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Real time control “es-dawet” mixer using dashboard based on PLC and WSN

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Abstract. The aim of this study is to monitor and acquire the remote parameters like Speed control a DC Motor, IR Sensor, Temperature of pasteurize mix of ice cream, and send these real values over wireless network. A proposed system is dashboard monitoring system for PLC based system wirelessly using ZigBee protocol. To implement this a ZigBee model is connected to a programmed digital signal controller which would transmit the data to Zigbee coordinator which is connected to a PC through RS232 serial communication. Person can need only to send the reply about the process that is to be carried out and PLC will check the status of the web base sent by person and take the action according to it where wired communication is either more expensive or impossible due to physical conditions. A low cost system for measured the parameters of motor such as IR Sensor, Speed control a DC Motor by PWM and temperature with Zigbee protocol connectivity. A database is built to execute monitoring and to save the motor parameters received by radio frequency (RF) data acquisition system. Experimental results show that the proposed system is less costly, provides higher accuracy as well as safe and gives visual environment.

1. Introduction

An automation system, the communication needs are traditionally served by wired technologies. These communication systems have been specifically designed to meet the stringent real time and reliability requirements found in many industrial applications. A low cost communication is wireless technologies should provide the same type and quality of services to industrial users as the traditional, wired technologies do. A lot of devices and machine can be controlled and data can be received and sent a data by wireless technology. A PLC based fault protection system has been introduced in which massages the type of faults on the display, but data can't be display and stored as well as the system becomes costly. In some cases, motor parameters have been used to display the electrical and mechanical performance of the motor through wires on a PC. The aim of this paper is to design dashboard web for monitoring, measuring a acquire the parameters of motor such as IR Sensor, Speed control a DC Motor by PWM and temperature with ZigBee protocol connectivity. A ZigBee model is connected to a programmed digital signal controller which would transmit the data to ZigBee coordinator which is connected to a PC through RS232 serial communication. Sensors are controlled and monitored through dashboard web correspondent its set value points. For RF module is to communicate their remote location areas. Depends on that corrected values from set points it can be functioned. Each process of sensors values can be transferred for dedicated system.



2. Related Works

2.1 ZIGBEE IEEE 802.15.4

Zigbee devices are capable of peer-to-peer, point-to-multipoint and mesh communications. They offer convenient low power wireless solutions for embedded systems where power consumption is a critical factor. A Zigbee network consist of three different types of ZigBee devices a coordinator, router, end-device. Each network has a 16 bit PAN ID. All devices in a Zigbee network is assigned a single PAN ID Protocol, Zigbee is a low power spin off of WiFi [6], [7], [10].

2.2 DC Motor Control and Sign/ Magnitude PWM Control

This motor is used for this project for control speed and position [4]. Controlling a DC motor with a sign magnitude PWM control signal requires one PWM control input, one directional control input, and the voltage source. Sign magnitude PWM requires more pins than locked anti-phase PWM control but offers twice the precision control of the speed [1],[3].

2.3 Features Of Mitsubishi Melsec PLC Controller

The name itself suggests the type of PLC and I/O it provides like LQ-F is a series name, 10 stands for (6+4) 6 inputs and 4 outputs, FX series. The delta PLC is cheaper than other brands of the PLC and easy to configure with any application of industry as well [8],[11]. The programmable controller PLC used in this study is Mitsubishi Melsec PLC LQ-F Series FX5.

2.4 Temperature Sensor LM35

The LM 35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius temperature [13]. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature. LM35 is rated to operate over a -55° to $+150^\circ\text{C}$ temperature range. In can be used with single power supplies or with plus and minus supplies. As it draws only $60\ \mu\text{A}$ from its supply, it has very low self-heating, less than 0.1°C in still air.

2.5 Es-Dawet

Es-Dawet or ice cream from Sumatra in Indonesia is made of the combination of coconut, milk, maezena flour, sugar, milk, and avocado. Es-Dawet making process takes 50 rpm for 3-4 hours [12]. This time is much shorter than the time used when screening is done manually by hand.

