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# GUI based Wireless Communication for Plant Automation

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## ABSTRACT
The field instruments of the process plant are communicated with the remote control room where the supervisor is alarmed to monitor the process parameters regulating at some desired value. The onsite monitoring is limited to only specific supervisors. This paper aims to interface the plant parameters to web server for constant monitoring the state of the process plant at various locations by multiple supervisors. This paper considered the temperature parameter (PV) to regulate at some desired value. The measured signal is logged by the arduino board and then the signal is transferred to the AT mega 328 microcontroller. PID algorithm is applied to regulate the parameters. AT mega 328 is used as a controller and to output the data serially to IEEE 802.4.15 wireless communication device. The data received at the personal computer for analysis and monitoring the state of the plant parameters using Graphic user interface (GUI) approach. GUI is implemented with the support of python, internet of things application. The developed model produced more reliable results to consider for implementation in process plants.

## Keywords
Process temperature, Arduino board, AT mega 328 microcontroller, Graphic user interface.

## 1. INTRODUCTION
Automation of the process parameters with programmable logic controllers (PLCs) with applied Supervision and data acquisition system (SCADA) or with Distributed control system (DCS) are having significant role in automation. With rapid advancement of technology the art of supervision of the process plant parameters on the off site is having a significant scope of research in plant automation.By adjusting the gate valve the flow rate of the fluid is maintained to be constant in order to avoid frictional forces of the fluid. An Arduino board is used to read the process temperature value and the flow rate of the fluid. Inbuilt 10 bit resolution ADC converts the input analog signal into digital signal. Atmega 328 microcontroller is programmed to process the received input signal to generate the error signal for enabling the actuating elements. Proportional ( p ) + integral ( I ) + Derivative (D) controller is applied to dominate on the offset and to improve the response of the system by adjusting the gain of the controller. The controller is tuned using Nichols Gigglers method. The error signal of the controller causes to drive the final controller i.e. Triac . The output signal of the microcontroller is converted into serial form using Max 232. Then the data is transmitted using IEEE 802.4.15 wireless communication protocol. The receiver is interfaced to the web server. Python software is used to plot the response of the process parameter w.r.t to the received input data. An open source of internet of things application is used to store and receive data from things with the support of HTTP protocol over the internet.

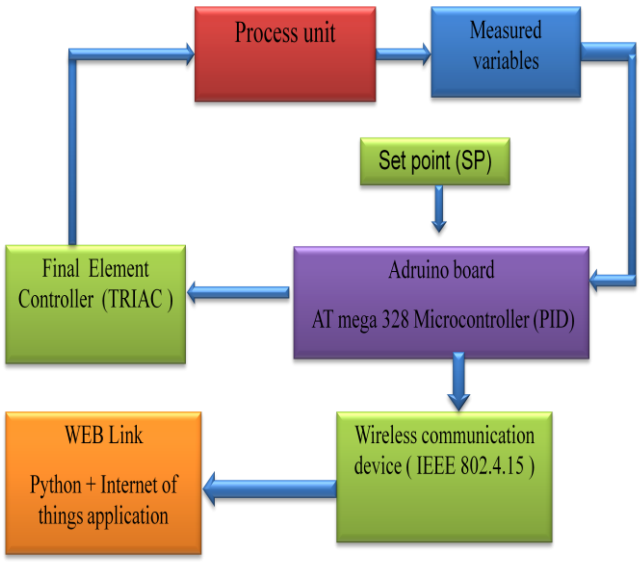


**Fig1.1 Blog diagram of the proposed model**

## 2. LITERATURE SURVEY
This paper proposed new software called GUI based real time industrial automation Software. This has the ability to extract the run time data from the server for monitoring the industry [1].

This paper proposed internet linked plant automation. The plant is to be supervised remotely to prevent the downtime and maximizing the operational life of the plant [2].

This paper discusses a simulation software package for the grain silo of Jordan. The author discussed the anticipated benefits and various phases of implementation. This paper considered the PLC and operator interface for monitoring the plant parameters [3].

This paper proposed a console master computer (CMC) to monitor various physical nodes. The proposed method is able to analyze the content area network and data traffic management [4].

This paper proposed a novel particle swam optimization mechanism to optimize the plant variables. The author applied the proposed algorithm for natural gas liquefaction plant for testing the efficiency and reliability [5] .

This paper describes the significance of ZIG BEE technology for automation. The author focused on various communication methodologies and compared with Zig bee technology for automation of the devices [6].

This paper describes remote controlling of the crane using mobile phone. This describes the communication methodology between the Supervisory control and data acquisition system (SCADA) server, general packet radio service (GPRS) and wireless application protocol (WAP) [7] .

