ZIGBEE based Wireless Monitoring and Controlling of Automation System using PLC & SCADA

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ABSRACT: Main aim behind this project is to monitor and control the PLC based system using wireless technology. In this project I am going to use a ZIGBEE and SCADA technology to get wireless automation system. Pair of ZIGBEE is used here, among that one is connected with the PLC in the industry side and another one is connected with PC in the control room. Data from the PLC side will be transferred continuously to PC via ZIGBEE by sending a bit of the process that occurs in the industry and it will be displayed in the SCADA software and also we can control industry by transmitting a bit again using ZIGBEE from PC side to PLC located at the industry side. Thus we can avoid the maintenance and cost of the long cables that are used to connect the PLC with a PC.

Keywords: Wireless, PLC, ZIGBEE, SCADA, Automation System

I. INTRODUCTION

In today's world many of the industries are getting automated using PLC and thus it has become a main part of the industries. Continues monitoring and controlling of industries are required due to the large amount of production. PLC is a device which is connected with equipment in the industry and it will transfers the data to PC via long cables and a person seating in the control room on PC can monitor and control the industry. Cost and maintenance of the automation system get increases due to long cables that we are using to connect the PLC with PC. We can solve this problem by using wireless technology.

Wireless technology is being widely used since last few years in automation and it has also become a part of our lives because now a day's people are using in their daily life. RF, GSM, ZIGBEE are some technology that falls in to wireless category. By using single technology or combination of different technologies we can make the system wireless and we can handle the system easily.

In this project I am going to use a pair of TARANG F4 ZIGBEE Module, Allen-Bradley micrologix1000, SCADA Software with the KEPServerEx (Server that is used as communication medium between the PLC and SCADA). These are the main components of this project.

II. RELATED WORK

. ZIGBEE is a wireless technology that is used with microcontroller in many applications like home appliances, agriculture field, robotics etc. ZIGBEE with microcontroller [1] is also used for irrigation purpose where they have used the two modules among them one is sensor module which includes the controller AT89C2051 and that is interfaced with soil moisture sensor and temperature sensor and also with ZIGBEE module. Second module is substation module which includes controller interfaced with LCD, solenoid valves, another ZIGBEE module etc. Sensor module continuously check the status of the sensors attached with that and sends the current status via ZIGBEE to substation module and then substation module compares the status with data stored and take the action according to the predefined program.

In agriculture PLC can be used for many applications like seeding, irrigation, fertilizing etc same as many applications in industry. When sensor sense the low level of water in soil it will send the status to PLC via ZIGBEE and PLC will take the action according to the status. It includes the control of three process in the agriculture [2] as follows seeding, irrigation, ploughing. Here seeding and ploughing processes are performed by using mechanical hardware and software and irrigation is performed using valve on/off system controlled through software only. ZIGBEE can also control drip irrigation [3],[4] method in the agriculture field same as above method using wireless sensor network. Here controller will control the full process of drip irrigation according to the status of sensor and after that it will the send the data to computer using ZIGBEE method. Linear programming can also be used here for exact water supply to the plants after calculation of soil and water fertility parameters.

This type of automation in agriculture and industry will reduce the man power and increases efficiency of the production.

III. DETAILED STUDY

PLC is a controller based device which is used for automation in industries. PLC and controller both can be used for controlling the equipment but controller requires the external hardware for connection such as max232, capacitors, resistors etc. while PLC is a device with complete modular structure. Thus using PLC we can easily connect the input and output directly to the port given in the PLC.

ZIGBEE falls in the category of wireless domain like GSM and RF technology. ZIGBEE provides the wireless communication. It means ZIGBEE only reduces the cost and maintenance of the wires used for connections else all the process will be same such as ZIGBEE will provide a particular bit on/off status to the other side due to which same message or data we can get on the other side as wire provides. Thus ZIGBEE replaces the connecting wires and provides a wireless communication.