3. Design and implementation

3.1 Proposed Model

Architecture contains the pair of ZIGBEE USB modules, Mitsubishi Melsec PLC, 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, Raspberry Pi 3, Temperature of pasteurize mix ice cream and ZIGBEE USB is connected with PLC via communication port RS485 (RS485 to RS232) converter is PC, that is shown in Figure 1.

Figure 2 shown Es-Dawet making processed which takes 50 rpm for 3-4 hours [12]. This time is much shorter than the time used when screening is done manually (by hand). The plan is to design mechanical a pasteurize mix that is show in Figure 3 and the architecture plan, that is shown in Figure 4 needs a device a LM35 Sensor, IR Sensor, Zigbee, RS232 converter, Raspberry pi3, regulator supply 24 V, 5 V and Mitsubishi Melsec PLC Controller.

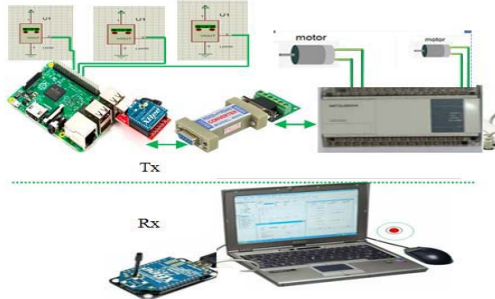


Figure 1. System Design



Figure 2. Traditional pasteurize mix by hand

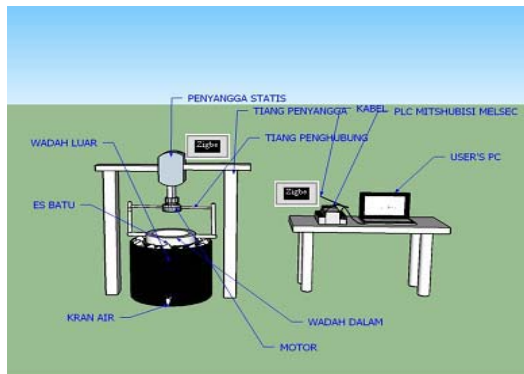


Figure 3. Mechanical design a pasteurize mix "Es-Dawet"

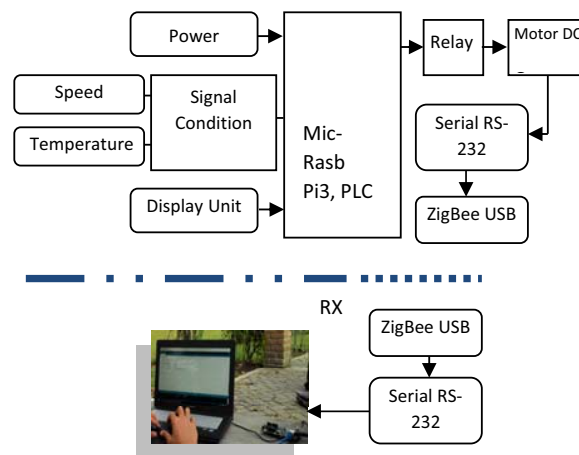


Figure 4. Block System

3.2 Regulated power supply

A regulated + 5, + 24 VDC power supply is designed to power up the raspberry microcontroller. A 220 V to 6-0-6 volt, and 25-0-25 volt, 500mA center tapped transformer is used to step down the AC Voltage. Bridge rectifier made of UF4007 is used for AC to pulsating DC conversion; capacitors are used to filter ripples. The voltage regulator IC 7805 is used to produce regulated +5V and IC 7905 is used to produce regulated -5V dc supply and voltage regulator IC 7825 is used to produce regulated +25V.

3.3 Mechanical a pasteurize mix and DC Motor Control

A DC Motor are specifications for this motor: continuous stall torque 0.402 Nm, peak stall torque 2.825 Nm, no load max. speed 6000 RPM, terminal voltage 24-60 Vdc, motor inertia 0.00006286 Kg-m², motor weight: 1.588Kg 2.4.3. A mechanical a pasteurize mix "Es Dawet" need median rpm is 50 rpm. The DC motor is ideal motors for applications using 6000 RPM. so, pasteurize mix "Es Dawet" needed 50 RPM. To doing a round tubes in a centrifuge to 50 RPM by selecting rotation ratio gear reducer (gear box) is 1:90. If speed DC 6000 RPM motor, so that output rotation reducer becomes $6000/86 = 69.788 = 70$ RPM. Reducer pulley diameter 5 "and pulley shaft tube 7 ", so that the speed of rotation tube = $5/7 \times 70 = 50$ RPM.

