Real-Time Wireless Re-Beamer Automation on Labview Platform

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Abstract---The paper represents the primary development of wireless control and monitoring system based on PLC (programmable logic controller) with LabVIEW communication. The objective of the project is to maintain the tension of thread by controlling the MPM (meter per minute) of Re-beamer of winding system used in textile industries. I have used ZigBee (IEEE standard 802.15.4) as wireless platform. I have used OPC (object linking and embedding for process control) server to link LabVIEW with PLC and to plant. LabVIEW is applied as an SMI (software machine interface) in project. The operation of project execution is – Develop the ladder program and takes Tachogenerator feedback signal of carrier beamer from system and enables the control of VFD (variable frequency drive).VFD worked as a final control element in close loop system. Winding system is controlled under VFD only. Frequency from VFD varies the speed and maintains MPM of the Re-beamer.

Keywords: LabVIEW,OPC, Wireless Sensor Network, ZigBee devices, PLC, VFD

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. Automation is assignment of human control functions to technical equipment for increasing productivity, better quality, increasing safety in working conditions reducing manpower & cost. 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.

In recent era, various wireless technologies are used for the Data Acquisition. Recently ZigBee Technology has become one of the most promising technologies for data acquisition. ZigBee is an up-and-coming technology that is likely to change the way we monitor and control our working and living environments. The potential for cost savings and improved performance is huge. The 802.15.4 standard provides stability at the core (PHY and MAC), and the ZigBee specification provides standardization of network communications and operations. ZigBee Wireless Technology is the leading global standard for implementing low-cost, low-data-rate, short-range wireless networks with extended battery life. ZigBee technology uses one of three different frequency ranges. In Europe, the frequency range is either 868 MHz or 2.4 GHz, and in the U.S., the range is either 915 MHz or 2.4 GHz. Using the 2.4 GHz band worldwide allows access to the unlicensed ISM frequencies,

which makes implementation easy because there aren't any license requirements. The transfer data rate of ZigBee Technology is 250Kbps [1].
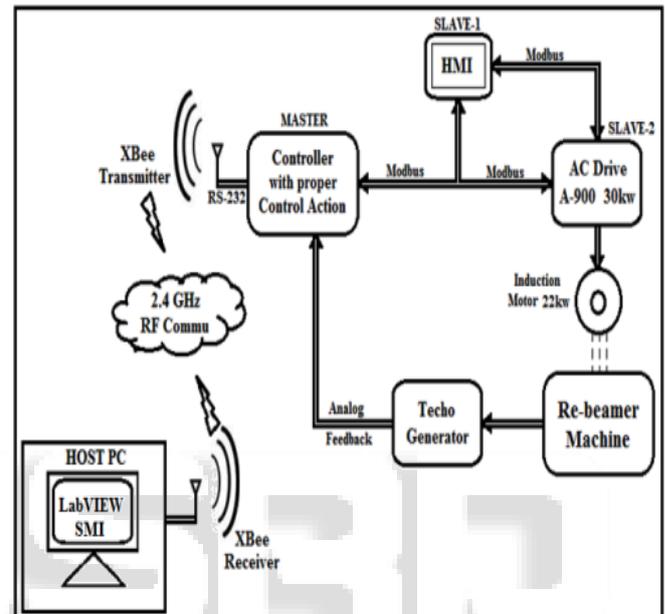
II. SYSTEM BLOCK DIAGRAM

Fig.1: System Block Diagram

Here in this system, Allen Bradley MicroLogix 1100, used as a main controller. PLC itself acts as a Master in that system while HMI and Variable Frequency Drive (VFD) act as Slave-1 and Slave-2 devices accordingly. Both HMI and Drive operate with Modbus communication and connected on Ethernet port of PLC. Drive works as final control element in that system

In that application, I have to maintain the MPM (meter per minute) of the Re-beamer. This system MPM has been change by increase the diameter as the thread wound on it. I have control this MPM by taking Tachogenerator feedback and controlling the frequency of the induction motor through the Drive.

For makes the system wireless pair of Xbee Series 2 RF module is used. At transmit side, Xbee connected on DF-1 channel (serial port) of PLC. At receiver side Xbee directly connected on USB port of host PC. Xbee transmit the real time data to PC where the Xbee receiver is connected. This actual data can be monitor and control on LabVIEW. LabVIEW maintain the day by day record of data by punching it on excel sheet. That daily record will used to improve the production ratio of the system.