SCADA is software that works with PLC for controlling the PLC based system from distance. Using SCADA we can generate an animated file of the hardware that is to be controlled through a PLC so we can easily handle and view the process in the SCADA software. SCADA connects with PLC through a server and takes a data through a PLC via server (e.g. KEPServerEX in this project) in hidden way that is backward process and thus we cant see the flow of data and directly appears on the SCADA software.

IV. PROPOSED ARCHITECTURE

Architecture contains the pair of ZIGBEE modules, allen-bradley micrologix1000, SCADA software installed in computer. PLC is a central unit to control the process and sensors and other inputs are connected at input terminal of the PLC and ZIGBEE is connected wih PLC via communication port RS485 (RS485 to RS232 converter is required) and output such as conveyer belt motor, dc motor etc are connected at output terminal of the PLC. At the other side PC is connected with ZIGBEE directly through the RS232 port and this ZIGBEE will communicate with PLC through another ZIGBEE as shown in fig 1 and display the status in SCADA.
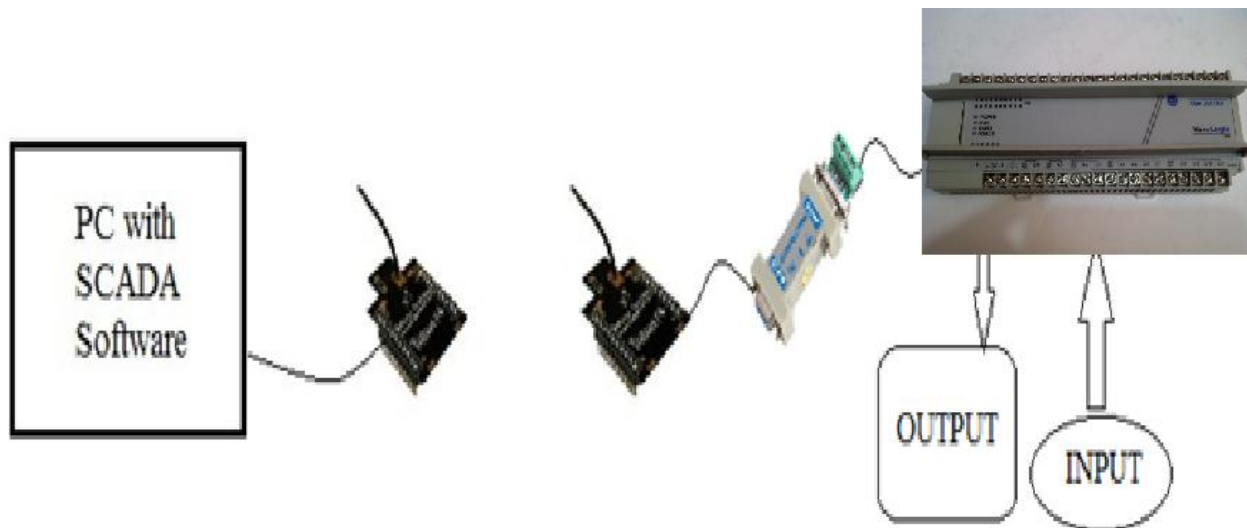
Fig. 1 System Architecture

