Unmanned Distribution Power Line Inspection System: E-Line Fault Robot and Security using IoT

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Abstract— Inspection of overhead distribution power lines involves high risk of accidents leading to time consumption and costly operation. Therefore a lightweight, portable and flexible smart manipulator made of insulated material is proposed. Using this system the operator can perform inspection from control room, thereby increasing efficiency and safety. The robot continuously inspects the power line for fault and takes photos of any obstacles which cause power failures. It detects the exact position of fault and sent photographs along with the message to electrical department by means of IoT. The beneficiaries of the system are electrical and police department and the consumers of energy who can access the data through a PC or a mobile phone. It also gives a provision for complaint booking and provides night security.
Key words: Robot, Camera, PIR Sensors, Motor Driver, PIC Microcontroller, Internet of Things Technology

I. INTRODUCTION

Electric power distribution networks are undeniably strategic assets for every nation. Among several power distribution structure types, overhead power lines generally present the lowest cost, due to the fact that most of their insulation is provided by air. This instrumental work presents a novel manipulator, designed and made of a telescopic, flexible and portable structure monitor the distribution power line. Besides that, the proposed system uses online wireless actuation and control, i.e., the motion, orientation and the movement of the structure can be controlled in the base control room. Many more things use electricity than are connected to the Internet today, and essentially everything that uses electricity can be made more useful by connection to this network. Thus, the Smart Grid part of the IoT could be larger than the Internet is today. And, just as the Internet would not have been possible without the existing electric grid, a modern, intelligent grid will not be possible without the Internet. The IoT will be the new reality of the grid. The electric grid will converge with the Internet. It will become an "Enernet" as expressed by Bob Metcalfe. Through this system the electrical networking is possible, that is, all the electric systems can be interconnected and operated from a control station.

II. BASIC WORKING

The robot is continuously checking the line and connects to the internet using IoT. To implement this connection of physical objects via the web, embedded sensors are affixed to ordinary objects in order to collect data on them. Each of these objects are connected to the Internet, which is how all of the collected data is gathered to be analyzed, and ultimately, how these objects can be manipulated. The parameters like voltage, current, obstacles and power theft are monitored through the smart inspection system. This strategy allows inspection from ground level or control room itself, thereby increasing efficiency and safety. If any fault is occurred in the power line, then a message is send to Electrical Board. It detects the exact position of fault and sent photographs along with the message. Thereby authority can take necessary actions immediately. The robot is equipped with PIR sensors and a high-definition camera to detect obstacles which will cause the power failure. Also Camera continuously takes the photos of any robbery or some unlawful activities and the visuals are sent to concerned authority.

III. PROPOSED ARCHITECTURE

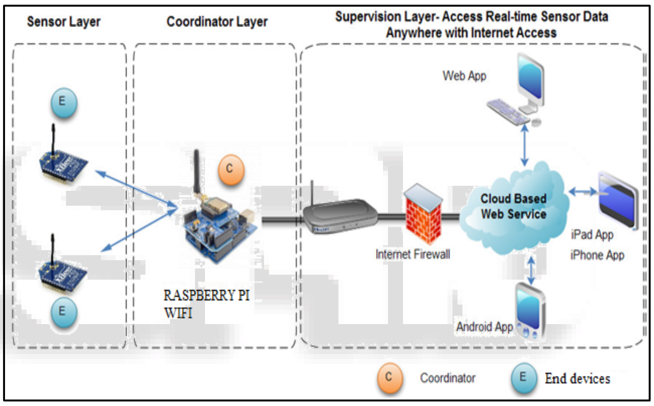

Fig. 1: Proposed Architecture

In order to address the above mentioned issues of flexibility and centralized decision making process, we use a more flexible architecture for integrating WSN to Cloud using REST based Web services as an interoperable application layer which can be directly integrated into other applications. The architecture presented in this work can be customized in different ways in order to accommodate different application scenarios with minimum recoding and redesign. The Sensor Layer consists of sensors that interact with the environment. Every sensor was integrated with wireless nodes called End Devices. These End Devices form a Mesh network and send the information gathered by the sensors to the Coordinator Layer through the sink node called the base station. Messages are routed from one End Device to another until they reach this base station. There are several hardware platforms available for wireless sensor network deployment such as TelosB, Mica, IRIS and Wasp mote.