III. MAIN IDEA WIRELESS DATA ACQUISITION SYSTEM

The Wireless Data Acquisition System contains four principle elements.

1) Feedback Element (Re-beamer system)
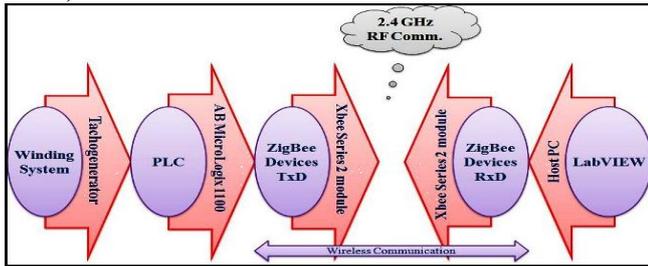2) PLC
3) ZigBee Devices
4) LabVIEW

Fig. 2: Block Diagram of Data Acquisition System

As shown in fig-2 the feedback element gives reference feedback from Re-beamer System that will be processed and converted into proper digital form by the PLC. The Data which is comes from PLC is transmitted through wireless medium to PC using ZigBee Devices. At receiver end that Data is Control and Monitor on LabVIEW.

IV. RE-BEAMER SYSTEM CONFIGURATION

In that project, I have provided customize automation for Re-beamer System by selecting the proper devices according to the proposed system.

Tension measurement and strain control of thread is the most critical parameter in that particular application.

Fig. 3: Re-beamer System

Re-beamer system is shown in above fig-3. From figure you can shows that how thread pass over the carrier beamer and wound over the Re-beamer. This carrier beamer is rotate on simple bearing mechanism and is free to rotate as the thread passed over it.

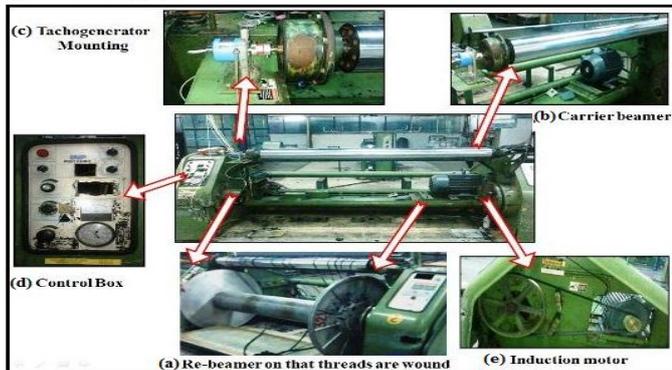Here tension of thread must be maintained between the two beamers.

Fig. 4: Different parts of Re-beamer System

Different part of the Re-beamer System is separate out in that above fig-4. Followings are the main parts of Re-beamer System:

A. Re-beamer: Threads are wound on that Re-beamer with proper tension on constant speed.

B. Carrier beamer: It's rotate on bearing mechanism as the threads are passed over it.

C. Tachogenerator: It is mounted on carrier beamer as shown in figure. It gives output in 0-10 Vdc according to the speed of the carrier beamer.

Selection process for Tachogenerator:

Choosing the Tachogenerator from given standard system specification.

Mechanical parts	Specification
Motor rpm (A1)	1500
Motor pulley circum (B1)	0.37m
Winder pulley circum (C1)	1.60m
Re-beamer circum (D1)	0.95m
Carrier beamer circum (E1)	0.4m
Carrier teeth	30
Techo teeth	16

Table.1: Mechanical System Specification.

Calculation of Tachogenerator RPM from given above system specification:

$$X = B1 \left(\frac{C1}{D1}\right)\left(\frac{E1}{F1}\right)$$

$$= 1500 \left(\frac{0.37}{1.60}\right)\left(\frac{0.95}{0.4}\right)$$

$$= 838 \text{ rpm}$$

D. Control Box: Potentiometer provided in control box for giving manual speed reference to system. Also control buttons are provided for forward and reverse direction selection or for selecting a Jog.

E. Induction motor: 22Kw induction motor used to rotate the Re-beamer as shown in fig-4. This motor is operated by VFD (variable frequency drive). According to output drive frequency motor speed has been control.

