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Smart Grid Inspection Robot Exclusively Designed for High Power Transmission Lines

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Abstract - *India relies heavily on electric power systems for industrial as well as home utilization. Unfortunately, the electrical power distribution systems are inefficient causing wastage of about 30% during transmission from power plants to the end point. This paper is devoted to share innovative robot application for transmission line maintenance & inspection. It revolves around the creation of a mobile device designed to move along the high power transmission lines continuously analyzing varying parameters including rate of power loss during transmission of energy from the power plants to the homes of the consumers. In case of any malfunctioning or abnormality, the device intimates the people responsible through IoT. Parameters like GPS, temperature and distance are measured and solar panel is used by coupling with battery making the device environment-friendly.*

***Key Words*: Smart grid, Transmission lines, Inspection robot, Energy, Power loss, GPS, IoT.**

1. INTRODUCTION

In a developing country like India, the usage of electric power has risen to an alarming amount due to increase in user and industry consumption. Regardless of how cautiously the designing of the circuit is carried out, losses are existent in these transmission lines. External factors or internal factors result in the development of wasteful electric power losses, and thus energy is dissipated in the system. Some of the power losses include losses due to resistance, atmospheric conditions, miscalculations etc. during transmission between sources of supply to the consumers (or load centre).

1.1 Aim and Objectives

Survey tells us that only around 35-40% of the total power generated in the power plants reach the end user. This causes extensive power loss which, in the long run, will affect the economic and electrical stand of our land. Hence, we decided to design a machine that will travel along the high power transmission lines where normal manual inspection cannot be done frequently. The device keeps track of environmental conditions such as temperature and transmission line parameters such as current.

Conventional methods need manual inspections which are dangerous due to the high power in the transmission lines. Through these devices, periodical check-ups can be avoided.

Any damage in the transmission lines can be detected only after conditions like low-voltage or power cuts occurs. By using these machines, future mishaps can be prevented.

High power transmission lines stretch out for long distances, sometimes exceeding 50-100 kilometers. It is futile to check every inch of these lines to pinpoint the location of the distress. This device contains a GPS which will intimate the necessary authority about the precise latitude and longitude.

1.2 Need

It is a semi- autonomous robot consisting of wheels which moves on the lines with the help of two DC gear motors or Bo-Motors, it has real time monitoring is carried out using camera setup which includes AV receiver, Honestech VHS to DVD 3.0 software installed device and camera. NodeMCU (ESP8266EX) facilitates wireless transmission of the measured parameters which intimate the concerned authority to rectify the problem before it becomes an issue. . Analysis of the above mentioned parameters is controlled using Atmega2056 which is programmed using Arduino IDE. We have used proximity sensor to sense any obstacle around the robot, in case of any obstacle just like spacers on the transmission lines, robot slow down its speed and activates the locking mechanism which props up and maintains the stability of the robot while crossing clamps, hanging across the wires.

2. LITERATURE SURVEY

In [1], we develop a real-time situational awareness framework for the electrical transmission power grid using Wireless Sensor Network (WSN). While WSNs are capable of cost efficient monitoring over vast geographical areas, several technical challenges exist. The low power, low data rate devices cause bandwidth and latency bottlenecks. In this paper, our objective is to design a wireless network capable of real-time delivery of physical measurements for ideal preventive or corrective control action.

In [4], the Indian utility electricity sector installed one National Grid on 31 August 2018 with a capacity power of about 344.69 Giga Watts. More than 33.60% of total installed capacity was established by the renewable power plants. The years 2017-18 saw that the gross electricity produced by utilities in India was 1,303.49TWh and the total electricity generation including non-utilities in the nation was around 1,486.5 TWh. As the world's third largest producer and third largest consumer of electricity, India shows a statistic of the

gross electricity consumption as 1,149 kWh per capita in the year 2017-18. The total electrical power consumed in the field of agriculture was documented to be the highest (17.89%) in 2015-16 among all countries while the per capita electricity consumption is little when equated to other countries regardless of cheaper electricity tariff in India.

