Implementation of Industrial Internet of Things based Industrial Tank Level Control Process

S.Arun Jayakar, M. Kalimuthu, S. Sakthiya Ram, G. M. Tamilselvan

Abstract: ***The Industrial internet of Things (IIoT) is wide used to interconnect the industrial process with the cloud and it will be shared by many of users, this process variable which is measured from the plant will be controlled through the clout using industrial internet of things. This process will increases the reliability, sensitivity, linearity, high precision, effectiveness, sensible watching and management options in process industries. The proposed work gives the solution for the users to controlling the parameter by applying the IoT for the industrial level process system which is nothing but cylindrical tank system, watching and alter set point and controller parameters from remote places using cloud services. In this paper, a simple arrangement of level process system prototype is considered for the experimental purpose and the PID control algorithm is selected as a controller part.***

Keywords: Level – Linear Tank- Cloud Computing

I. INTRODUCTION

Industrial Internet of Things (IIoT) based fluid level checking framework is a programmed a framework that will give the suggestion message or flag to the client about Liquid head in the cylindrical tank and maintain the liquid head free from overflow as well as drain completely [1]. On this occasion that already discussed at local or modern level, at this point it can be seen generally with the spare of the fluid, for example, water or any compound material in a tank that is of various shapes like round and hollow or some other kind of a tank. In order to round out the tank considered a motor pump will be connected with this. In some places it may be controlled physically and in some other place it may be controlled consequently. Wherever it is controlled physically, there an administrator has to be appointed to work on this motor pump. It is much so general arrangement and alongside this, at some point because of administrator carelessness so much expensive fluid material or water is squandered. So to avoid this IIOT based fluid level observing framework is considered as an extremely valuable for locally situated applications.

As one can be undoubtedly view, any essential commitment given to the progress of the IIoT should be the consequence of synergetic exercises directed in the various fields of learning methodology, for example, informatics, broadcast communications, hardware, software engineering and sociology. At present, the procedure business is beginning to investigate and actualize IIoT ideas and advances to increase the use of technology. The IIoT vision in the process ventures is of greatly instrumented in the universe of smart sensors (simple and computerized) and actuators (simple and advanced) imparting utilizing Internet Protocol (IP) in order to enhance execution and proficiency. As of late, the IoT and Cloud Computing (CC) are the two coordinated advanced techniques being produced rapidly and they now offer various new open doors for the number of assignments, for example, information obtaining, capacity in cloud and disconnected information handling in cloud. In this paper, a system for the shut circle control of direct tank utilizing PID controller is proposed keeping in mind the end goal to screen level parameters from any piece of the world whenever by utilizing IoT and distributed computing [2]. In this world we are confronting number of crisis issues so that to reaction to such kind of crises we have to outline a remote system which reacts to such crisis and conceivable to control it. Level observing is conceivable utilizing remote system additionally controlling of level is likewise conceivable. On the off chance that we can outline such kind of system then certainly in future we can keep away from process station from harm. Late advances in inserted frameworks and portable innovations are making ready for the following unrest in registering the future towards which all the current mechanical improvements are driving, the innovation inclines over the globe are indicating toward this path make wise gadgets, all inescapable and viably undetectable to the client. In this paper, Blynk application is utilized to design the Arduino IDE and Arduino IDE implanted C coding is utilized to tune the PID parameters. The information is from the Differential Pressure Transmitter (DPT) and yield is given to the control valve which is the last control component.

II. EXISTING METHOD

The main objective of this work is to designing LabVIEW based controllers for the cylindrical tank framework. This LabVIEW based PID controller is constructed by using the tool boxes in the LabVIEW programming which developed by National Instruments. The data from the process plant is interfaced by means of interfacing Data Acquisition board NIUSB6009 (DAQ) [3].

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This DAQ card is a a product of the as National Instruments. An automatic control is accomplished by sensing the water level and later dominant the position of an entry valve that discharges water in to the tank. The stream of project execution is: The cylindrical tank is consisting of capacitance based transmitter, which gives the out of 4-20 mA in proportional to the 0-60cm of the full scale range of the cylindrical tank. The transmitter is working by applying 24v power supply. Based on the level of the tank the capacitance will vary the variation will be converted in to 4-20 mA by means of signal conditioning element constructed in the transmitter arrangement. The DAQ card exchanges it to the I/P device which can exchange the electrical pulses 4-20mA into air signal of 3-15psi to activate the control valve [4].