V. ZIGBEE DEVICES

I have used this Digi International make Xbee Series2 RF module in my project to develop the wireless sensor network. I have use this module because modules were engineered to operate within the ZigBee protocol and support the unique need of low-cost, low-power wireless sensor network. The modules require minimal power and provide reliable delivery of data between remote devices.

The modules operate within the ISM 2.4 GHz frequency band.
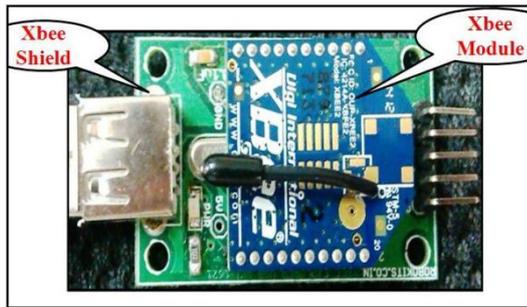

Fig. 5: Xbee Series2 RF Module

The modules operate within the ISM 2.4 GHz frequency band and are compatible with the following:

- XBee RS-232/ RS-485 Adapter
- XBee Analog and Digital I/O Adapter
- XBee Sensor
- XBee USB Adapter
- Connect Port X Gateways
- XBee Wall Router.

Key Features Specification [2]:

1) High Performance, Low-cost
- Indoor/Urban: up to 133' (40m)
- Outdoor line-of-sight: up to 400' miles (120m)
- Transmit power: 2mW (3 dBm)
- Receive sensitivity: -96 dBm

2) High Performance, Low-cost
- Tx peak current: 40 mA (@ 3.3V)
- Rx current: 40 mA (@3.3 V)
- Power down current : < 1 µA

3) Advanced Networking & Security
- Retries and Acknowledgements
- DSSS (Direct Sequence Spread Spectrum)
- Point-to-point, point-to-multipoint and peer-to-peer topologies supported.

4) Usability:
- A/D conversion
- Digital I/O lines
- AT and API command modes for configuring parameters.
- No configure necessary for out-of box RF communication.

VI. OPC SERVER

OPC tends for (Object Linking Embedding for Process Control). I have use INGEAR AB-OPC server for AB-PLC which is used for acquired real time data from PLC. This OPC perform important role to linking a LabView with actual system.

A. Configuring Plc Driver

INGEAR AB OPC provides different driver like Serial DF-1 (Full-Duplex), Ethernet PLC-5 etc. You can select Device Driver according to your requirement. I have use of   Serial DF-1 (Full-Duplex) channel of AB-1100. Set the Comport, Parity, and Baud rate as shown below. After selecting the Driver selects Device properties accordingly.
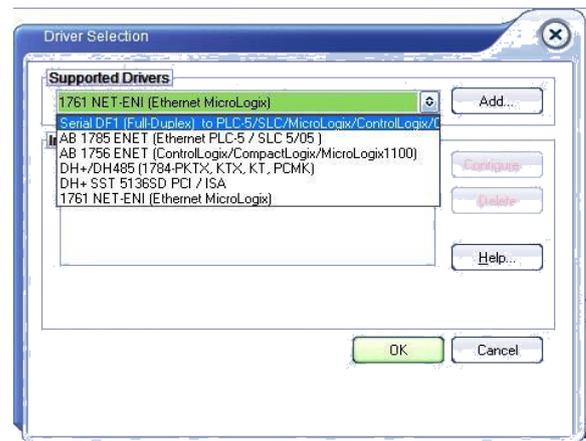

Fig. 6: Configuring PLC Driver

B. Creating New Device

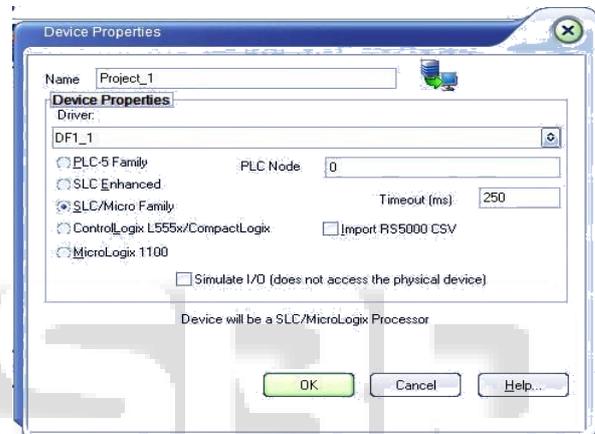Next we create a new device with defined device name and select SLC/Micro family for device and click OK.

