Proceedings of the
International Conference on Mechanical Engineeringand Renewable Energy 2013
(ICMERE2013) 1 - 3 May 2014, Chittagong, Bangladesh

ICMERE2013-PI-033

DESIGN AND IMPLEMENTATION OF MICROCONTROLLER BASED PROCESS LINE LIQUID LEVEL CONTROL AND MONITORING SYSTEM FOR INDUSTRIES

S. M. Muslem Uddin[1,*], Md. Rafiqul Alam[2], Madhur Bansal[3], Parvez Akhter[4], Roky Baidya[5] and R. Kabeer[6]

[1, 2, 4-6]Department of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology (CUET), Chittagong-4349, Bangladesh
[3]Department of Electrical and Electronic Engineering, University of Information Technology and Sciences (UITS), Chittagong, Bangladesh

[1,*]muslem.eee04cuet@gmail.com, [2]mra_cueteee@yahoo.com, [3]bansalmadhur@gmail.com, [4]suzon_cuet06@yahoo.com, [5]rokybaidya@cuet.ac.bd, [6]ziko_ridwan@yahoo.com

Abstract- *In this paper, a new microcontroller based digital control scheme is proposed to improve the tracking performance of a water tank liquid level control system, which can be applied to industrial applications. The key feature of this control scheme is to improve the tracking performance of the liquid level. This paper concern with microcontroller based liquid level control and industrial system control. This paper presents a well explained and reliable control system for industries. This work has been carried out by developing an algorithm and designing the system model and also followed some important steps for hardware implementation. The validity of the proposed control scheme is verified by means of a practical testing on an experimental liquid level control device. The implementation of this control in a prototype design shows satisfactory and encouraging results which are effective, precise and reliable in the industrial system control.*

Keywords: Microcontroller, Process Control, Liquid Level Control, Automatic Control System.

1. INTRODUCTION

Liquid level control of any tank, packages or industrial process is a veryimportant requirement; it belongs to accuracy, quality, quantity and finally with cost. This is directly related to efficient use of the resources, which means by controlling liquid level,it reduces or eliminates possibility of wastage which is directly related to cost saving, energy saving, optimal utilization of resources. Sudden fall of liquid level can effects continuous process and requirement in industries. So intelligent close loop independent control with monitoring, display status can help to maintain process continuous. A design technique for the implementation of the liquid level control system by based on the use of a single chip microcontroller presents in[1]. Single chip microcontroller based control is advantageous in carry out information processing and control functions[2]. It is obvious that the digital control system can offer high accuracy and high speed responses[3]. In discrete time domain actual systems and controllers are widely implemented since microprocessors and computers are employed. Recently, a variable structure control in the discrete-time domain has much received the attention[4],[5],[6].A systematic approach introduces to design and realize a temp and volume based liquid mixing system using three low cost micro controllers in[7]. An analytical design method for a conventional PI controller that enables the constrained optimal control of the liquid level loop in [8]. A new sliding mode control scheme based on the sliding surface design is proposed to improve the tracking performance of a water tank liquid level control system, which can be found in many industrial works [9]. The motion of water level monitoring and management within the context of electrical conductivity of the water is implemented in [10]. Here It has been used modern electronics to make a model, which works independent and also displays output status. The main aim of this paper is to show effective use of modern technology to get efficient, reliable, economic and legible control. This model can save energy by controlling start and stop of motor based on feedback of liquid level, hence can say motor will run only when it is required. This model also helps to avoid possibility of wastage of liquid due to over flow.

This paper is organized in the following manner. Section 2 presents the working principle of level control system. Section 3 describes proposed methodology of the system, section 4 depicts the hardware design and implementation of the microcontroller based level control system, validated with the simulation results in section 5, and finally conclusions are expressed in section 6.

2. WORKING PRINCIPLE

Any level control works, based on level monitoring device. Feedback of level monitoring device arecompared or checked then decide actuation of level makeup device such as pump or valves. When it is to involve digital circuit or micro controller then it needs DC power supply for electronics and 5 Volt DC for micro controller. In this model, it is shown process tank level control based on two point level monitoring and controlling start – stop of pump or motor.

In this model, motor body temperature and system voltage was monitored which displayed at LCD screen and also used for safety of motor from over temperature, under and over system voltage. In addition of above reservoir tank level was monitored, which helps to avoid unwanted motor run and damage of pump and motor from jam / air lock. In this model, current status of the system and operation will be displayed on LCD, for motor ON and fault alarm. Two relay has been used, one for each function. So it needs 3 digital input for getting level point feedback and two analog inputs for monitoring temperature and voltages. Also it needs two digital output and dedicated communication with LCD from microcontroller. For operating pump motor it needs to have process tank level under low level, reservoir level above min level, normal motor temperature and normal supply voltage. If any of these conditions fails motor will stop and alarm will get on.

