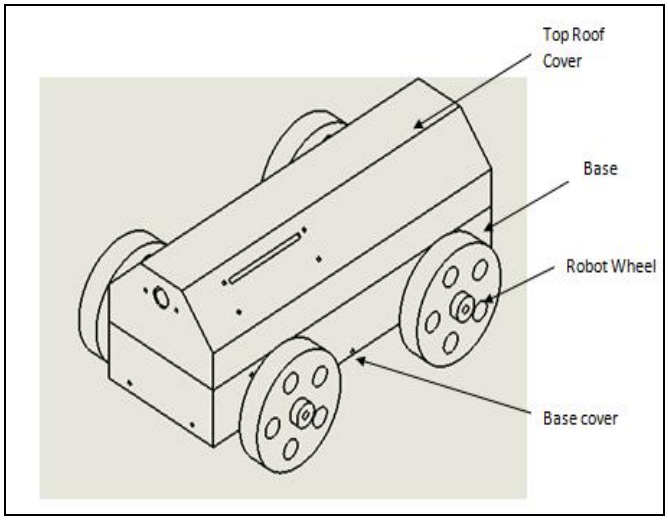

Fig -6: Basic design of robot

2.2 Electronic system design

2.2.1 Basic concept and hardware requriment

The basic concept of electronic circuit which is to be mounted in robot for inspection of roller is shown in Fig -7.

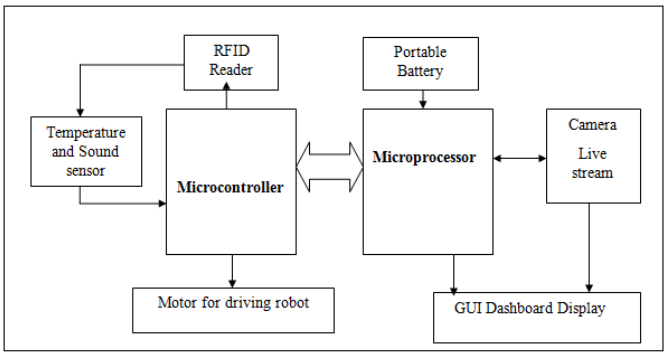

Fig -7: Block diagram of system components

2.2.2 Hardware requirement and robot assembly

1. Sound Sensor – To measure sound in decibels of roller the sound level meter can be used which can be program through microcontroller

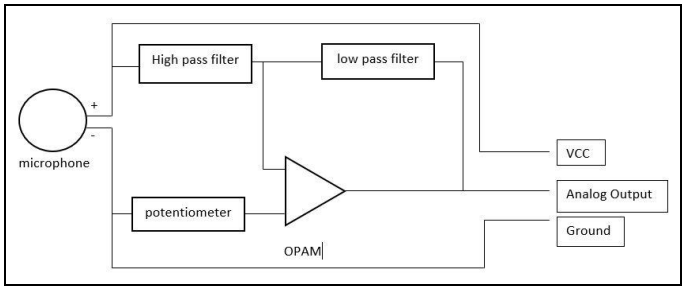

Fig- 8: Sound sensor layout

2. Temperature sensor – To measure roller temperature the non-contact Pyroelectric sensor can be used which measure temperature within a range of 500mm. The selected sensor can be programmed through the Microcontroller by using serial communication.

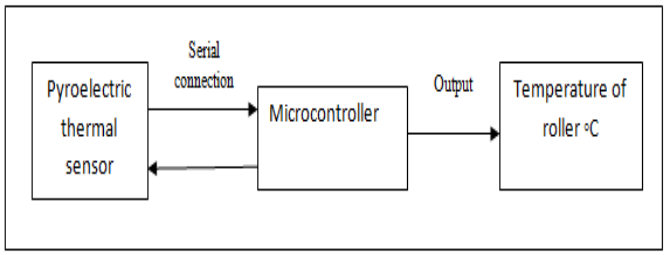

Fig -9: Working of temperature sensor

3. RFID Reader – To get the location of a roller unit of the conveyor the RFID reader is used in the robot which will read tag mounted on a frame where the roller unit comes on a conveyor.

4. Camera – In order to have live stream of filed area the camera is used, it is connected with Microprocessor and program by same.

5. DC Motor – To move the robot along with conveyor the dc motor is used. The selection of DC motor is done on basis of torque needed to move the robot with all hardware components

6. Microcontroller – It is used to program all the sensor and motor the selection of microcontroller is depends on the compatibility of it with microprocessor because It is to powered by microprocessor.

7. Microprocessor – It is the brain of the electronic circuit which supplies power to the whole system and controls the Microcontroller. The selection of microprocessor can be done on the availability of Wi-Fi facility in it to connect our robot wirelessly.

After connecting all sensors with microcontroller and microprocessor along with its mounting, an automated machine can be seen as shown in Fig-10.