## 3. HARDWARE IMPLEMENTATION

This paper considered two process parameters. The fluid temperature is measured using immiscible thermostat type temperature sensor. The sensor is mounted in the pipe line. The flow rate of the fluid in the pipeline is fixed to a constant value. So that the frictional forces on the influence of the fluid is restricted. The fluid temperature is to be regulated using the controlling unit. The control unit is designed using arduino board to sense the field instrument signals and to drive the output variables. An AT mega 328 microcontroller is inbuilt within the board to control the process parameter and to transmit the data serially. PID controller concept is imposed in the microcontroller.

**Fig 3.1 Experimental setup, control and transmitter section**

The microcontroller behaves as a soft PID controller. The measured signal is compared with the desired signal cause to generate the error signal. This error signal is used to fire the triac to deliver the load to the heating element. The measured signal and the error signal from the controller are transmitted serially to the control room. IEEE 802.15.4 wireless communication device is used to transmit and to receive the signal serially.

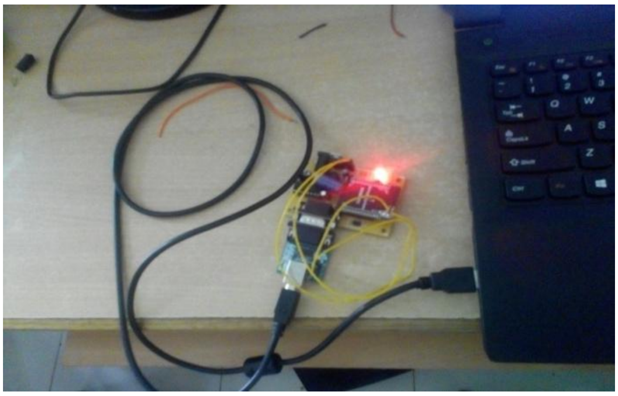

**Fig 3.2 Receiver section at the personal computer**

## 4. SOFTWARE IMPLEMENTATION

A Programming language Python is used to implement Graphic user interface (GUI). The Signals transmitted from the arduino received serially to personal computer using IEEE 802.4.15 receiver. The received signals are interfaced to the Personal computer for graphical analysis using Python programming language.

Internet of things application is used to retrieve the data using HTTP protocol through local area network. Thing speak is providing the facility of data logging from field instrumentation. The logged data is plotted using the python software.

This process unit is linked to the internet server with a separate I.P Address (192.168.1.49). The authorized person can access the process station at any location to observe the process parameters regulation mechanism.

## 4.1 IMPLEMENTED ALGORITHM

### Algorithm 1

**Step1:**Initialize the PID error equation

PID = Proportional gain(KP) * actual error + integral gain(KI) * Sum of previous errors + derivative gain (KD) * Actual error – last error

**Step 2:** Error = Set point ( SP ) – Process value (PV)

**Step 3:** Initialize the floating values for PID, SP,PV.
Initialize Error old = SP – PV

**Step 4:** Initialize
‘P’ error = err
‘I’ error = Err old
‘D’ error = err-Err _old

**Step 5:** Initialize the Gain constants for
P+ I+D
Equate KP with 0.1
Equate KI with 0.3
Equate KD with 0.02

**Step 6:** Initialize the dead zone
If
Err < 2
And Err ≥ -2
Then
Error = ‘0’
Else
Error is a constant variable

Step 7: Go to algorithm 2

### Algorithm 2

**Step 1:** Initialize the ports

**Sensors initialization**
Port C_0 is equated with temp sensor
Port C_1 is equated with flow sensor

**Output device initialization**
Port C_2 is equated with triac
Port D _0 is equated with Wireless transmitter

**Step 2:** Initialize the sample time with 1 sec

**Step 3:** Call the algorithm 1
If the error value is > 2 and ≤ -2
Then Enable the triac
Else read the data from port C_0

**Step 4:** Transmit the data serially through Port D_0

**Step 5:** Display the state of Set point (SP) regulation
If
The Measured value is regulating above the set point
Then
Enable the RED LEDs
Apply the corrective mechanism Go to step 6
If
The measured value is regulating below the set point
Then
Enable the BLUE LEDs
Apply the corrective mechanism Go to step 6
Else
Go to step 7 of algorithm 3

**Step 6:** Adjust the Tuning values of Proportional (P) + Integral (I) + Derivative (D) gains
Call the Algorithm 3

## Algorithm 3

**Step 1:** Adjust the Set point value
**Step2:** Assign 'ZERO' to Derivative and Integral Levels.
**Step3:** Define the safe value for Max_ power
**Step 4:** Adjust the Proportional gain to Minimum
**Step 5:** Initialize the' PID' Tuning adjust value 'Tn' =0.1
If
The gain 'KP' is minimum
Then
KP+ Tn
If
The Set point value is increasing / decreasing
Then
Measure the oscillations period
If
The Oscillations are ≥ 5 % of SP
Then
Tn = Tn + 0.1
Else
Consider the value is ultimate gain
Measure the Ultimate Period of oscillations (Tu)

**Step 6:** Readjust the P+I+D values in step 5 of algorithm 1
KP = 0.60 * ultimate gain
KI = 2 / Ultimate period of oscillations 'Tu'
KD= Tu / 8