3. PROPOSED METHODOLOGY AND CIRCUITS

The proposed methodology is expressed with flow chart in Fig.1 and overall proposed circuit in Fig.2.

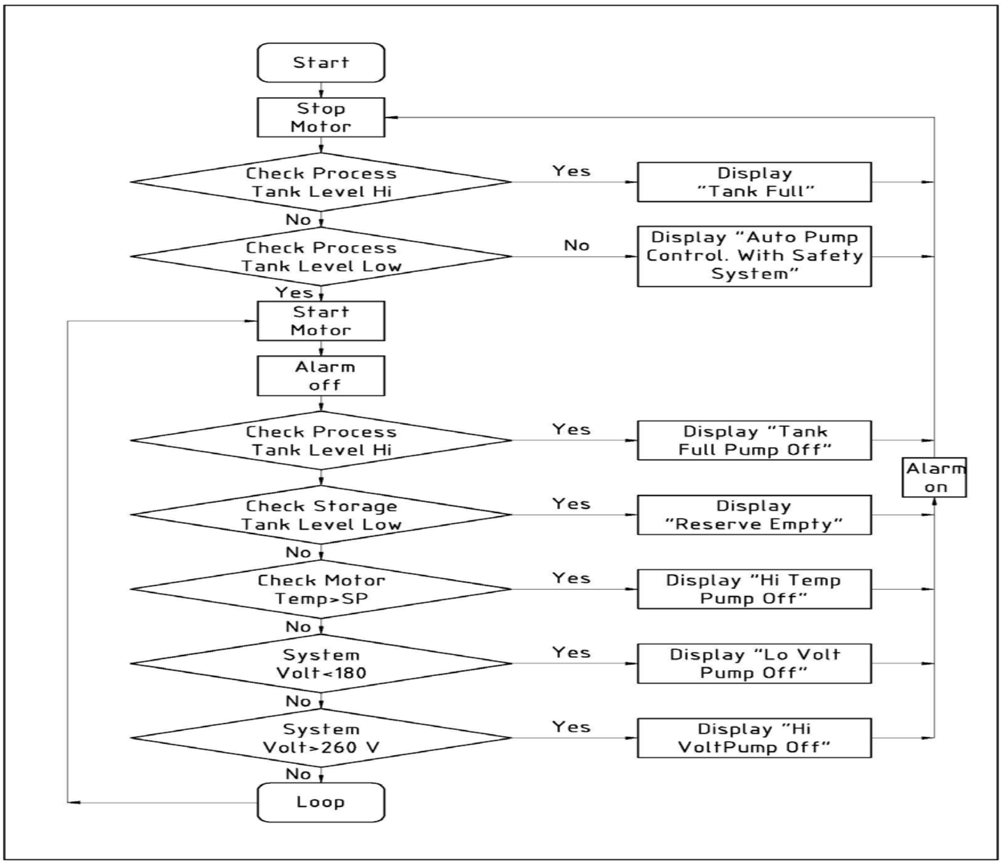


Fig.1: Overall Proposed Program Flow Chart.

