INTERNET OF THINGS (IOT) IN ELECTRICAL RESEARCH

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Abstract: *The Internet of Things (IOT) fills the gap between the real world and cyber world. This technology enables the world to achieve connectivity between objects by combining physical and digital world; through various objects such as; actuators, processors, sensors which communicate over the internet. It is one of the flourishing technologies in the world. A Distribution Static compensator (DSTATCOM) which is installed in a remote village of Warangal district is interfaced with IOT. In this paper we combine IOT with a DSTATCOM, to keep a check on the power factor and other transmission line parameters remotely. IOT technology is used to monitor the health conditions of the DSTATCOM, with the swift and apt notification feature using Gmail.*

Index Term **- Internet of Things (IOT), DSTATCOM, JAVA Programming, MATLAB.**

1. INTRODUCTION

Internet of Things (IOT) was first invented by Kevin Ashton in 1999. Internet of things is an integrated platform of devices or objects, interconnected to each other through wired/wireless mode and they share information to develop an application. The internet of things dwells in two parts; the first comprises of physical objects i.e. devices, vehicles, buildings and other items. The second part is the electronics, software sensors and network connectivity which are embedded to the first part. These enable the objects to collect and exchange data. The internet of things is an emerging topic of global technological advancements. Consumer products, household appliances and large industrial equipments are connected using this technology [1-2]. It provides connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play [3]. In the days IOT will become an imperative part of our daily life.

There are the major advantages and characteristics of IOT which can be utilized for the benefit of mankind. IOT is characterized such that everything can be connected to the global information and communication infrastructure [4]. It can be utilized to provide services within the constraints of things, such as privacy and consistency between physical and virtual things. The devices within IOT have different hardware and use different networks but they can still interact with other devices through different networks. It can be used to change the state of a device dynamically. Devices powered by IOT have a unique identity and unique identifier. They have the capability to dynamically adapt with the changing contexts and take actions based on their operating condition. These devices will be integrated with information network for communication purpose.

The IOT is cinch, elementary and uncomplicated, thus many modern day systems utilize this platform for the amelioration of their products. In an IOT based atmospheric environmental

monitoring system, the quality of air in terms of air pollution index can be measured using this system; without the restriction of place and space. The atmospheric environmental measurement device is linked to the environmental analyzer through LTE networks. The analysis is based on C# and DBMS, whereas the user application is implemented in C# Windows Presentation Foundation (WPF). This system is known to measure fine dust, ultra-fine dust and also ozone characteristics [5]. Among many prominent applications of IOT is wireless home automation using MQTT protocol. This system uses multiple sensors which notify the users in several ways for diverse devices [6]. The Application of IOT have also reached the agricultural field, where the concept of IOT based system is utilized to measure the temperature, humidity and water level moisture values of the field; resulting in the improved quality and quantity of the farm yield [7-8]. It is evident that the use of IOT technology in association with the other aspects of science and technology is trending as many embryonic technologies [9].

In this paper DSTATCOM is interfaced with IOT technology to improve power factor and real time monitoring of the distribution line. The calling mechanism of the JAVA program in MATLAB gives accurate results. The use of IOT technology for sending timely notifications in the case of a low power factor; is an efficient system for the monitoring of the health of the DSTATCOM.

2. WORKING OF INTERNET OF THINGS

A device powered by this technology can sense the environment and collect information related to it and transmit it to a different device of same or different networks. The users are entitled to set conditions for the working of the devices and these can be programmed into the device. The device can be actuated to other devices in correlation to the conditions set by the users. The device is designated to receive information from the network and to provide information between two devices of the same or different networks.