**Step 7:** Go to step 6 of algorithm 1

## 5. RESULTS & ANALYSIS

The experiments are conducted for various set points to regulate the process parameter with the proposed methodology. The results obtained are favorable to meet the challenges of the industry. The process parameter is regulated at the desired value. The results obtained at the field instrumentation are favorably good and the communication with the web server is enabling us to provide multiple control stations for constant monitoring even on offsite. This work is more flexible to improve the plant management levels. Fig 5.1 represents the data extracted from the field instrumentation. The temperature reading, flow value and the output signal of the controller (Error value). The 'ON' and 'OFF' state of the heater is depending on the error signal. The error signal causes to enable the heater to raise the temperature of the fluid. A 'Zero' error signal will cause to turn off the heater. Fig 5.2 represents the process unit linked to the institute web site. This enables the authorities to monitor the plant status at any location. Fig 5.3 and Fig 5.4 depicts the graphical view of the plant parameters w.r.t to time. Placing the cursor on the graph will indicate the parameter values at any time axis. The status of the heating device is also specified to identify the process parameter above and below the set point values.

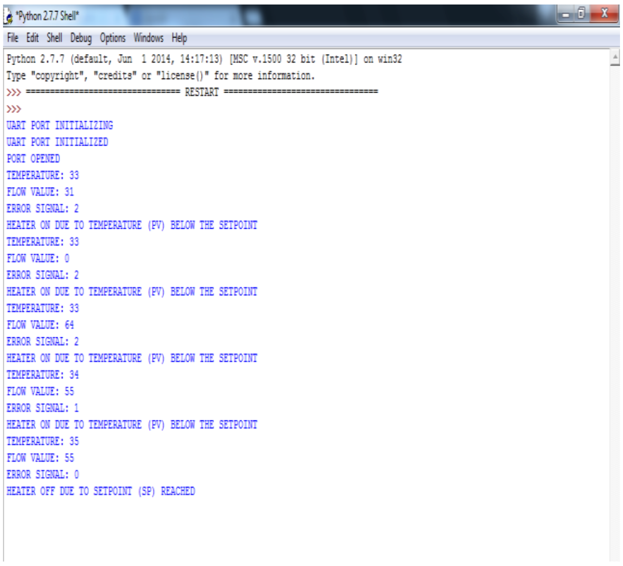


**FIG 5.1 Data received at the control room**


**FIG 5.2 Title page linked to institute website**

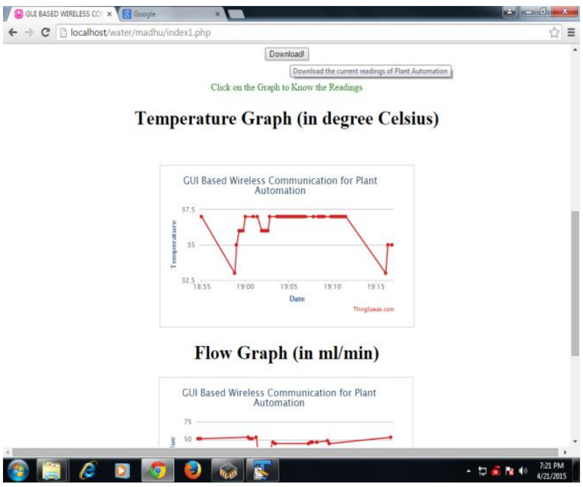


**Fig 5.3. Graphical view of the process parametres**

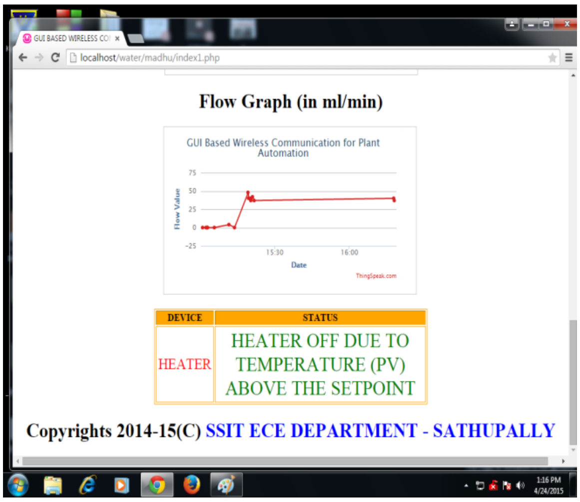


**FIG 5.4 Status of the heating unit**

## 6. CONCLUSION

Web Linked plant automation is the new era in process automation. The plant officer can supervise the state of the process parameters at any location.

The experiment conducted by considering two parameters. Python software enabled to for graphical analysis of the process parameters. The results obtained with this methodology are favorable to the expectations.

**In future** this work is proposed to be extended with more process parameters and back propagation neural networks in association with applied Fuzzy logic may improve the precision control of the plant parameters.

## 7. ACKNOWLEDGMENTS

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