As shown in fig 1 PLC and ZIGBEE are connected via RS485 to RS232 converter and other side ZIGBEE is directly connected to RS232 port of PC. When inputs are active, will send the status to PLC and after processing the status PLC will send the data to PC via ZIGBEE and that will be displayed on SCADA software. Now user will respond to that status by passing the command to PLC to process the output.
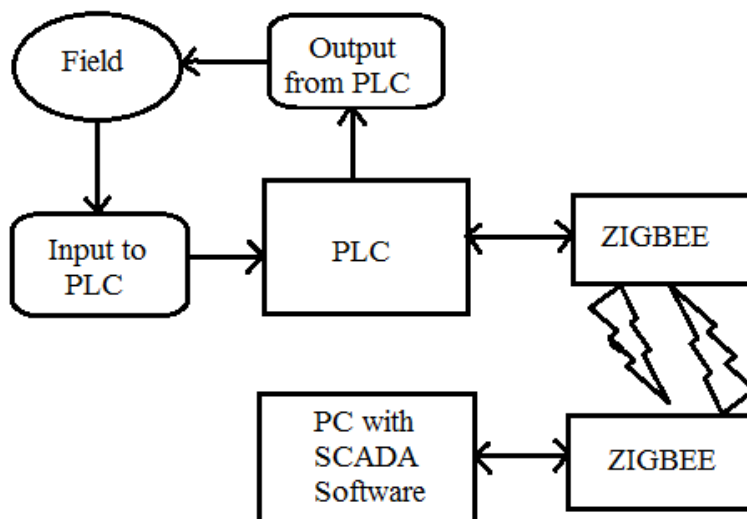

Fig. 2 Block Diagram

Fig 2 shows the system block diagram. Here input signal is coming from the field and goes to input terminal of PLC. Now PLC will send the data to PC using ZIGBEE module and PC will again gives reply to PLC for process. Output from PLC will again goes to field.

A. *RS485 to RS232 Converter*

It is a converter that converts the rs232 communication port to rs485 communication port. It needs the separate power supply to initialize and convert the data as shown in fig 3. At rs485 side one connection is for power supply, two connections are for ground, and remaining two are for rs485A and rs485B.

Fig. 3 RS485 to RS232 Converter [7]

B. *Allen-Bradley micrologix1000*

The programmable controller is also called the programmable logic controller (PLC). It is highly reliable and easily connected to the computers and also provides high performance. It falls in the SLC 500 category of micrologix series. RSLinx software is require to configure the SLC category. It is a one of the good PLC as a performance wise.

This PLC is better from performance side and also it provides the more input and output ports with effective cost. The software for this PLC is available at free of cost on internet thus we can easily install and update the software.

Fig. 4 Allen-Bradley micrologix 1000 PLC [8]

C. *ZIGBEE Module*

ZIGBEE is a device that is based on IEEE 802.15.4 standard as shown in fig 5. It has 4 layers based on ISO model. They are physical layer, media access control layer, network layer and application layer as shown in fig 6. ZIGBEE contains three nodes and they are sink node, routing node, terminating node [2]. Sink node is initialized first and during this network and equipment parameters are configured. After configuration it selects the channel for connection to the network. It is fully controllable node. Routing node can be join or rejoin the network and also scans channel for new connection. It will act like sink node after the normal operation. Terminal node in normal operation just sends or receive data and as a parent node it will select the nearest sink or routing node.
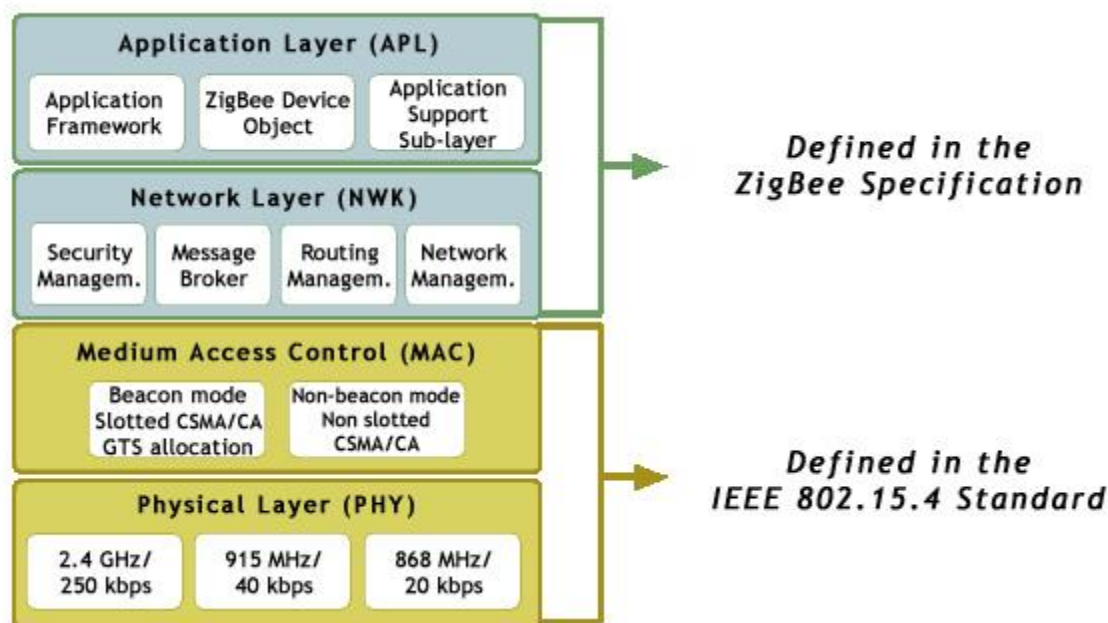