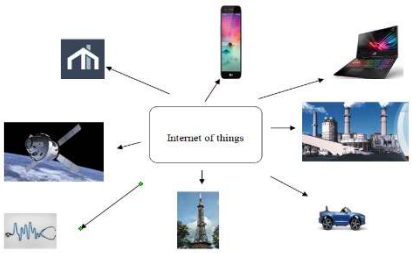

Fig 1 – Architecture of Internet of Things

The basic architecture of IOT is apparent and effortlessly simple. It consists of different layers which are interconnected to give the user the simplest working [10]. The precipitation layer consists of sensor devices. This layer covers and adjusts everything needed in the physical worlds to gain the necessary insights for further analysis. Next in line is the network layer, this layer is a connecting link between the upper and the lower layers. It forwards information from lower layers to the upper layer. This layer works through Wi-Fi, wired LANs and transmits the information between layers. The Middle layer is concerned with service management and storing the lower layer information into the database. This layer enables for follow-up revision and feedback for the lower layers. The application layer is known to manage the IOT applications. It is the frontend layer visible to costumers and used in daily lives. The top most layers is the business layer, it covers the entire IOT applications and service management [11]. It is a sophisticated integration of the architecture of IOT. The layered architecture of IOT provides stability and flexibility to the IOT devices and systems.

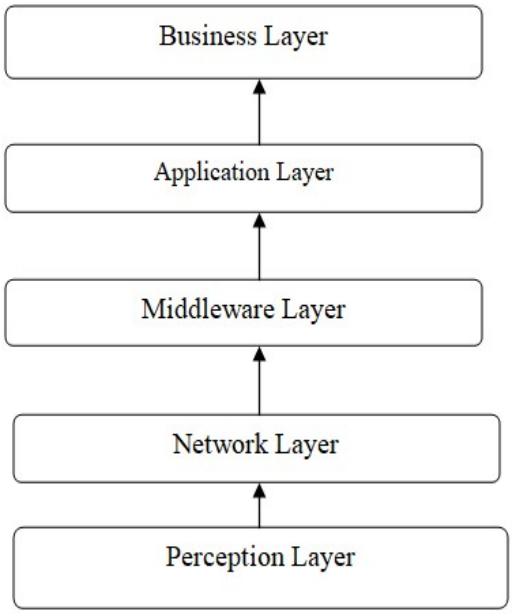

Fig 2- Layered Architecture

3. APPLICATIONS OF IOT TECHNOLOGY ON AN ELECTRICAL DEVICE – DSTATCOM

3.1 DSTATCOM

DSTATCOM is a shunt connected device crafted for power factor improvement, toning source currents and harmonic mitigation in distribution lines. It is meritoriously used in load compensation for balancing unbalanced load currents for various source voltage conditions [12]. In recent years Distribution Static Compensator (DSTATCOM) is the most active device used in distribution lines for easing of power quality hitches like high reactive power compensation, unbalanced loading conditions and low power factor. It be made up of of Voltage Source Inverter (VSI) [13]; controller to stimulate firing pulses for IGBT's in VSI, dc link capacitor and coupled at Point of Common Coupling (PCC) through an interfacing inductor to reduce ripple content in distribution line.

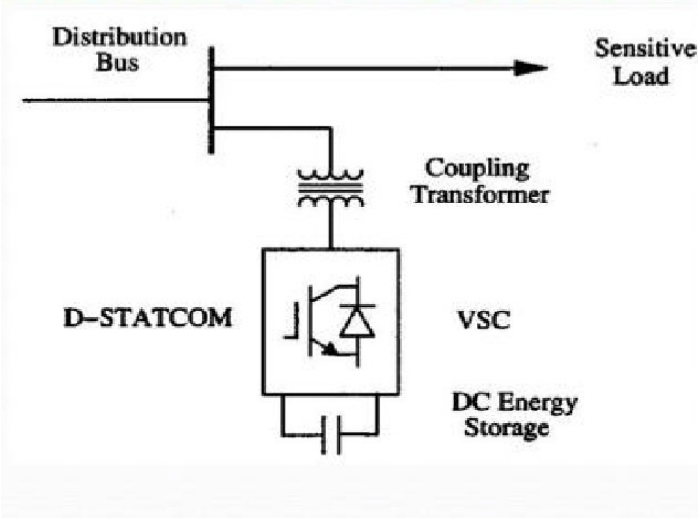

Fig 3 – DSTATCOM Block Diagram

3.2 APPLICATION OF DSTATCOM AND IOT

In this paper IOT technology is implemented to monitor the characteristics, performance and health of the DSTATCOM. A DSTATCOM has been installed in the rural village of state of Telangana, India called, Chandrayangutta. This village is situated in Warangal district, where