The Coordination Layer is responsible for the management of the data received from the sensor network. It temporarily stores the gathered data into buffer and sends it to the Supervision layer at predefined intervals. It serves as a mobile mini application server between the wireless sensors and the dedicated network and has more advanced computational resources compared to the End Devices found in Sensor Layer. At the base station, the sink node gathers data from wireless sensors and sends this data to Cloud based sensor data platforms. Finally, the Supervision Layer accommodates the base station with a Web server to connect and publish the sensor data on the Internet. This layer stores the sensor data in a database and also offers a Web interface for the end users to manage the sensor data and generate statistics. Alerts can also be automatically generated to notify the user each time if the desired event has been sensed by the domain rules programmed in the base station.

IV. BLOCK DIAGRAM

A. Transformer Section

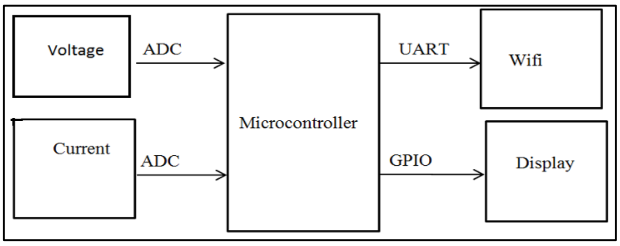

Fig. 2: Transformer Section

B. Robot Section

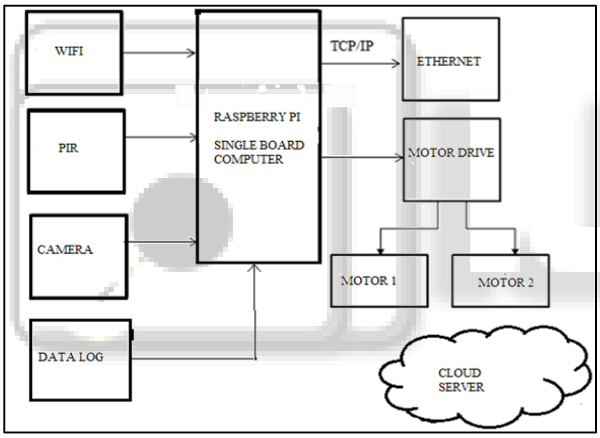

Fig. 3: Robot Section

C. User Section

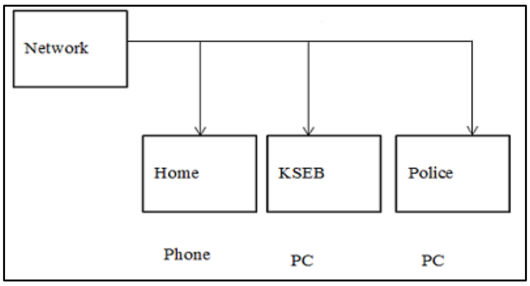

Fig. 4: Use Section

V. HARDWARE SYSTEM

A. Raspberry PI 2

The Raspberry Pi 2 delivers 6 times the processing capacity of previous models. This second generation Raspberry Pi has an upgraded Broadcom BCM2836 processor, which is a powerful ARM Cortex-A7 based quad-core processor that runs at 900MHz. The board also features an increase in memory capacity to 1Gbyte. It has 4 USB ports,40 GPIO pins, Full HDMI port, Ethernet port, Combined 3.5mm audio jack and composite video, Camera interface (CSI), Display interface (DSI), Micro SD card slot and Video Core IV 3D graphics core. Because it has an ARMv7 processor, it can run the full range of ARM GNU/Linux distributions, including Snappy Ubuntu Core, as well as Microsoft Windows 10. The Raspberry Pi 2 has an identical form factor to the previous (Pi 1) Model B+ and has complete compatibility with Raspberry Pi 1.