Fig. 5 ZIGBEE Module

Fig. 6 Communication layers of ZIGBEE [4]

Fig 6 shows the below layer i.e. physical layer for physical connection between device and module and actual communication between device and module takes place through it and also shows the speed of transfer for different frequency. Network layer provides network management with router management and also breaks the long message in to small frames of particular size.

Medium access control layer provides the operation like slotted aloha and provides the access to both slotted and non-slotted CSMA. Top most layer is a application layer which actually provides a wireless communication with another paired ZIGBEE module. This all the four layers are ISO OSI model based.
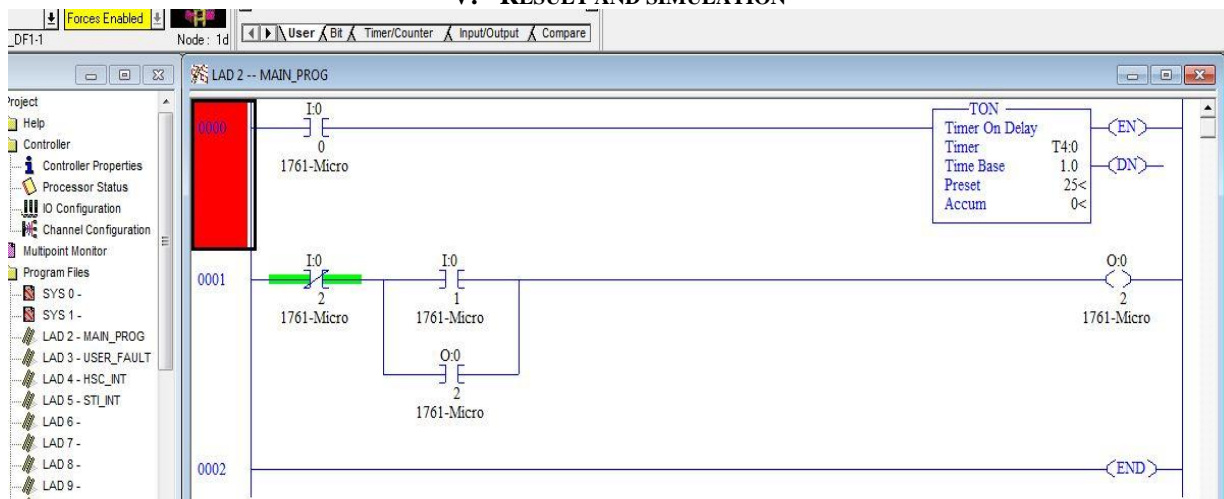
V. RESULT AND SIMULATION