In conclusion, though our nation has vast capacity for power generation, the requisite infrastructure for supplying electricity to all destitute people is wanting. Addressing the crucial crisis of providing adequate electricity supply throughout the nation, the Government of India launched a scheme called "Power for All" on March 2019. This scheme strives to ensure incessant and uninterrupted electricity supply to all homes, industries and commercial establishments by fashioning and refining required infrastructure. This united collaboration of the Government of India with its states enables the country to share funding and generate overall economic growth.

In [5], a methodology is proposed for detecting leakage of energy and theft of power in transmission lines using GSM and microcontroller. It is implemented as two sub-systems where one subsystem is utilised for power leakage detection and the other is used for theft identification. Line failure is found by measuring the difference in voltage between power transmission and reception.

The proposed system specifies that theft detection is found by measuring the total power consumed and comparing it with the total power transmitted. The parameters measured dynamically are intimated to the relevant electrical officers through SMS.

In [3], detection and location of the point of failure in the power line is used in wireless sensor network. This paper demonstrates that the power transmission line is divided by the use of wireless sensor networks. The energy difference and deviation in the transmission lines, if any, is informed to the concerned officials.

In [6], the discussion about the wide range of real-time line monitoring systems is carried out and used in determining the dynamic thermal rating of an overhead transmission line while ensuring that the power system is operating normally or during a system contingency. Real-time monitors are defined including the ones involved in the measurement of common parameters like temperature of the conductor, line clearance and weather information in the line. The most common types of real-time monitors are described including those that measure the line clearance, conductor temperature, and weather data in the line right of way.

3. TECHIQUES

Smart sensing especially read-time, dynamic analysis plays a crucial role in a smart grid system. Unwavering and accurate power line tracking of energy consumption is a very conspicuous issue. To precisely track and make perfect calibrations, the swing path of a power line should be anticipated using a robot. We develop robots with GPS for tracking the location of the robot and various sensors for the detection of faults in the grid lines. Different types of sensors like current sensors, temperature sensors, color sensors etc. are used in it for finding the faults. NodeMcu is used for wireless transmission and to intimate the concerned authority to rectify the problem before it becomes an issue.

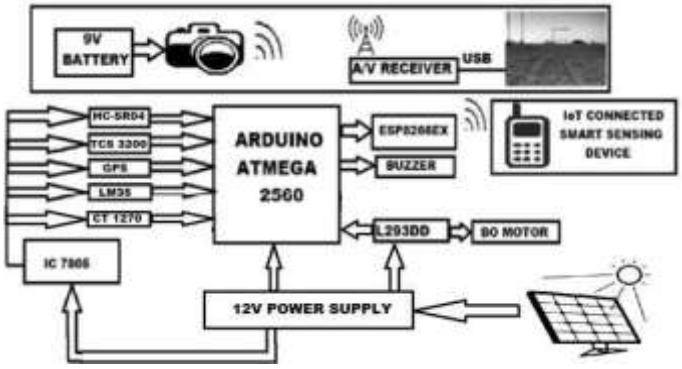


Fig-1: Block diagram.

4. WORK PLAN

Smart grid robots are hung along the grid lines for inspection and rectification. The robot is powered up using a 12V battery which is being continuously backed up using an environment-friendly solar panel. The power is distributed to the voltage regulator (IC7805) which in turn steps down and forwards the voltage to the relevant low- power components. Bo-Motors are attached to the driver circuit (L293D) for the rotation of the robot along the transmission line in order for horizontal movement along it. Sensors like ultrasonic (HCSR04), current (CT1270), temperature (LM35), color (TCS3200) are used for smart metering which ensures accuracy and reliability. Ultrasonic sensors are used for obstacle detection within the range of 20 cm. The expedience of the current limit can be checked using the current sensors. The damage to the wire in case of humidity, moisture which leads to color change is detected using color sensor. The upswing in temperature is measured using temperature sensor. The significant aspect of the robot involves the use of GPS (L80) module which provides the exact location of fault. Analysis of the above mentioned parameters is controlled using Atmega2056 which is programmed using Arduino IDE. Real time monitoring is carried out using camera setup which includes AV receiver, Honestech VHS to DVD 3.0 software installed device and camera. NodeMCU (ESP8266EX) facilitates wireless transmission of the measured parameters which intimate the concerned authority to rectify the problem before it becomes an issue.