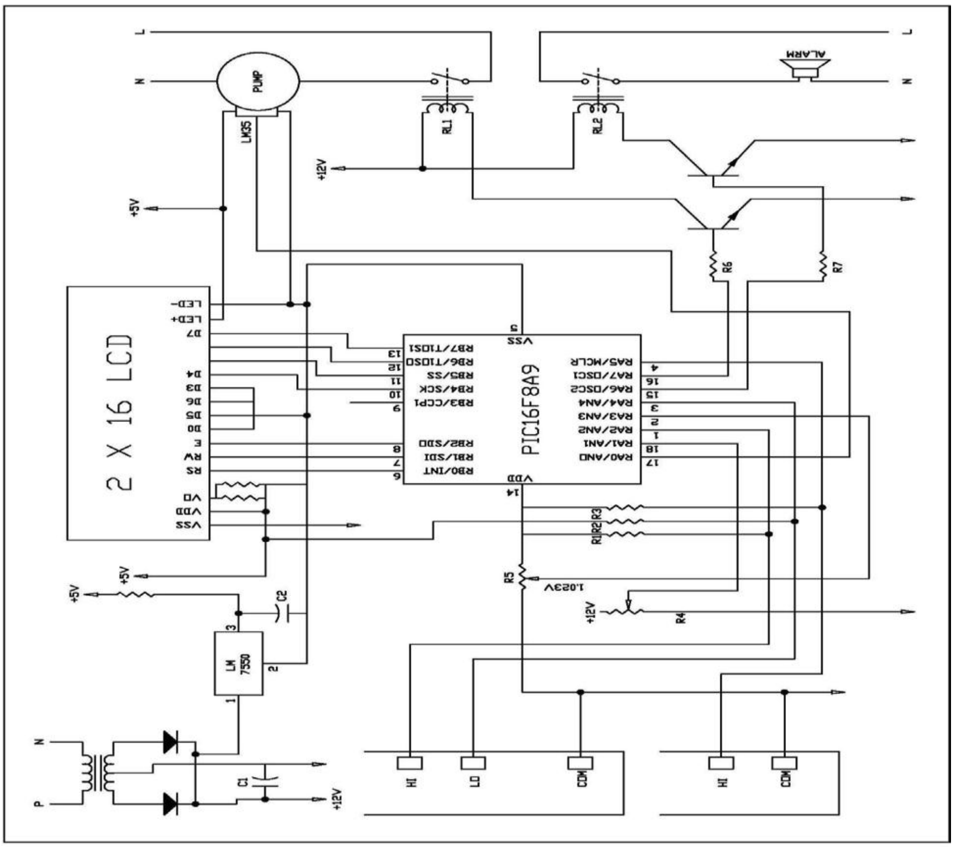


Fig.2: Overall Proposed Circuit Diagram for Proposed Model.

4. HARDWARE DESIGN AND IMPLEMENTATION

The experimental proto type of the proposed model is given in Fig. 3(a) and Fig. 3(b).

4.1 Steps Follows to Design

To establish the experimental setup, the following steps are followed:

(a) Drawing a circuit diagram using all listed component in Table.1.

(b) Step-down AC voltage from 230V to 9V AC.

(c) Convert AC to DC using diode IN 4007 and capacitors.

(d) Convert 12V DC in to regulated 5 VDC using IC LM 7805.

(e) Fix LCD at PCB keeping at B side of MCU.

(f) Decide analog and digital Input address or terminal.

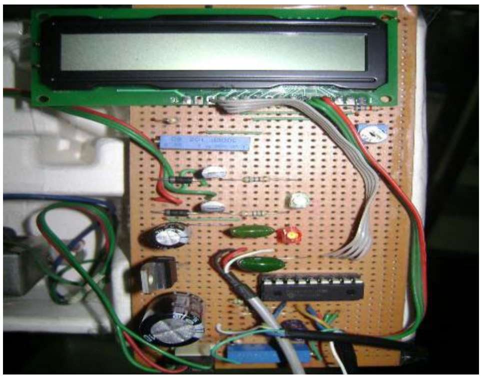
(g) Decide digital output terminal.

(h) Do the interconnection wiring as per circuit.

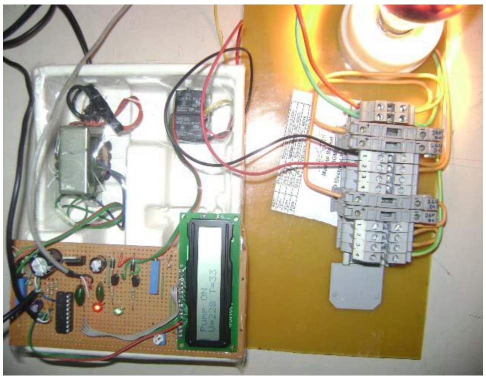
(i) Draw flow chart for required operation and functions.

(j) Write the program in visual pic basic to meet flow chart and compiled.

(k) Once the HEX file is generated, this HEX is transferred to micro-controller (PIC 16F819) using TOP 2005.



(a)



(b)

Fig.3: Experimental hardware proto-type of proposed model.

Table 1: Lists of component for working model.

SL. No	Name of The Components	Quantity Required (unit)
1.	Level Switches	03
2.	Temperature Sensors	01
3.	Step Down Transformer 230V/9V	01
4.	Diode IN 4007	02
5.	Capacitor3300micro Farad	01
6.	Regulating IC LM7805 for 5 Volt	01
7.	Micro Controller for 2AI,3DI and LCD interface	01
8.	LCD display2x16ch	01
9.	PCB	01
10.	Electromagnetic relay, 12 VDC coil	02
11.	Resistances	01 (lot)
12.	Wire Links	01 (lots)

5. RESULTS AND DISCUSSION

5.1 Tested by Simulating Conditions

This investigation has been tested by simulating with following conditions.