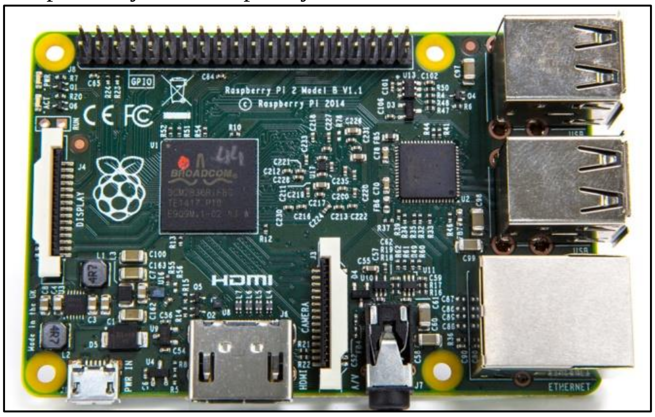

Fig. 5: Raspberry PI 2

B. PIC Microcontroller

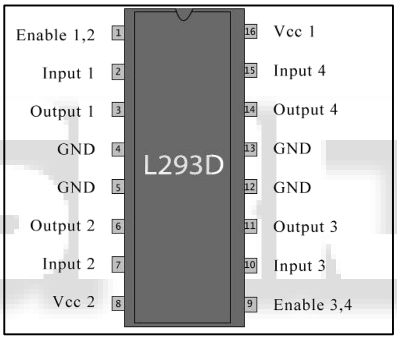

Fig. 6: PIC Microcontroller

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. On the L293, external high-speed output clamp diodes should be used for inductive transient suppression. A VCC1 terminal, separate from VCC2, is provided for the logic inputs to minimize device power dissipation.

The L293and L293D is characterized for operation from 0°C to 70°C.

C. Camera

A rotating line camera is a digital camera that uses a linear CCD array to assemble a digital image as the camera rotates. The CCD array may consist of three sensor lines, one for each RGB color channel. Advanced rotating line cameras may have multiple linear CCD arrays on the focal plate and may capture multiple panoramic images during their rotation. Line-scan technology is capable of capturing data extremely fast, and at very high image resolutions. Usually under these conditions, resulting collected image data can quickly exceed 100 MB in a fraction of a second. Line-scan-camera–based integrated systems, therefore are usually designed to streamline the camera's output in order to meet the system's objective, using computer technology which is also affordable.

Fig. 6: Camera

Line-scan cameras intended for the parcel handling industry can integrate adaptive focusing mechanisms to scan six sides of any rectangular parcel in focus, regardless of angle, and size. The resulting 2-D captured images could contain, but are not limited to 1D and 2D barcodes, address information, and any pattern that can be processed via image processing methods. Since the images are 2-D, they are also human-readable and can be viewable on a computer screen. Advanced integrated systems include video coding, optical character recognition (OCR) and finish-line cameras for high speed sports.

D. PIR Sensor

An individual PIR sensor detects changes in the amount of infrared radiation impinging upon it, which varies depending on the temperature and surface characteristics of the objects in front of the sensor. When an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection. Objects of similar temperature but different surface characteristics may also have a different infrared emission pattern, and thus moving them with respect to the background may trigger the detector as well.