Fig. 7: Selections of Device Properties

C. Creating New Group

After creating the new OPC server we create a new group. After assigning a name we leave the other setting to default. Build a group by various categorized.

D. Creating an ITEM/TAG

We give the addressing of the input/output variables as per the syntax of the PLC and the data type of the variable can be selected from the drop down menu. Also add a description with Tag.
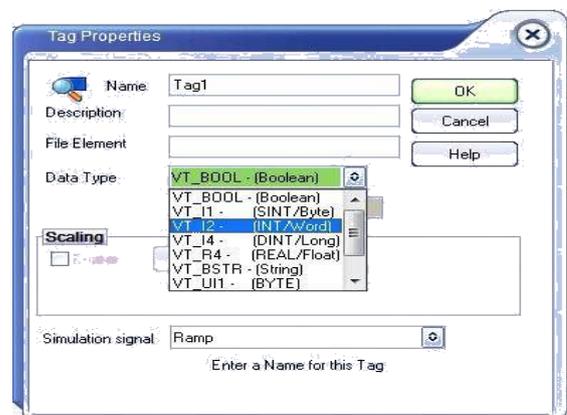

Fig. 8: Create Tag from Tag Properties

VII. IMPLEMENTATION OF LABVIEW

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming language.

The information development is complicated by the mix of hardware and software that exists in plants and the limitation of traditional systems. We can incorporate LabVIEW into existing system to add measurements and analysis to processes to gather complex data and convert it into useful information. Additionally, through the openness of Lab VIEW we can connect and provide the information where it is needed, whether that is in a database, available on a web based dashboard, or provided into the existing plant control hardware. We can even use Lab VIEW to close feedback loops and perform complex control operations using the provided information [3].

A. Data Binding Properties of Labview [4]:

1) *Data Binding Selection:* Specifies the server you want to use to bind the object.

- Data Socket: Binds the object to a data item on the network using the DataSocket Server, or on Windows, an OPC server, an FTP server, or a Web server. If you want to establish or save a URL for an object, create a shared variable rather than using front panel DataSocket data binding.

2) *Access Type:* Specifies the type of access LabVIEW sets for the object you are configuring.

- Read/Write: Specifies that the object reads data from and writes to a network-published project item or a PSP data item on the network.

B. Control and Monitoring Screen on Labview:

Lab VIEW software has two parts front panel and block diagram. Front panel is the GUI wherein the operator sets the input parameters as per the requirements along with various graphical and pictorial representations of the process. And the Block diagram executes the sequential logic and predefined algorithm in the form of G-programming (G-graphical). SMI (software machine interface) development of Lab View in project is given below

Screen_1 for STATUS: Operator can observe current of the system status from that screen.

Fig.9: Screen_1 for Status

Screen_2 FACTORY_1: System parameters and Drive parameters are control and monitoring on that screen.
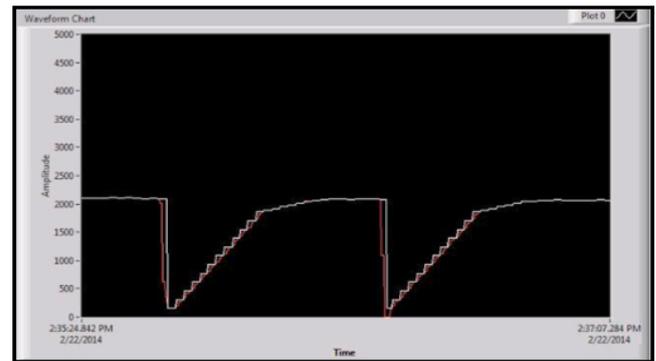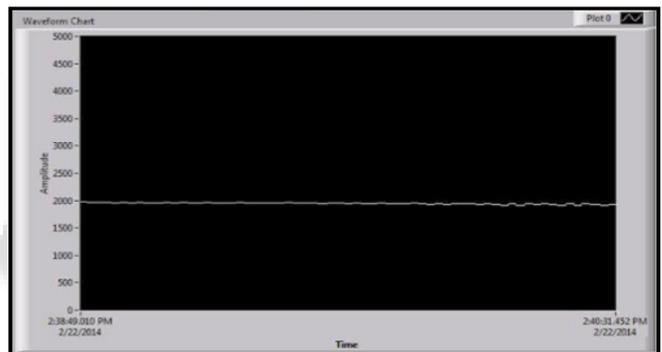

Fig.10: Factory_1

Fig.11: TREND Display

Fig.12: TREND Display

For better results I observe the input and output frequency of drive which is delivering to re-beamer.