III. PROPOSED METHOD

The essential purpose of our enterprise is to manage and screen the set purpose of level process in a linear tank framework. On these lines, we have a tendency to existent this set up utilizing Arduino UNO, Ethernet protect for moving info into a cloud, blynk internet application is employed as a distributed storage and in Arduino IDE stage coding is completed to create the control move of the process station and by this instrumentality and programming outline the yield is obtained.

This project is to effectively control and monitor the set point of the linear tank based on IoT. The components used are micro controller, Arduino Uno, Ethernet shield, cayenne web application, RJ45 connector.

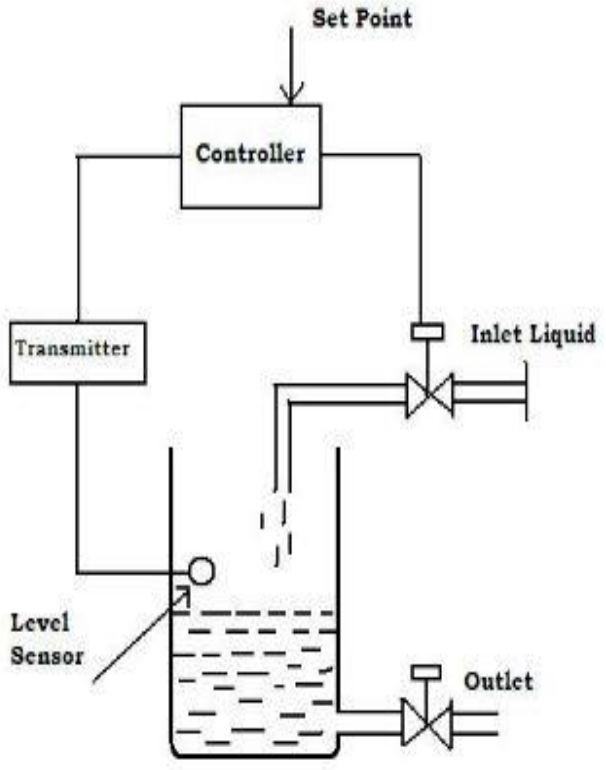

Fig.1. Schematic view of Closed loop Tank Level Control

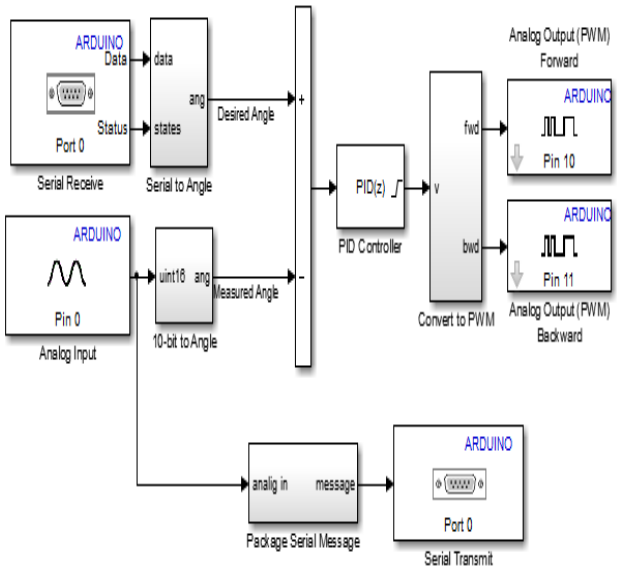

Fig.2. Arduino and IIOT Implementation

As if we need to control the level of a linear tank , we use controllers to perform the action. The input from the process station is current which is then converted to voltage. With the help of microcontroller and by using I-P converter, the variation of results that is set point changes are viewed by using cloud.

A. *Cloud Environment*:

Cloud computing could be an information innovation (IT) worldview that empowers the pervasive access to a shared pools of configurable framework assets and a lot of elevated quantity edges which will be quickly provisioned with insignificant administration travail, frequently finished of the Internet [5]. Cloud computing depends on sharing of assets to the accomplished understandability and the economies of scale, like associate degree open utility.