1. Process and reservoir tank empty.

2. Process tank empty and reservoir tank above min level.

3. Process tank full and reservoir tank above min level.

4. Process tank below high level but above low level and reservoir tank above min level.

5. Process tank level below low and reservoir tank above min level.

6. Increase temperature of temperature sensors during motor relay on.

7. Increased system voltage using variable transformer.

8. Decreased system voltage using variable transformer.

9. Checked AC current drawn by circuit in various condition.

5.2 Result After Simulation Test

Following are the results obtained in each steps are explained in below:

1. Got RA6 O/P at Microcontroller which energized alarm relay and message displayed on LCD “Reserve Empty”.
2. Got RA7 O/P at Microcontroller which energized relay to start Motor and message displayed on LCD “Motor ON”.
3. Got RA7 off at Microcontroller which de-energized relay for motor on and message displayed on LCD “Tank Full” and “Pump Off”.
4. Out Put RA6 and RA7 got off and message displayed on LCD “Auto Pump Controller” and “With Safety System”.
5. Got RA7 O/P at Microcontroller which energized Relay to start Motor and message displayed on LCD “Motor ON”.
6. Microcontroller O/P for motor on relay RA7 got off, O/P RA6 got ON and message displayed on screen “High Temp and Pump Off”

7. Microcontroller O/P for motor on relay RA7 got off, O/P RA6 got ON and message displayed on screen “High Volt Pump Off”

8. Microcontroller O/P for motor on relay RA7 got off, O/P RA6 got ON and message displayed on screen “Low Volt Pump Off”

9. Noted Currents by varying system voltage refers in Table 2.

Table 2:Output Parameters for Various Conditions

SL. No	System Voltage(V AC)	Circuit Current (mA)	Output for Motor	Output for Alarm
1.	180	10.86	OFF	ON
2.	190	12.32	OFF	ON
3.	200	14.05	ON	OFF
4.	210	15.66	ON	OFF
5.	220	17.80	ON	OFF
6.	230	20.54	ON	OFF
7.	240	22.08	ON	OFF
8.	250	26.12	OFF	ON

6. CONCLUSION

The result shows this model controls automatically and gives alarm whenever any interruption comes in the system. Optimum operation is maintained to run of motor and pump by monitoring level of process tank and reservoir which saves energy. By sensing the liquid level automatically zero possibility of liquid over flow can be achieved and display of system status on LCD helps to troubleshoot. This gives one digital output when there is some error in system which can use to communicate or call maintenance engineer by providing ringer or siren. Finally, this model is effective, reliable, informative, energy efficient, time efficient and automatic.

7. ACKNOWLEDGEMENT

The Authors wish to thank the department of Electrical and Electronic Engineering, University of Information Technology and Sciences (UITS), Chittagong, Bangladesh.

8. REFERENCES

[1] T. Dumawipata, S. Unhavanich, and W. Tangsrirat, "Microcontroller-Based Liquid Level Control Modeling," *The Journal of KMITNB*, vol. 12, p. No.2, Apr.-Jun.2002. .

[2] P. Neumann, "Communication in industrial automation—What is going on?," *Control Engineering Practice*, vol. 15, pp. 1332-1347, 2007.

[3] K. B. C., "Digital Control Systems," *Holt-Saunders International Editions*, 1980.

[4] W. Gao, Y. Wang, and A. Homaifa, "Discrete-time variable structure control systems," *Industrial Electronics, IEEE Transactions on*, vol. 42, pp. 117-122, 1995.

[5] J. Y. Hung, W. Gao, and J. C. Hung, "Variable structure control: a survey," *Industrial Electronics, IEEE Transactions on*, vol. 40, pp. 2-22, 1993.

[6] Y. Pan and K. Furuta, "DISCRETE ‐ TIME VSS CONTROLLER DESIGN,"*International Journal of Robust and Nonlinear Control*, vol. 7, pp. 373-386, 1997.

[7] A. Sastry, K. Srinivas, C. V. Krishna, and C. S. KiranKumar, "An Automated Microcontroller Based Liquid Mixing System," *interface*, vol. 2, pp. 2648-2651, 2010.

[8] M. Lee and J. Shin, "Constrained optimal control of liquid level loop using a conventional proportional-integral controller," *Chemical Engineering Communications*, vol. 196, pp. 729-745, 2009.

[9] H.-M. Chen, Z.-Y. Chen, and J.-P. Su, "Design of a sliding mode controller for a water tank liquid level control system," in *Innovative Computing, Information and Control, 2007. ICICIC'07. Second International Conference on*, 2007, pp. 335-335.

[10] S. A. M. T. a. S. M. M. R. S.M. Khaled R., "Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue," *Proceedings of the World Congress on Engineering and Computer Science* October 20-22, 2010, San Francisco, USA.