3.4 Real Time Control “Es-Dawet”Mixer using PLC Control and Feedback Sensors

The objective is to control the speed of two motors i.e. DC Motor, a motor 2 control a body of pasteurize Mix and motor 2 is pasteurize mixer in the Es-Dawet. The speed of the motor is sensed by wireless temperature sensor on the wireless sensor output the corresponding PWM are triggered to rotate the motor. PLC accepts 24 Volts signal, regulated power supply is input for device others and the sensor output is in the form of 5 Volts. A DC motor performance will be controlled by ladder set in PLC, procedure coder and set ladder that is shown in Table 1 and Figure 5.

Table 1. PLC Ladder Diagram

Input	Output
X ₀ = System Start	Y0 = Temperature ON
X ₁ = System Stop	Y1 = Shutter motor forward direction
X ₂ = Sensor 1	Y2 = Torque motor forward direction
X ₃ = Temperature Sensor	Y3 = Shutter motor reverse direction
X ₄ = Sensor 2	Y4 = Torque motor reverse direction
X ₅ = Sensor 3	Y5 = LED

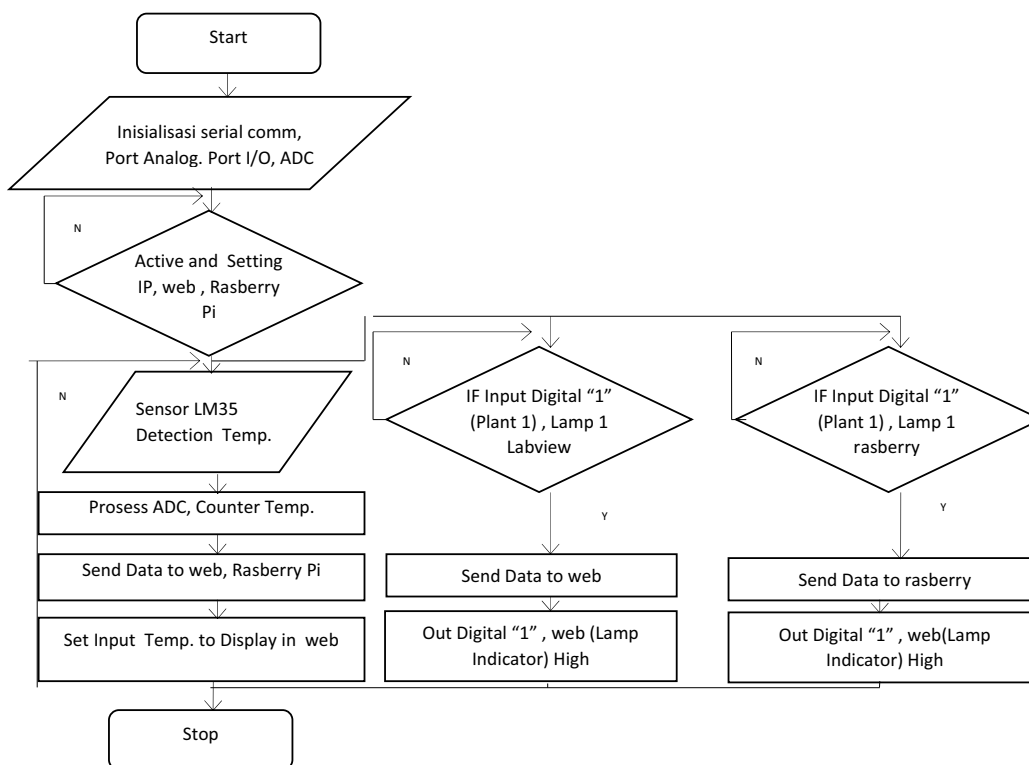


Figure 5. System flowchart

The dashboard web design for remote wireless temperature monitoring system places multiple nodes in different regions. Each node collected measured the temperature of the object information. Then it transfers data to the coordinator node via wireless multi-hop routing. Dashboard web interface for communication with Zigbee protocol, the first step a system proses is will initialize the flash drive and display all files on the flash drive to the COM port on the computer. It will then setup a TCP socket where the controller is the server, and print