5. PROPOSED SYSTEM

The major difficulties our product resolves to solve are:

- Conventional methods need manual inspections which are dangerous due to the high power in the transmission lines. Through these devices, periodical check-ups can be avoided.
- Any damage in the transmission lines can be detected only after conditions like low-voltage or power cuts occurs. By using these machines, future mishaps can be prevented.
- High power transmission lines stretch out for long distances, sometimes exceeding 50-100 kms. It is futile to check every inch of these lines to pinpoint the location of the distress. This device contains an GPS which will intimate the necessary authority about the precise latitude and longitude.
- Theft of power: In India, financial loss due to theft of electricity may be around $16 billion yearly. Some power companies continue to bleed and lead to bankruptcy due to one of these factors. This may also lead the legalized users to pay more. This creates a scenario where numerous villages have huge cut in power supply and altogether availability of power in the grid with no purchase.

Losses in the connector systems connections leading to premature failure of capital equipment's like transformer. As the robot prototype runs along the line, it can detect the obstacles, current fluctuations, abnormal sag and convey the information about the fault to the control room, i.e. user mobile phone.

6. FUTURE SCOPE & SIDELINE

This project enables only the transversal of the smart grid robot along a single transmission line without any obstacles. With the aid of the ultrasonic sensor to detect the presence of obstacles, the present robot stops whenever it reaches the end of a particular line.

Future enhancements include building a mechanical structure which can move to different transmission lines by bypassing the repeaters and transformers between them. The futuristic enhancement of this device including the mechanical components that will help in the complete movement of the robot across the entirety of transmission lines over the absolute distance.

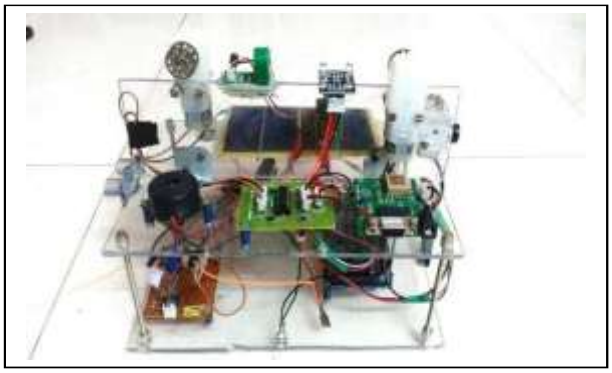
With mechanical arms, the robot will be able to move in all directions and able to detect and store the real- time data. Several other sensors including Flame Detector and Smoke Sensor could be included to monitor extensive dynamic parameters. With the evolving infrastructure of our country, the proposed communication technique could be modified in the future.

The sideline for this project is Sag online monitoring system for power transmission wire based on tilt angle measurement was proposed; the mathematical model of catenary for power wire was established. Sag calculation models of power wire in the situation without swinging and swinging were derived. By measuring the power wire axial angle and swing angle with dual-axis tilt sensor, the sag could be accurately calculated with the wire swinging. By testing the sag detection system, the result showed that the sag detection system could meet the engineering requirements of sag measurement.

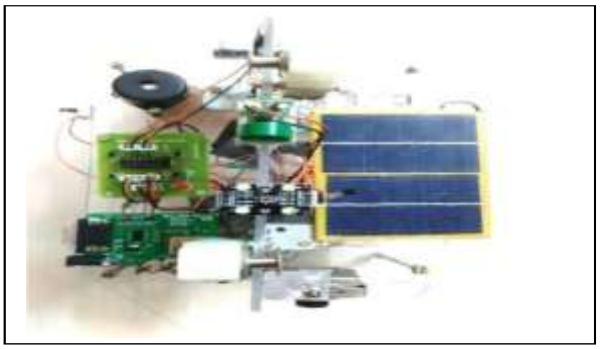
7. OUTPUT

7.1 Webpage Output:

7.2 Prototype Model: Side View



7.3 Top View of the Project:



8. CONCLUSIONS

The project has been designed in a way so as to improve efficiency and to be as much user friendly as possible. Simplicity of component use also works as a factor for low power consumption and easy maintainability. We are also working on a Webinar training link which can be attached to the product to guide the first time users to utilize the product efficiently.

These power line loss detection smart grid robots will be very much effective and, we hope, will bring about a revolution in the Power and Electricity Board of our nation leading to a greener future and unlimited and uninterrupted power for all.

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