B. Voltage To Current Signal Conversion

Op-amps can be utilized to "change over" a voltage motion into a current flag effortlessly. Voltage signals are generally simple to deliver straightforwardly from transducer gadgets, though precise current signs are not .In instrumentation hardware, DC signals are frequently utilized as simple portrayals of physical estimations, for example, temperature, weight, stream, weight, and movement. Most normally, DC current signs are utilized as a part of inclination to DC voltage signals, since current signs are precisely equivalent in size all through the arrangement circuit loop conveying current from the source (estimating gadget) to the heap (marker, recorder, or controller), though voltage motions in a parallel circuit may fluctuate from one end to the next because of resistive wire misfortunes. Moreover, current-detecting instruments regularly have low impedances (while at the same time voltage-detecting instruments have high impedances), which gives current-detecting instruments more noteworthy electrical clamor insusceptibility. Another name for this circuit is trans-conductance intensifier.

C. Current To Pressure Converter:

A "current to pressure" convertor (I/P) changes over an easy signal (4 to 20 mA) to a proportional linear air output (3 to15 psi). Its purpose is to decipher the easy output from an impact framework into a definite, repeatable pressure an incentive to regulate pressure actuators/operators, air valves, dampers, vanes, and so on. The core of the framework is that flapper nozzle electronic equipment. It changes over tiny displacement signal (arranged by microns) to variation of atmospheric pressure. the essential construction of a flapper nozzle electronic equipment Constant atmospheric pressure (20psi) is equipped to at least one end of the pipeline. At the alternative end of the pipe there's a nozzle and a flapper. The gap between the nozzle and therefore the flapper is ready by the input signal[6]. Because the Flapper attracts nearer to the nozzle, be less flowing through the nozzle and therefore the atmospheric pressure within the pipe will increase.
The Hardware utilized is Arduino Uno, Ethernet shield, Blynk web application, RJ45 connector, Arduino IDE.

D. Rj45 Connector

RJ45 is a kind of connector basically used in Ethernet networking. As the Ethernet links has RJ45 connector on each end, Ethernet links are called as RJ45 links. The "RJ" in RJ45 stands for "enlisted jack," since it is an institutionalized networking interface. The "45" simply suggest to the number of the interface customary. Every RJ45 connection has eight pins, which suggests a RJ45 link contains eight separate wires. On the off likelihood that you simply take a goose toward the end of associate ethernet link, you'll truly observe the eight wires, that square measure every associate alternate shading. Four of them square measure robust hues, whereas at identical time the opposite four square measure stripy. RJ45 links are often wired in two numerous ways in which.

E. Blynk Web Application

Blynk may be a platform incorporated with iOS and automaton apps in order to regulate the Arduino, Raspberry Pi and therefore the likes over the web increases. It is one of the digital dash board wherever you'll be can be able to build a graphic interface for the project needed by merely dragging and dropping the widgets available. It's very simple to line everything up and may be able to begin tinkering in five minutes of time. Blynk isn't prescribed to some specific board or defend. Instead, it is a supporting hardware for an alternative purpose. Whether Arduino or Raspberry Pi is being connected to a web over a Wi-Fi, LAN or with the new ESP8266 chip or not, Blynk can be used get us on-line and be prepared for the web of our required Things. Blynk isn't simply "another IoT cloud". It's associate degree finish-to end answer that saves you time and resources once building applications for connected merchandise and services. With Blynk, one engineer will get any equipment on-line, connect it to the web, and build a mobile application in minutes to remotely monitor and management it. Blynk is named "the most easy IoT platform" for a reason [6]. Strive our drag-n-drop mobile app builder and see for yourself. quick and light-weight Cloud it's secure, scalable, light-weight and quick. able to manage billions of requests from your edge devices. Deployable in minutes, Blynk Cloud is ASCII text file. Deployable in minutes, Blynk Cloud is ASCII text file. It will run in your surroundings, domestically or on a fervent Blynk Business Server.