out the IP address of the dashboard web. This only works if you are connected to Ethernet, otherwise an error message will display. Once this socket is set up, it will wait for the web client to establish a connection to it. On the web server it will display “Wait for connection...” until a proper connection is established. Once this happens, the web client will display both the IP of the board and the IP of the computer running the dashboard web application. For this system used a default port of 40 but any port could be used. When this is done, it will wait for the run time and time interval from the dashboard web application and, once received, proceed to initialize all of the system, the real time task (setting the period to the time interval received), and start the timer.

4. Result and Discussion

Dashboard web interface for communication with Zigbee protocol, the first step a system proses is initializing the flash drive and display all files on the flash drive to the COM port on the computer. It will then setup a TCP socket where the controller is the server, and print out the IP address of the dashboard web. This only works if you are connected to Ethernet, otherwise an error message will display.

4.1 Set Zigbee parameters to PC for receiving data

After the start of the receiving node (the coordinator node) network, receiving temperature data from a remote node, and serial data transfer to the PC. The PC software displays real time information. Setting set a communication zigbee to PC that is shown in Figure 6 and serial communication between zigbee and reception of data on X-CTU that is shown in Fig. 7.

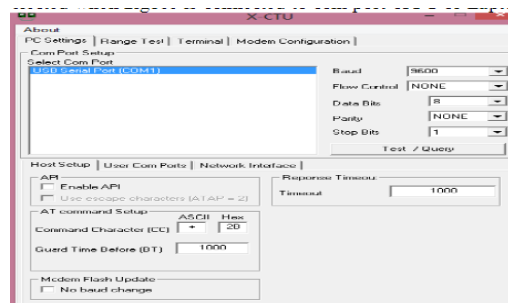


Figure 6. Zigbee COM port setting

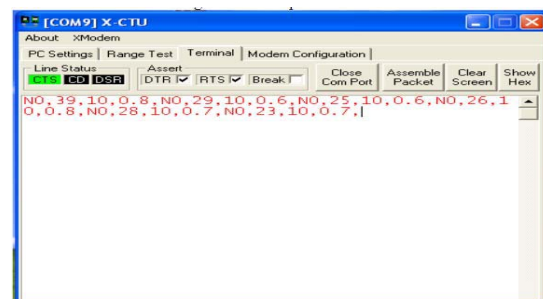


Figure 7. Communication zigbee and reception of data on X-CTU

4.2 Temperature Sensor

The Temperature Read Thread is the real-time task which periodically reads from the temperature sensor. The data is set up in a Temperature structure which is defined as follows: Every time the real-time task executes, it will allocate memory for a piece of mail of type Temperature, which is very similar to a FIFO (essentially an allocatable queue), Once this is done, it will pass the mail and shared buffer into the function calcTemp() to calculate the data received from the temperature sensor and store it on the mail and buffer. It will also signal the semaphore for the LED and speaker thread. It then puts this mail onto the Mailbox. Also, you must remember to free this memory after you put it onto the mailbox, otherwise you will likely run out of memory. The USB Write Thread will have already called mail_boxes.get() which will block until the Temperature Read Thread has put this data onto the Mailbox. Once this has happened, it will write the data to the text file “Temperature_Loger.txt” on the flash drive, and also print the data through the COM serial port.


```

Typedef struct {
float    temperatureC;
float    temperatureF;
float    timeStamp;
float    avgC;//average change in celcius per second
float    avgF;//average change in Farenheit per second
}temperature;

```

PC interface displays dashboard web real-time temperature information after the coordinator node transfers data to a PC through the RS232. The specific requirements of the system, using C # host computer interface dashboard development the design of the PC software data flow: 1) serial data is received; 2) to determine whether there is complete data head (the software is simple "PAN ID :"); 3) extracted four node PAN ID value (PAN ID value is mainly used to distinguish between different devices); 4) Extraction temperature data; 5) the extracted data is graphed.