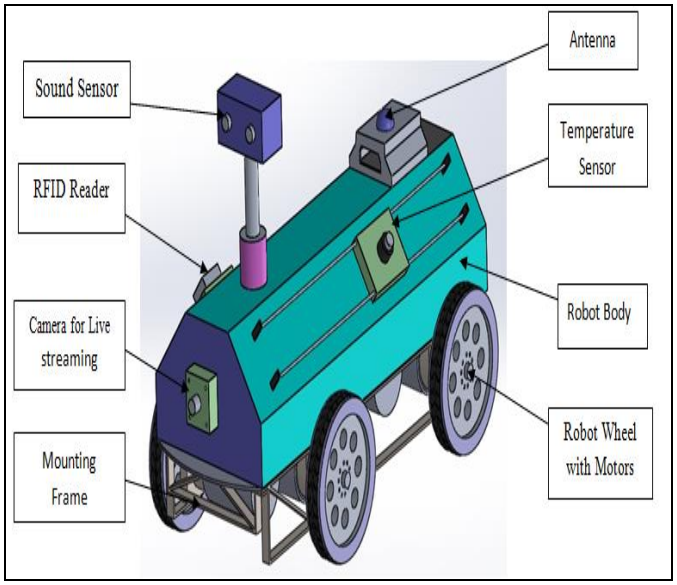

Fig -10: Assembled robot with sensor [1]

2.3 Programming of robot

The programming is main part of robot, ones the electronic circuit is assembled then all sensor and hardware connected then they need to be programmed. The program is done in Microcontroller by using C Programming Language. The serial communication is used for communication of hardware and software. The Fig-11 shows the procedure of whole program which is to be followed

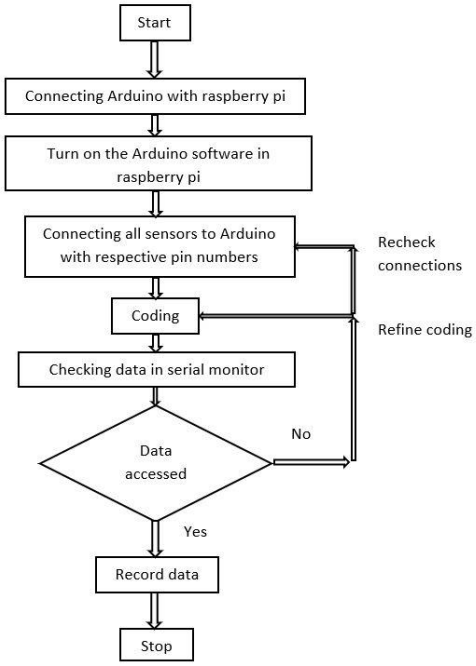

Fig -11: Programming flow chart

2.4 Robot control system by GUI

GUI (Graphical User Interface), it is used to interact with electronic devices by using graphical icons and the visual indicator. GUI helps to control sensor and other electronic components wirelessly.
There are various modes for GUI creation using different languages and software like python, C++, processing, Matlab etc.

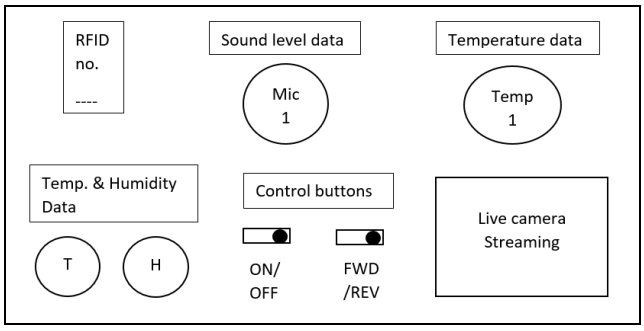

Fig -12: GUI dashboard

3. Result and testing of robot

As the robot is controlled from GUI dashboard, so when the ON button is pressed then robot moves on track developed along with conveyor system and sense the roller noise and temperature by sensor placed on robot. The robot is programmed in such a way that it will stop at each stage of roller by just sensing the RFID tag and then take the sound and temperature data of roller. By using serial communication between controller and processor the sensor

data is get collected at microcontroller and then gets stored in microprocessor in .txt file.

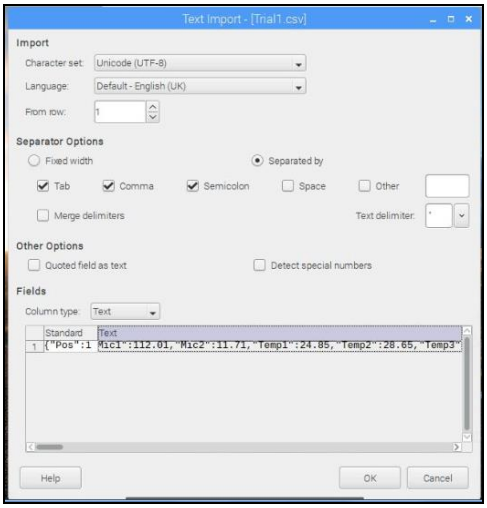

Fig -13: .txt file

This .txt file can be imported in excel to get inspection report clearly. The excel file can be programmed in such a way that the value which exceeds the threshold value after which roller abnormal behavior take place that stage get automatically mark, so that maintenance personnel can easily find out which is roller stage is in critical stage .

A	B	C	D	E	F	G
Roller Frame Number	Mic 1	Temp 1	Ultrasonic	Internal temp	Humidity	Battery Voltage
2	53.8	84.22	107.42	27.3	46.4	13.2
1	53.01	112.01	98.85	26.2	42.5	13.18
3	51.12	118.92	80.27	29.5	42.4	13.18
1	50	98.45	72.76	29.5	42.4	13.13
2	49.2	118.92	65.71	29.5	42.4	12.98
1	48.8	97.64	58.27	29.5	42.5	12.81
2	48.1	101.71	43.18	29.4	42.4	12.52
3	47.5	98.45	36.82	29.5	42.5	12.23
0	46	100.89	31.77	29.5	42.4	12.2

Fig -14: excel format inspection report

4. CONCLUSION

The implementation of the system reduces the inspection time and cost as well as manpower. The preventive maintenance reduces the frequency of breakdown leads to efficient working of plant.

ACKNOWLEDGEMENT

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