Condition Monitoring of Renewable Energy Resources

R. B. Dhumale[#1], N. D. Thombare[2], Mr. Amit M Umbrajkaar[3], A. N. Sarwade[4]
1, 2, 4 Department of Electronics and Telecommunication Engineering, Sinhgad College of Engineering, Pune.
3Department of Mechanical Engineering, Dr. D. Y. Patil Institute of Engineering, Management & Research, Akurdi, Pune.

Abstract: This work shows Wireless Sensor Networks based Condition Based Maintenance using low cost devices for the maintenance circuit and by using Zigbee which is beneficial to the industry as it has low power consumption, has reliable, secure communication and supports 65000 node connections. All the condition monitoring is done remotely from Control room with the help of Wireless Sensor Networks. The monitoring is done, and according to the position of devices, it will decide whether it is good or faulty. These conditions are sending to the control room and monitored by observer. The proposed system will prove to be the significant and beneficiary factor in CBM of Standalone solar street light systems.

Index Terms **- Condition based maintenance, wireless sensor networks, renewable energy.**

I. INTRODUCTION

The growth of solar products in consumer market shows awareness of renewable energy also remote sensing and maintenance is becoming more important with accelerating advances in technology. In order to get maximum benefit and efficiency and to prevent damage it is necessary to monitor the condition of panels and related devices of standalone system continuously. In a modern operating and maintenance technique of renewable energy systems, condition monitoring plays an important role in monitoring and managing the state of devices including the system. This project helps to maintain the system by providing local and remote condition monitoring of Renewable Energy System using Wireless Sensor Networks (WSNs).

In the era of consistent advancements in maintenance systems, Condition Based Monitoring (CBM) using Wireless Sensor Networks (WSNs) plays a vital role. WSNs have a wide area of application in industrial as well as process control applications. Without interference of the human being the actual condition can be monitored with the help of WSNs. WSNs can provide solutions with high Return of investment for CBM, control and safety. Zigbee is an emerging short-range, low-rate, low power wireless network technology [1, 2, 3]. CBM is a major component of predictive maintenance. It provides us with the advantage of knowing the system better. Using WSN as a part of this system highly benefits remote monitoring. Merging Internet of things (IoT) with this technology further enhances the system efficiency due to means of connectivity. While there is cost involved with monitoring, it is usually minimal compared to the downtime associated with doing maintenance too often or making unexpected repairs. The exact factors involved with condition monitoring will vary from one piece of equipment to another. The hardware and software implementation for fault detection and continuous monitoring system for solar panel in remote area are described in [1]. This research problem has been stated by engineers working in Solar panel maintenance system. As proposed solution to this wireless sensor node is provided with Voltage sensor, Current sensor, Light sensor, Temperature sensor Dust sensor and XBeeS2 to implement WSN [4, 5, 6]. Data are being continuously stored and monitored at central station called HUB.

Sufficient facilities are provided by the government, also large investments are made for the solar street lights all across the world, but there still is the problem of maintenance which results into dark streets and people grappling around with lanterns at night. As the street light network is large it becomes difficult to monitor each and every system. Also with the enormous investment already done, this demands for a maintenance device which is low in cost and efficient. Wireless communication network, use of cost efficient components and immediate response to the fault in renewable energy systems of such type has not yet been implemented.

II. METHODOLOGY

The proposed system of 'IoT based Condition monitoring of Renewable energy resources (IBCMRER)' is shown in Fig. 1.The main blocks of IBCMRER are given below:

- Multiple Slave nodes (SN)
- One Master Node (MN)
- One Control Unit (CU)

The system is designed to continuously monitor a group of stand-alone solar street lights in a particular area. The blocks diagram in Fig. 1 prototypes the actual system. The individual streetlights are called as nodes. Each node will be provided with its unique address so that it will be easy to locate the street-light. Three nodes are present in this system. Two of them are named as Slave 1 and Slave 2 respectively, and one node is addressed as Master node. The devices present in individual nodes i.e. Solar panel, Battery, Battery Charger and bulb are all connected to the maintenance circuit. The entire nodes serve the same task of monitoring all the mentioned devices continuously except for the Master node with comes with additional functions. Consider a fault has occurred in either of the devices, each device will represent a switch which will either turn on or off according to the logic embedded in them. This data will be transferred from Slave nodes to the Master nodes using Wireless Sensor Network (WSN). Master node receives all the Slave node data (solar panel, bulb, battery and charger status) form the nearby Slave nodes and transfers this data to the maintenance officer using GSM also displayed through GUI design in Visual Basic software.