F. Arduino Software (Ide)

The ASCII text file Arduino code (IDE) performs the simple to compose code and transfer it to the board. It keeps running on Windows, MAC, OS X, and Linux. The process planet available in the Java and visible of process and different ASCII text file programming. The Arduino Integrated development surroundings - or Arduino code (IDE) - contain an application for composing code, a message region, a content comfort, a toolbar with buttons for basic capacities and a progression of menus. It associates with the Arduino and real instrumentality to transfer programs and speak with them. Outcomes composed utilizing Arduino code (IDE) square measure referred to as outlines. These representations square measure composed within the content tool and square measure spared with the record growth. The editor has highlights for cutting/sticking and for looking/replacing content. The message region offers feedback whereas at constant time stinting and commerce and moreover shows mistakes. The comfort shows content yield by the Arduino code (IDE), as well as complete mistake messages and different knowledge. The lowest mitt corner of the window shows the designed board and interface. The toolbar buttons change you to see and transfer programs, make, open, and spare outlines, and open the serial monitor. Amid tests it is signified that blynk permits to send esteems and the dashboard permits to review the esteem and it facilitates while adding the related gadgets to that esteem. For the control of the Led in Arduino IDE, the capacity log of cayenne as a matter of course is designed, which actually tunes in to the parameters of any channel that sends information from blynk to the ESP, for this situation the gadget button? It takes the estimation of the channel allocated to the button and that esteem goes from String to whole number to activate the GPIO 04.

G. Pid Implementation In Arduino

PID controller provides satisfactory closed loop set point tracking capability under servo and regulatory operation. The output of PID controller given as [7],

$$U(t)_{PID}=Kp[E(t)+KiE(t)+Kd\,dE(t)/dt] \quad \ldots\ldots\ldots (1)$$

Where,
Kp=Proportional gain
Ki=Integral gain
Kd=Derivative gain
E(t)=Setpoint-Process variable=Error
U(t)=Controller output