Fig. 7 Progamming language of PLC

Fig 7 shows the main screen of the programming software RSlogix for Allen- Bradley PLC. Image shows the program which contains the input and output. Input are on left side indicated with two seprate lines and output are on right side indicated with coil like structure.
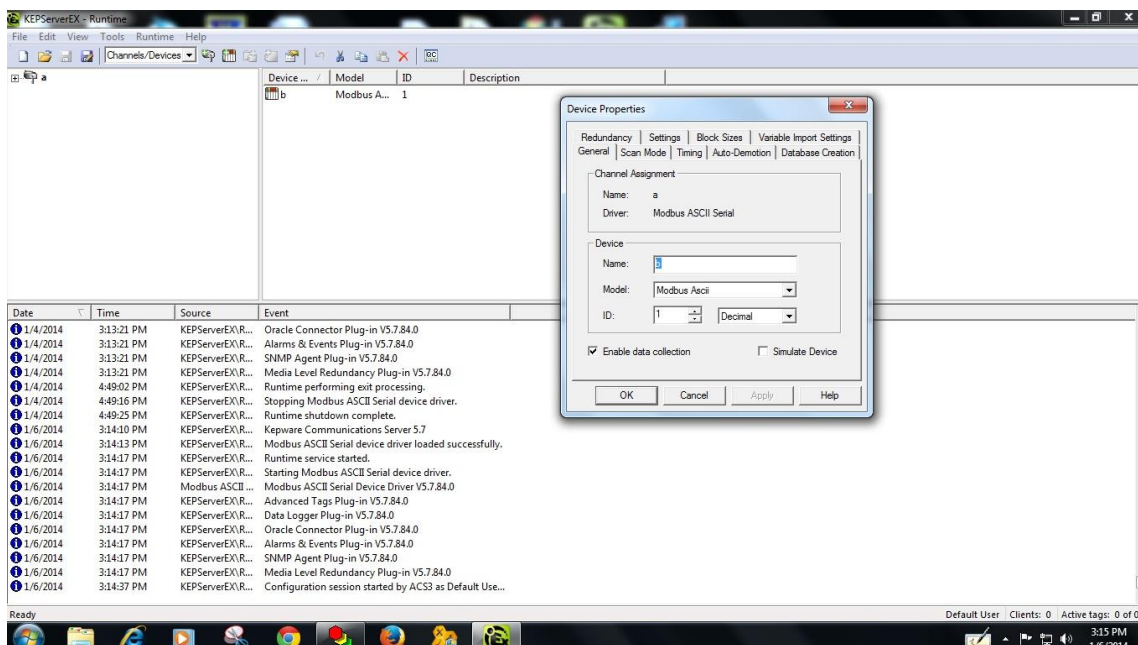

Fig. 8 KEPServerEx main screen

Fig 8 shows the image of KEPServer software which is required for SCADA to run. This software helps the SCADA to communicate with PLC. We have to first configure the device and their input/output in the software with other communication parameters and basic setting required for device as shown in fig 8. After configuration of device when we run the system SCADA will take the data from KEPServer and KEPServer will communicate with PLC. Thus SCADA will communicate with PLC indirectly and shows the result on main screen of SCADA.
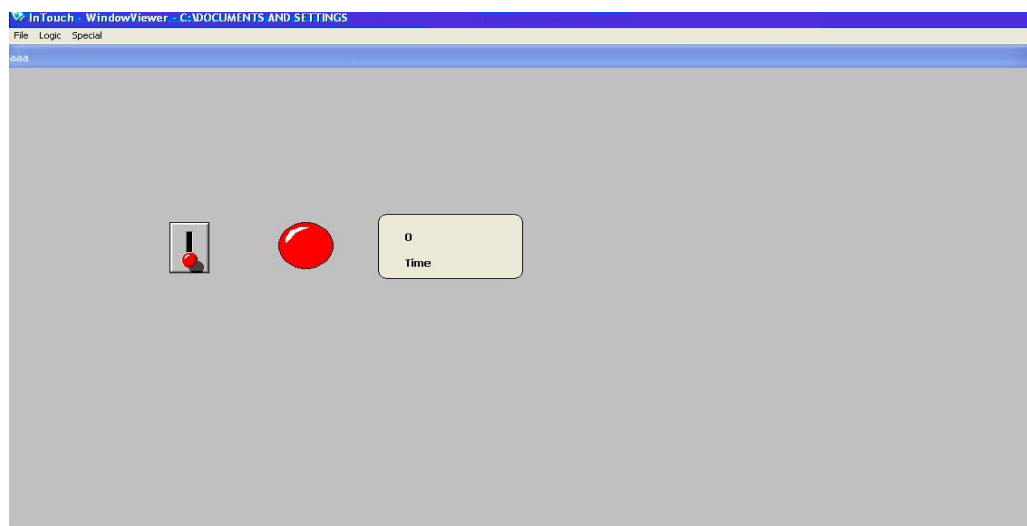
Fig. 9 Main screen of SCADA Software