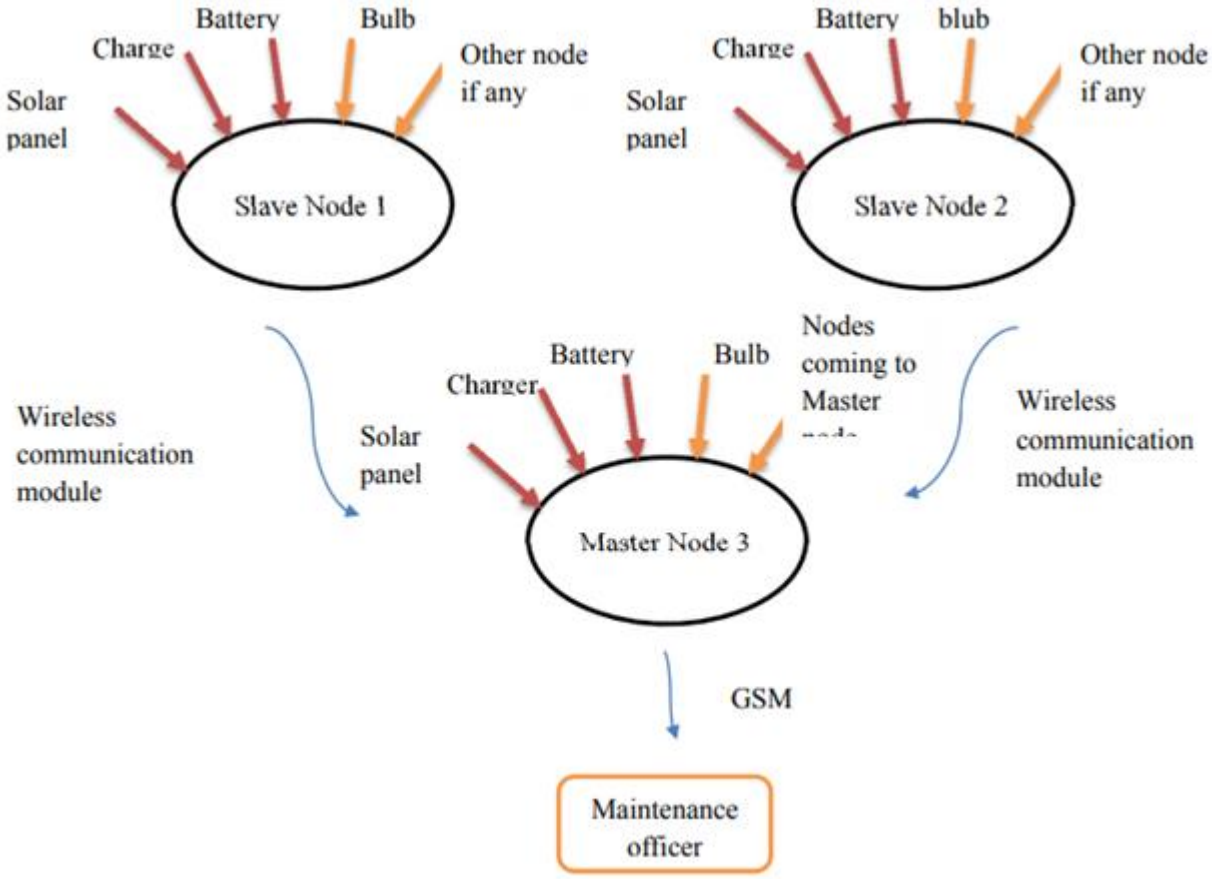

Fig. 1: Block Diagram

The communication between the devices will be wireless as shown in Fig. 2. Slave nodes will be communicating with the master node and master node will send message to the maintenance officer using GSM technology.

III. IMPLEMENTATION OF PROJECT HARDWARE AND SOFTWARE

The implementation of the circuit hardware consists of two parts; both the circuits will be installed on the nodes i.e. stand-alone street lights:

A. Monitoring device
B. Controller unit

The monitoring device: This circuitry monitors solar panel, Battery charger, Battery and bulb. Fault detection and sending the fault signal will be the two functions performed by this device.

Circuit design description: Stand-alone solar street lights will be tested for two conditions, one during the day time and another during the night time. Different components of the system will be monitored in these two conditions. Depending upon Day time and night time conditions the monitoring device will also consider two conditions:

1. Day condition: During day time it will monitor solar panel, battery and battery charger.
2. Night condition: during night time it will monitor the bulb.

These two conditions will be determined by a simple light detection circuit. Controller device: Controller device is used for processing of signals coming from the maintenance device. After processing only the faulty signals will be considered and forwarded to the master. Trans-receiver functions of Zigbee will be carried out in controller device.