Fig-11 shows how gradually output frequency follows the input frequency gradually. In this trend you can shows the White graph as the set input frequency and Red graph as output frequency. Slop in the system represent the rise time of the system. We can also observe that how both frequencies fall to zero when operator momentary release the RUN commands of system.

Fig-12, after giving a RUN command you can show how nicely an output frequency follows to input frequency and become a steady at maximum speed.

VIII. HARDWWARE IMPLEMENTATION

A. Allen-Bradley MicroLogix 1100:

This programmable controller is highly reliable, easy to develop Ladder program and also provides high performance. It falls in the SLC 500 category of MicroLogix series. RSLinx Classic software is required to configure the SLC category.

Fig. 13**:** AB MicroLogix 1100 PLC

B. Interfacing Of Xbee with PLC:

Xbee module has been connected on DF 1 channel of PLC through logic level conversion circuit. For proper communication between Xbee and PLC MAX 3232 logic converter IC has been used to convert TTL level to CMOS level and vice versa.
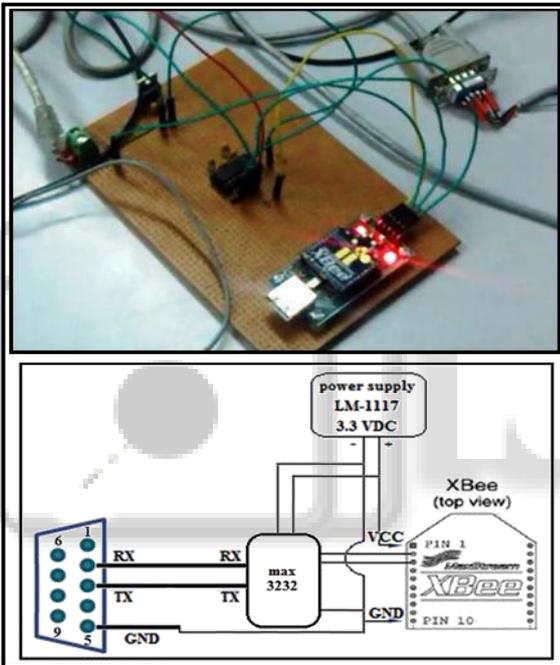

Fig. 14**:** Logic Converter Circuit with Diagram

C. Interfacing Of Xbee with PC:

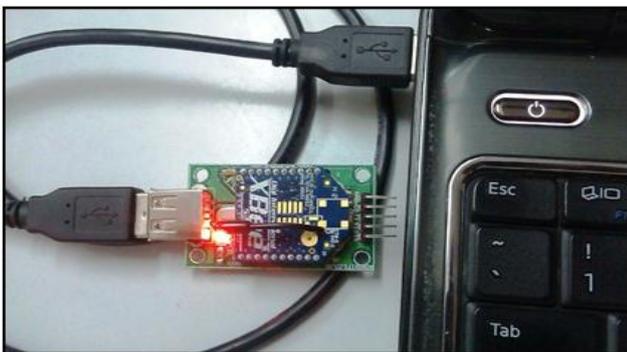At receiver side Xbee directly connected on USB port of PC as shown below fig-14.

Fig. 15**:** Interfacing of Xbee with PC

IX. CONCLUSION

This paper proposes design and implementation of a Wireless data acquisition system on ZigBee networks. This system uses Wireless sensor network which provides better flexibility to install in many areas where wired connections are not possible.

From FIG-12 you can show that at full speed how exactly system follows the input frequency. As the diameter of Re-beamer increase, Drive gradually reduces the output frequency to maintain the speed of Re-beamer. Thus variable frequency drive can controls the MPM of the Re-beamer and by doing this it will maintain the tension of thread.

This type of system can be applied in many applications in textile industries. As a future work, we consider expansion of the system using various sensors and actuators

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