IV. RESULT AND DISCUSSION

Fig.3. Process Station Setup

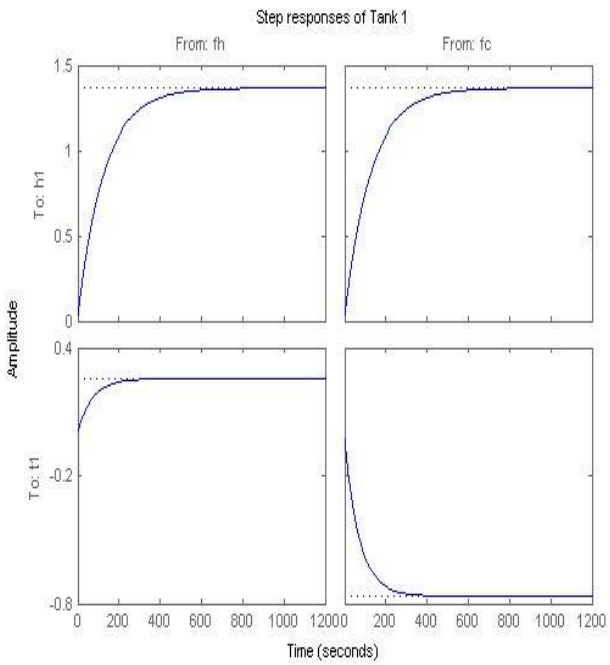

Fig.4. Step Response Analysis for tank level control

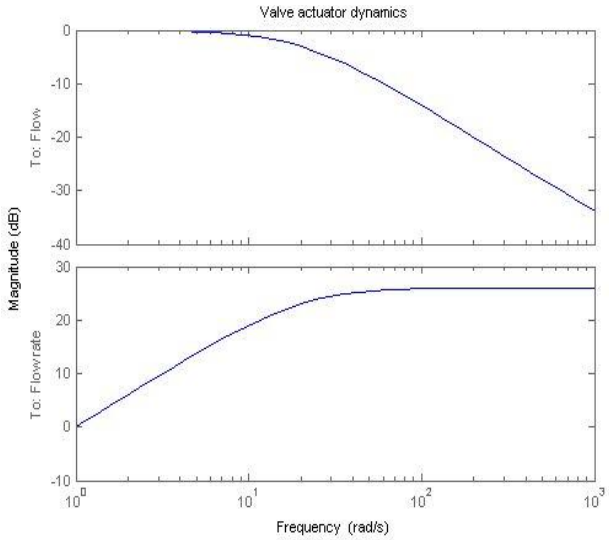

Fig.5. Actuator Dynamic model Response

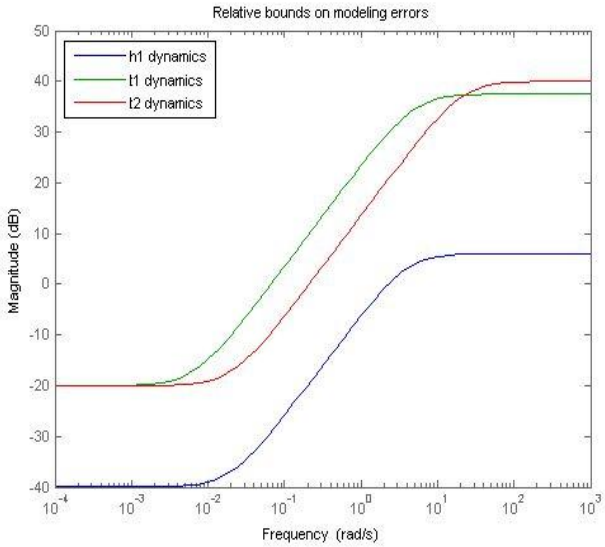

Fig.6. Frequency Response Analysis

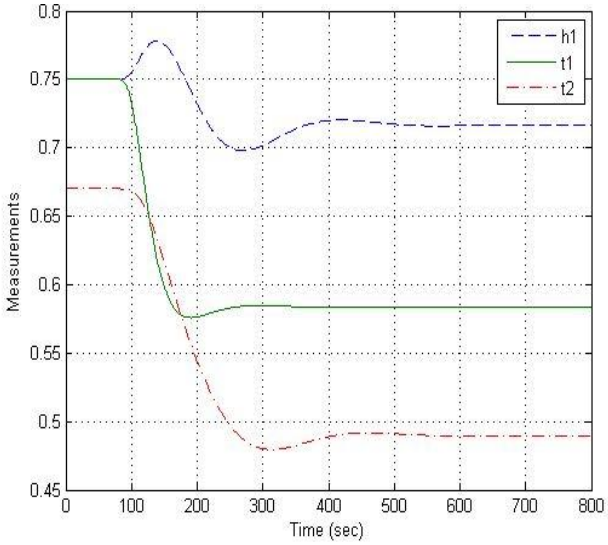

Fig.7. Closed loop Response Analysis under flow disturbance

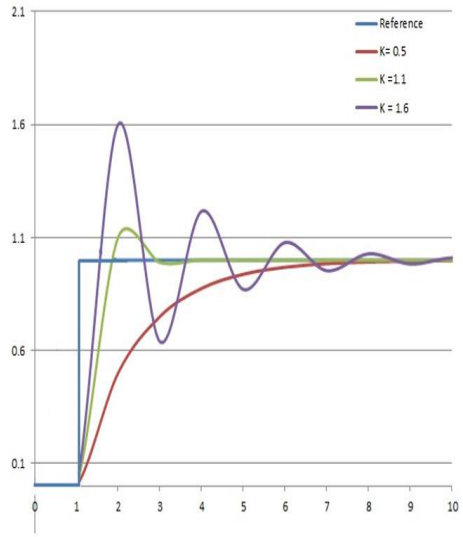

Fig.8. Set point tracking analysis

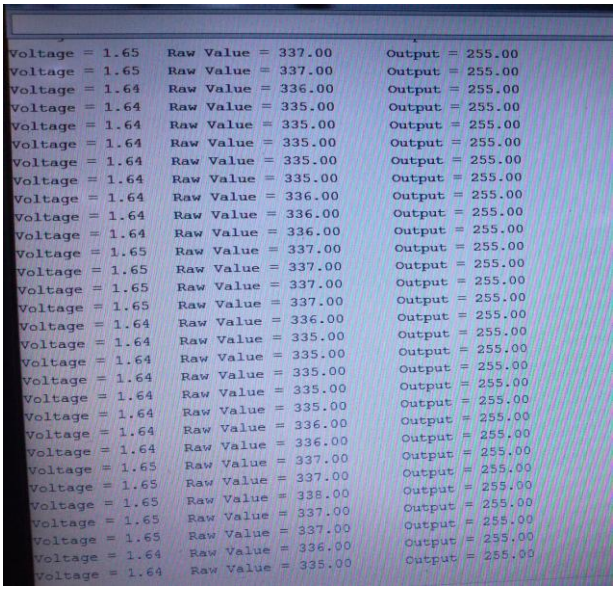

Fig.9. Sample Online results for tank level control

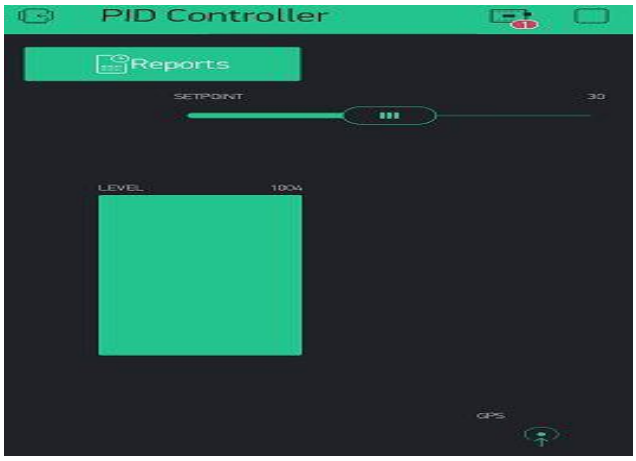

Fig.10.PID implementation in IOT platform using blynk

Fig1-2 shows the IOT implementation and closed loop control view of level control process. Fig4 shows the step response analysis under unit step value and clearly indicates the offset error and need of closed loop performance. Fig5 deals with valve dynamics response change with respect to time period. Fig6 provides the indication of frequency response analysis under modeling of error criteria. Fig7 shows the disturbance rejection response under unit flow rate change. Fig8 shows the set point tracking capability of closed loop PID controller which is implemented in bylnk open source IOT platform.

V. CONCLUSION AND FUTURE WORK

Designing of level control of cylindrical tank using IoT with cloud computation will improve the controlling of the process variable that is head of the tank from the remote place where ever in the globe. The digital version of PID controller will provide very good set point as well as load tracking of the particular system and this kind of arrangement gives the optimum time domain specifications like minimum rise time, less over shoot and reduced setting