The algorithms for Slave node, Master node are given below which is also presented in the form of a flowchart.

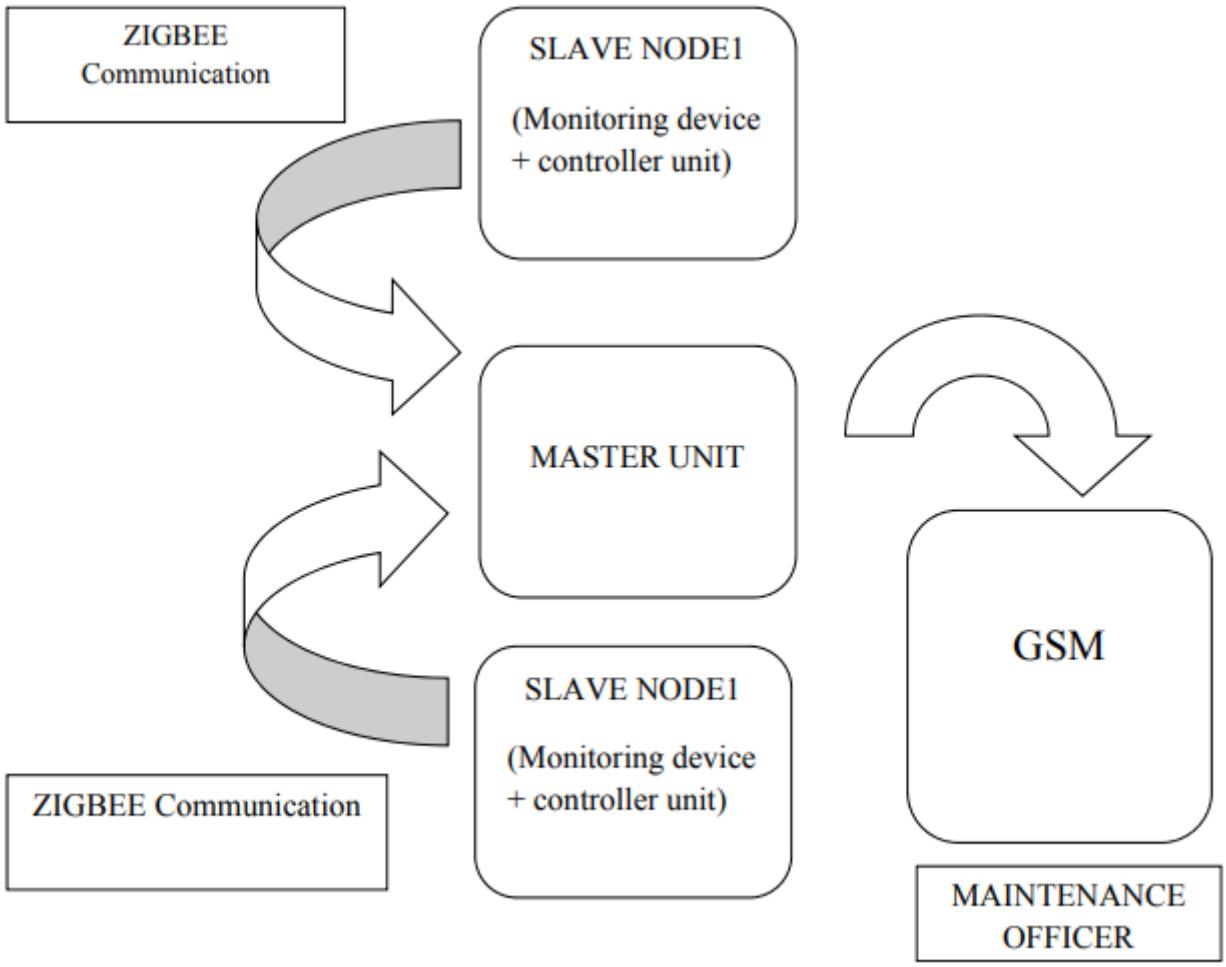

Fig. 2: Flow of communication between devices

Algorithm:

Slave Nodes:

1. START
2. Initialize all the devices like maintenance circuit, LCD display, Zigbee module, etc.
3. Read device values and check if fault is generated
4. Display name of the node on LCD
5. Read switch position, check for fault in the maintenance circuit.
6. Display OK condition and fault condition on LCD
7. Send all the data related sensor value and switch position to Master node
8. Go to step3

Master Node:

1. START
2. Initialize all the devices like maintenance circuit, LCD display, Zigbee module, etc.
3. Read device values and check if fault is generated in Master node.
4. Display name of the node on LCD
5. send request to Slave 1
6. Check if data received from Slave 1
7. If yes go to step 11
8. send request to Slave 2
9. Check if data received from Slave 2
10. If yes go to step 11
11. Send all the data received from its monitoring device and from Slaves on WSN to maintenance officer using GSM and to the Visual Basics software
12. At Master unit side display all the data received from all the Devices on monitor.
13. Go to step3 and continue

Global System for Mobile:

1. START
2. Initialize all the serial communication, database.
3. Check if data received from Master
4. If yes then send message to the Maintenance officer using GSM
5. Update database with date and time
6. Go to Master and continue.

IV. RESULTS AND DISCUSSIONS

In this work all the device conditions are displayed in the control room as well as the message which is sent to the Maintenance officer using Visual Basic (VB) software through GUI design and GSM respectively. In this work, the system has a monitoring circuit on WSN nodes which is continuously observing the devices for fault. After processing, microcontroller will continuously update data on GUI With the personal computer; we can easily access data using cell phone or personal computer.

Wireless sensor network provides continuous and near data acquisition. In these work all the device condition is displayed in the control room using Visual Basic (VB) software through Graphical User Interface design. In this work, we can monitor the conditions of industry with data using WSN, Zigbee technology.

The entire system will be communicating using Zigbee, WSN the monitoring device will be connected to the solar panel, battery, charger and the bulb. Fault generated in any node will be transmitted to the Master node. Initially 111 will be no fault condition and 0 will be indicating fault. The system hardware is shown in Fig. 3.

A message indicating fault will be generated by GSM module connected to the Master node. This message will be as shown in Fig. 4. Immediate indication by the system will be beneficiary for the maintenance officer. It will also inform us about which node is faulty.