heavy motors are a cause of low power factor in the lines. Various power factor problems are analyzed in the considered village. A major issue for the villagers is the monitoring of the device. We aim at merging the two emerging technologies of IOT and DSTATCOM to improve the power factor and real time monitoring of the distribution line. The software is designed to identify low power factor conditions and communicate the same to the user. The communication module uses JAVA programming which is integrated in MATLAB through calling procedure. The interface of IOT with DSTATCOM is studied in terms of performance using MATLAB/SIMULINK, with the help of simulation results. The information of low power factor in the distribution line is collected by the IOT module and an email notification is to be sent to the users Gmail account.

The software is designed to process the low power factor in the DSTATCOM. JAVA Programming is used by the system in integration with MATLAB as a calling procedure.

3.3 THE LOW POWER FACTOR DISCRIMINATION ALGORITHM AS FOLLOWS:

1)Created java project with class DSTATCOM IOT.

2) Created class for Complex Number which holds the real and imaginary values in the form of data type double.

3) Created a utility class to handle arithmetic operations (add, subtract, multiply, square root, inverse, divide) between complex numbers and real numbers which are stored in the form of Complex Number object.

4) Created the static method called calculate Power Factor in DstatcomIot class which takes the Va, Vb, Vc, Ia, Ib, Ic, time, logflag as input in the forms of real and imaginary numbers to calculate Power Factor and returns the p,q,and pf values.

5) Created a map for getter and setter method to store variables like mailsSent, positivePFCount, negativePFCount, prevPF, switchoffTime .

6) MailsSent value prevents sending mails more than
Configured count (ex: send one mail per shut down of system)

7) PositivePFCount, negativePFCount, prevPF, switchoffTime values to prevents sending mails only when power factor reached lessthan desired value.

8) Additionally added a flag to print the input, output values.

9) Used a method called printData to print logs for any additional information required.

10) Created the jar file called DstatcomIot.jar file.

11) Created the javaclasspath.txt file in MATLAB BIN DIR ($MATLABHOME\BIN\) by adding jar classpath as content.

12) Created Matlab function which takes input Va, Vb, Vc and Ia, Ib, Ic.

13) Created statements to call java from Matlab [e.g.: code Extrinsic (“java method”)] and called calculatePowerFactor java method from matalab function by passing Va, Vb, Vc and Ia, Ib, Ic, time, logflag and capture the powerfactor.

14) Using the setValue, getValue method store and retrived the mailsSent, positivePFCount, negativePFCount, prevPF, switchoffTime variables to prevents unnecessary mails.

15) Developed logic for sending a mail when power factor level gets decreased.

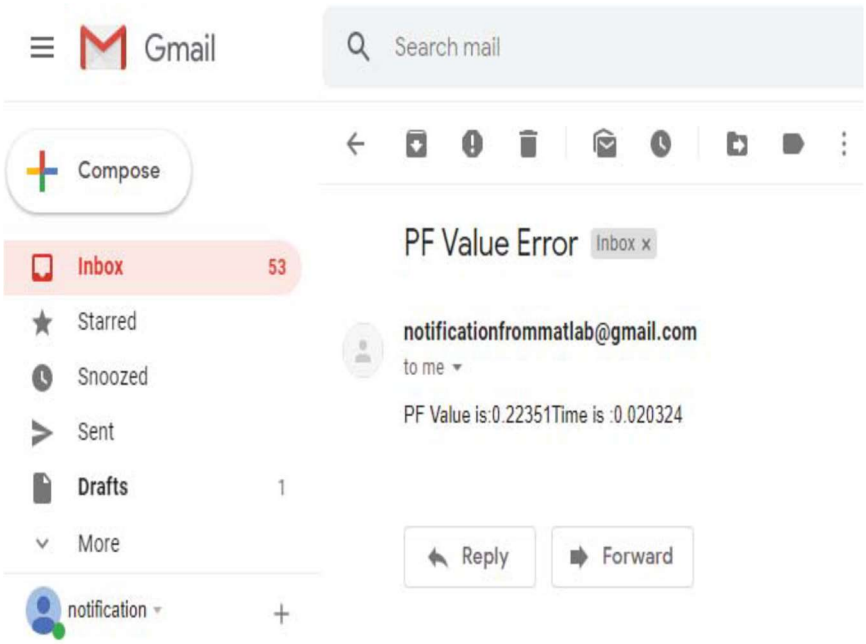

Fig 4 – Low power factor notification 1.