Fig 9 shows the image of SCADA software where we have configured 1 switch and 1 lamp for testing purpose. When we press a push button switch connected with PLC it will pass the data to PC via PLC and ZIGBEE and it will be displayed on SCADA screen. So like this we can control any hardware connected with PLC using ZIGBEE and SCADA.
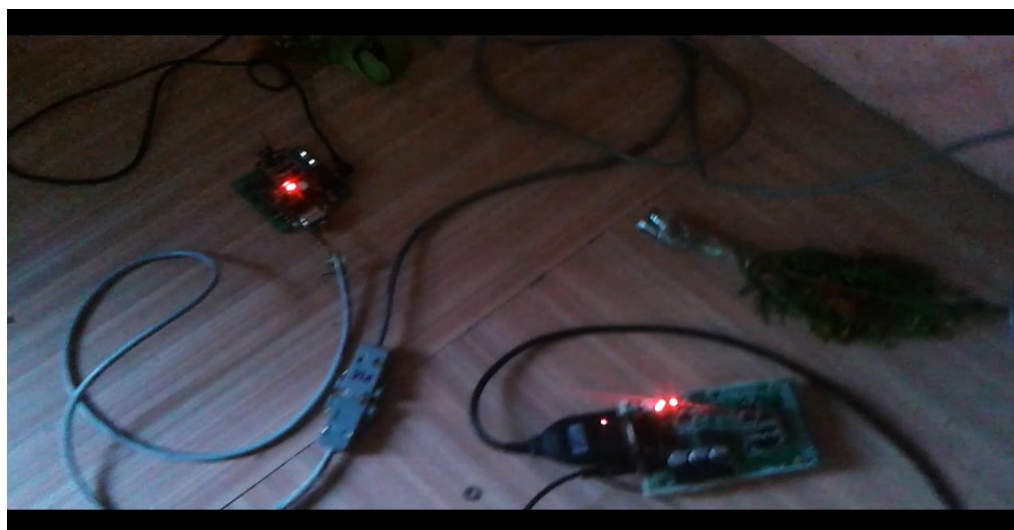

Fig. 10 Communication between pair of ZIGBEE modules

Fig 10 shows the actual image of connection of modules of this project and communication between pair of ZIGBEE indicated with glowing led's. Bottom right module is connected with PC through a black cable with yellow led shown in fig. Top left is connected with allen-bradley PLC through cable. Both module communicates with each other and shares the data.

VI. CONCLUSION

From the above simulation and results we can conclude that PLC can be interfaced with any wireless module and can be used for wireless application in small or big application of automation in any field. Status of the process can also

be displayed on SCADA software so user can easily monitor and contol the process by seeing the animated process in the software.

VII. FUTURE WORK

Now a day's PLC is a very reliable and highly compatible device for all the automation processes. Wireless technology can be easily used with PLC to make automation process wireless based. Like ZIGBEE and GSM we can also use RFID technology with PLC to make system based on wireless application.

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