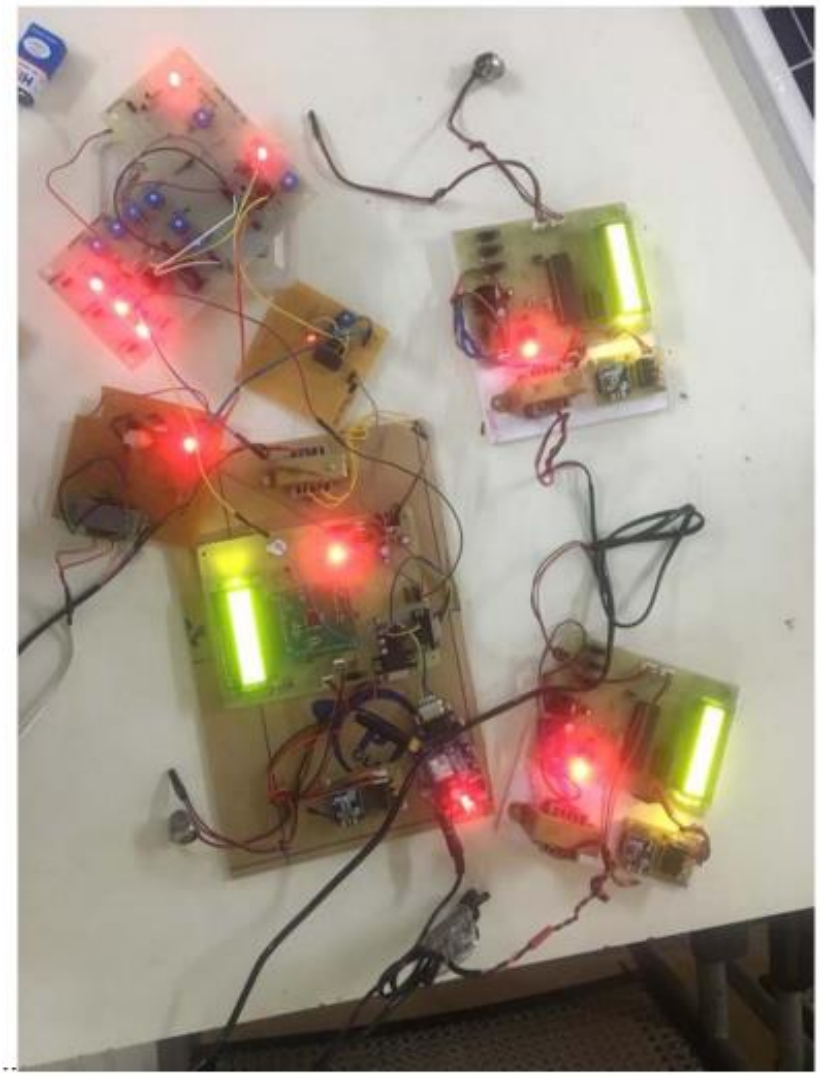

Fig. 3. Hardware of system

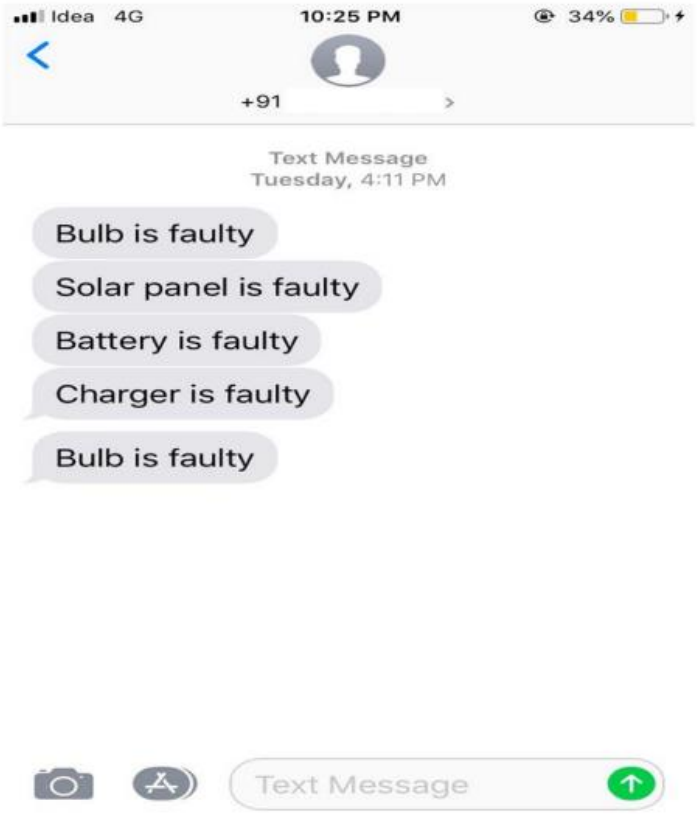

Fig. 4. Received message.

V. CONCLUSION

The project will implement a system for a particular area having a group of stand-alone solar street lights in need of maintenance, in order to minimize human intervention and avoid delay in repairing. The main aim is to build a circuit for monitoring each and every component in the stand alone system and all this data is sent, node to node using Zigbee wireless communication technology. To diagnose the various types of faults occurring in remote location renewable systems, this work describes a monitoring and analysis system. This proposed system will provide the combinational benefits of CBM, WSN and IoT.

VI. REFERENCES

1] R. B. Dhumale, S. D. Lokhande, "Diagnosis of multiple open switch faults in three phase voltage source inverter", Journal of Intelligent and Fuzzy Systems, vol. 30, iss. 4, pp- 2055-2065, 3/10/2016. [IF-1.812, ISSN (print): 1064-1246, ISSN (Online): 1875-8967 ,Publisher: IOS Press, Netherland, DOP: 10 March 2016]

2] R. B. Dhumale, S. D. Lokhande, "Comparative Study of Fault Diagnostic Methods in Voltage Source Inverter Fed Three Phase Induction Motor Drive",IOP Conf. Series: Materials Science and Engineering, vol. 197, pp. 1-14, June, 2017. [ISSN: 1757-899x]

3]. Chetan Vinayak Gawali, R. B. Dhumale, "Web Based Irrigation System using Wireless Sensor Networks", CiiT International Journal of Artificial Intelligent Systems and Machine Learning, Vol. 10. Iss. 06. April 2018, pp 145-148. [ISSN: 0974 – 9543]

4]. R. B. Dhumale, N. D. Thombare, P. M. Bangare, Chetan Gawali, "Internet of Things for Smart City", International Research Journal of in Engineering and Technology, vol. 04, iss. 06, pp. 792-797, Jun, 2017.[Impact Factor:5.181, ISSN: 2395 -0056, 2395-0072]

5] R. B. Dhumale, N. D. Thombare, P. M. Bangare, "Supply Chain Management using Internet of Things ", International Research Journal of in Engineering and Technology, vol. 04, iss. 06, pp. 787-791, Jun, 2017.[Impact Factor:5.181, ISSN: 2395 -0056, 2395-0072]

6] R. B. Dhumale, S. D. Lokhande, "Condition Monitoring of Voltage Source Inverter" 2nd International Conference on Research Trends in Electronics and Telecommunication (IRTET, IRET, Anakapalli, Visakhapatnam, Andhra Pradesh, India, Oct. -2015.