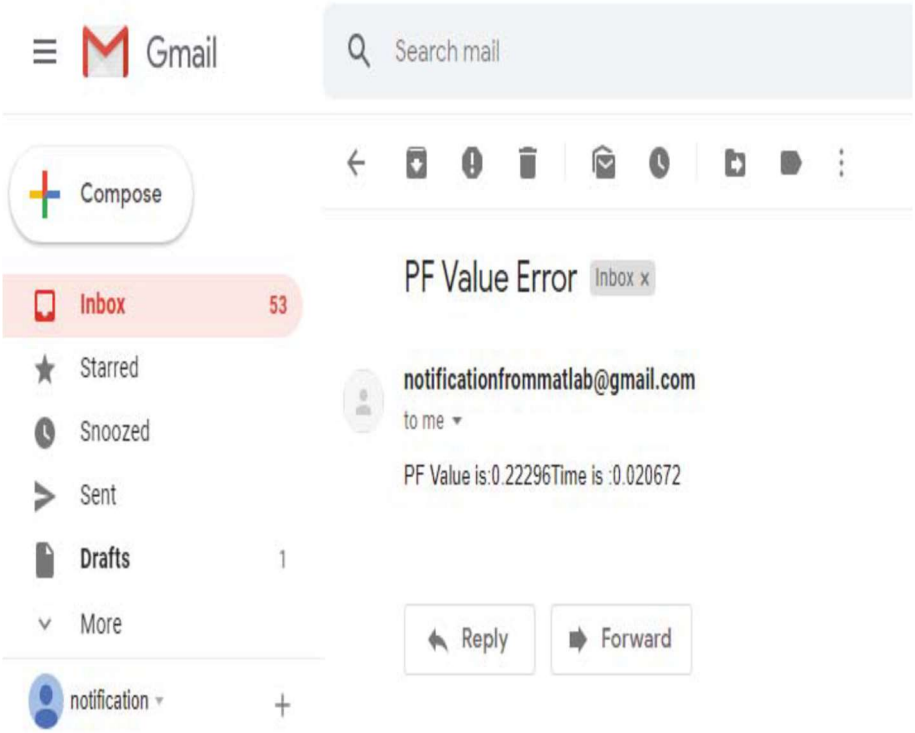

Fig – 5 Low power factor notifications 2.

It is observed that here a metering technology based on IOT is being used to solve this problem. Internet of things provides the connectivity between objects timelessly, seamlessly combining physical and digital world. The IOT based module is helpful in monitoring the results very precisely and it leads to taking necessary actions astutely and on time. Even the minute and very small variations can also be monitored remotely using this IOT technology. The monitoring of

the distribution line is metaphorical to one to one care using this system. The Internet of Things (IOT) represents a step beyond the utilization of conventional technology by increasing the use of wireless technology and provides real-time data acquisition. This system is evident to function without human presence at the site of fault, thus making it tranquil and efficient.

4. CONCLUSION

In this paper the use of IOT for the monitoring and control of an electrical device – DSTATCOM is proposed. This technology can be utilized for the real time monitoring of the distribution lines distantly. The IOT module is supported by the low power factor discrimination and communication module developed using JAVA Programming in MATLAB/SIMULINK. The results have proved that the use of IOT technology leads to monitoring of low power factor conditions. The data acquisition using IOT is very powerful and accurate. The mail sent to the registered user during the condition of low power factor is the most crucial part of the system, as this is responsible for the in-time action of switching on of the DSTATCOM. As, part of our future research we intend to develop a real time prototype; for the evaluation and on ground implementation of this technology. It is evident that the real time monitoring and timely action of the distribution system will increase the efficiency of the whole distribution system. Apparently, it has come to light that IOT is an emerging technology and a powerful tool which has its applications in various fields of work. It can flawlessly be known as a multidimensional technology useful in all works of life.

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