Figure 8. Dashboard Web control application a DC motor

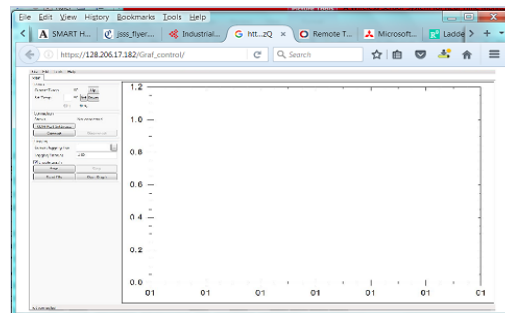


Figure 9. Prompt for IP Address of of Server display a sensor graph

The design of dashboard real time wireless temperature information about pasteurize mix, places multiple nodes in different regions. Each node collected measured the temperature of the object information. Then it transfer data to the coordinator node via wireless multi-hop routing. A testing, the serial transmission baud rate is set to 9600 -38400, after the system is running, real-time temperature information is displayed by the host computer that is shown in Figure 8 and Figure 9. Through the COM port, the following message appeared: Temperature_Log.txt is where all the information will be stored to 128.206.17.181/graph. It then proceeds to display the IP Address in which this case is 128.206.17.181/graph. It then proceeds to wait for a connection from the web application. When a connection is received it will, take the runtime and interval from the application and start the real time task that is shown in fig.8, wait to display graph of a sensors, one item was sent through the socket, and the USB file was opened successfully that is shown in Figure 10.

A set PWM control motor can do it without entering a run time and interval, and then press the start button. After this, both system will start running and displaying the data. The minimum interval used was 2 second. The data being sent through the socket, each time a system send the current time in seconds and temperature to the web application. Since it is rapidly being sent, you will notice that multiple of the same pieces of data are being sent. A code is mess with wait statements to decrease the amount of same results being sent, but found it to occasionally make the application lag slightly so decided to leave them out and

allow it to continue to send multiples, see the data was successfully written to the text file twice in Figure 11.

```

In Host_init
Initializing Host Stack
Host Initialized
Connect a Mass Storage device
Mass Storage device connected
Successfully initialized mass storage interface: 31299583 blocks of size 512
Inquiry type:
Peripheral device type: 00h
Removable Media Bit: 1
Warning! Direct access (floppy)
Warning! must be 0
Warning! must be 0
Warning! must be 0
Warning! should be 1
Additional length: 10h
Vendor Information: General
Product Identification: USB Flash Disk
Product Revision: 1.00
List of files on the flash drive:
- System Volume Information
- Temperature_log.txt
- test_1.txt
- Final Presentation.pptx
- Final Presentation.pptx
IP Address is 128.206.17.181
Wait for new connection...
Connection from 19.79.143
Running 5 interval 1
Sent through socket: .054.1
File opened successfully

```

Figure 10. A connection of received data

```

Temperature_Log.txt - Notepad
File Edit Format View Help
Timestamp(s): 1.0 Temperature(C) = 0.0 Average Change = 0.0 56.7 Temperature(F) = 0.0 Average Change = 0.0
Timestamp(s): 2.0 Temperature(C) = 0.0 Average Change = 0.2 57.2 Temperature(F) = 0.2 Average Change = 0.2
Timestamp(s): 3.0 Temperature(C) = 0.0 Average Change = 0.1 56.9 Temperature(F) = 0.0 Average Change = 0.1
Timestamp(s): 4.0 Temperature(C) = 0.0 Average Change = 0.1 57.2 Temperature(F) = 0.1 Average Change = 0.1
Timestamp(s): 5.0 Temperature(C) = 0.0 Average Change = 0.1 56.9 Temperature(F) = 0.0 Average Change = 0.1

```

Figure 11. Data Written to Text File

5. Conclusion

This system has been done to monitor and control the DC motor parameters which is widely used in industries. Use of Zigbee communication protocol helps in reducing the wires and hardware significantly. That the dashboard real time task and multithreading involved in the software implementation performed as desired. As the correct data was displayed on all dashboard web application, and USB Text File.

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