time for both servo and regulatory problems with the help of Arduino UNO board. Using the Arduino programme and the Blynk web service, we can be able to control and monitor the set point of our process station from anywhere and at anytime. In this work the simple PID controller is implemented without tuning the controller parameters but for future work can be extended by including the optimization algorithms for tuning the existing PID controller and even good advanced control digital algorithms like model predictive controller, soft computing technique may be performed From this project, it is understood that the IoT interconnect based controller will gives reliability, effectiveness and Intelligent monitoring of industrial process .

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ANNEXURE

```
#include <PID_v1.h>
#define PIN_INPUT A0
#define PIN_OUTPUT A3
double Setpoint, Input, Output;
double aggKp = 1, aggKi = 0.001, aggKd = 0;
double consKp = 1, consKi = 0.001, consKd = 0;
PID myPID(&Input, &Output, &Setpoint, consKp, consKi,
consKd, DIRECT);
void setup()
{
 Input = analogRead(PIN_INPUT);
 double s = 4;
 Setpoint = s*0.0009775171;
 myPID.SetMode(AUTOMATIC);
 Serial.begin(9600);
}

void loop()
{
 Input = analogRead(PIN_INPUT);
 Serial.print("Input = ");
 double Input2 = Input*0.0009775171;
  Serial.println(Input2);
 double gap = abs(Setpoint -
Input2);
 double gap1 =
abs(gap*1023);
```

```
  Serial.print("gap1 = ");
  Serial.println(gap1);
  if (gap1 < 5)
  {
    myPID.SetTunings(consKp, consKi, consKd);
  }
  else
  {
    myPID.SetTunings(aggKp, aggKi, aggKd);
  }
  myPID.Compute();
  analogWrite(PIN_OUTPUT, Output);
  double Output2 = Output * 0.0048875855;
  Serial.print("Output = ");
  Serial.println(Output2);
  delay(500);
}
```