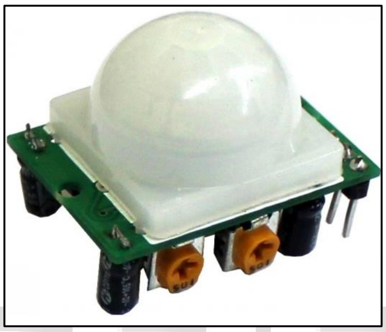

Fig. 7: PIR Sensor

VI. CIRCUIT DIAGRAM

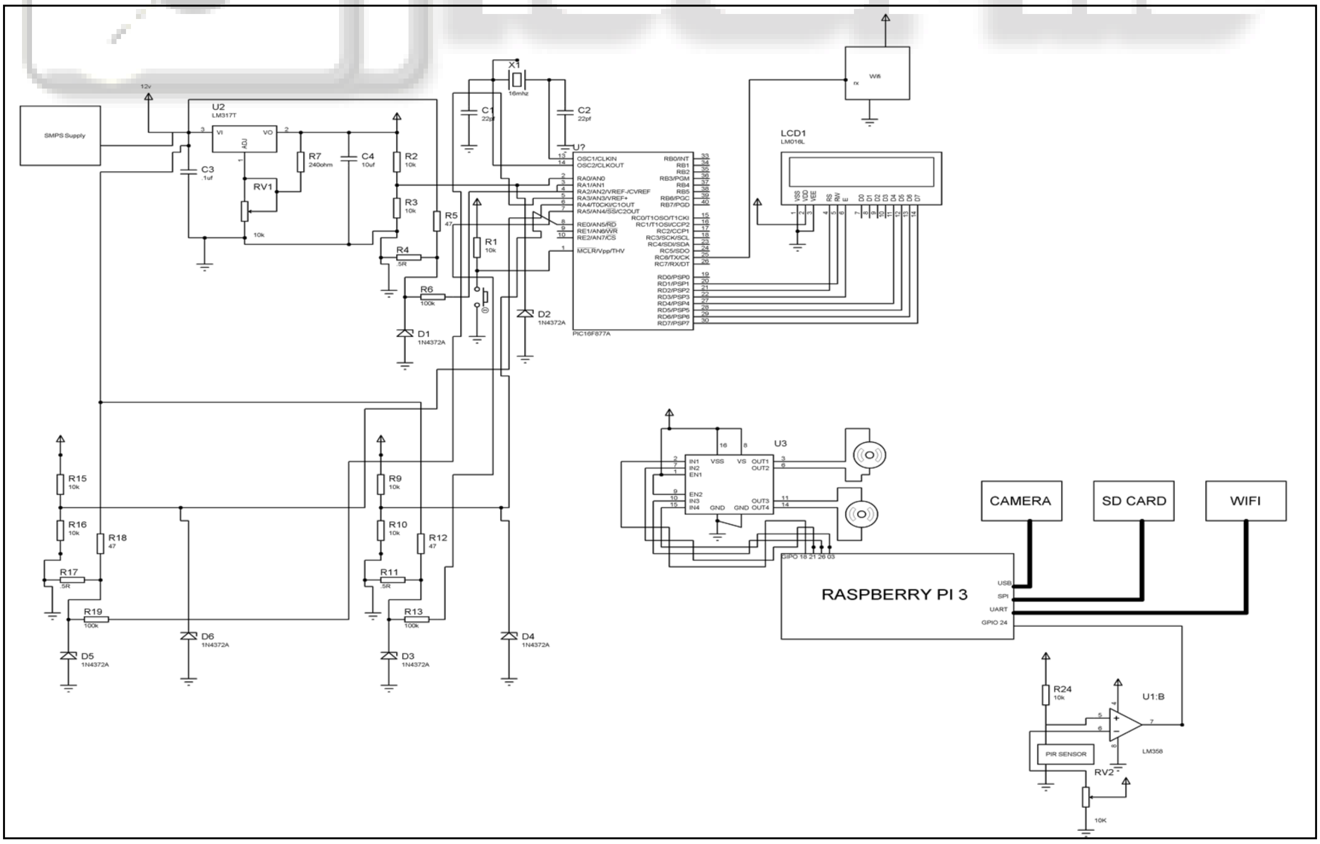

Fig. 8: Circuit Diagram

VII. ADVANTAGES

- Skilled Fault Detection: As voltage, current, temperature etc of the transformer is monitored continuously, any undesirable changes are noted and fault is detected. Robot visits the place and send message to KSEB along with necessary photographs.
- Night Surveillance: The robot safeguards its domain from any unlawful acts. Hence it provides night patrol.
- Complaint Booking: Online complaint booking is also available through this system which provides a delay free maintenance.
- User Friendly Applications: Consumers of electrical energy, police and electrical department can have an effortless access to information imparted by the e-line robot via internet of things (IoT).

VIII. CONCLUSION

We developed a system for skilled fault detection and earlier rectification of threats in electrical power distribution system. This enables a hazardless operation. It builds up an EA (Electrical Area) network and can be accessed through our finger tips.

IX. FUTURE SCOPE

The robot now works in DC power, it can be made to work using solar power in future so that the cost of energy is reduced. The data uploaded in the cloud server can be easily accessed through a mobile application in the future. The terrestrial robot can be made an aerial one as such works may become common in future.

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