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# Implementation of ultrasonic sensor as a chemical percol fluid level control based on Atmega 16

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**Abstract.** The use of a transmitter level detects the liquid level of a chemical percolation tank instead of a level switch, because the transmitter level provides accuracy in reading the value of the chemical fluid level. Ease of installing the transmitter level can be programmed and set up easily. The high price of a transmitter level causes entrepreneurs in the industrial world not to use the transmitter level as a reader or detector of chemical fluid levels in the production process. Based on this background, the chemical fluid level control device was designed using an ultrasonic sensor, by implementing Atmega16 as a controller. Controlling the level of chemical percolation fluid level using an ultrasonic sensor HC-SR04 as a reader or level detector. Drivers to run the motor when filling the chemical fluid tank of percol are run manually or automatically. The overall test results of ultrasonic sensors work optimum that is 75% of the 8 test data according to program settings. The average value of the ultrasonic sensor error to detect the level of percolating fluid in both tank 1 and tank 2 is 0.125 cm.

## 1. Introduction

Rapid technological advances provide many conveniences in the industrial world, one of which is the use of level transmitters as a means of reading or detecting fluid levels in reservoirs. The transmitter level is used instead of the level switch which has been widely used to control liquid levels, because the transmitter level provides accuracy in reading the liquid level value, ease of installation, and can be easily programmed or adjusted according to the height of the shelter to be used. The problem that occurs in the industrial world is that not all companies can use a level transmitter as a liquid level sensor or detector [1]. This is because the price of the transmitter level is quite expensive, causing entrepreneurs in the industrial world not to use the transmitter level as a reading device or detecting fluid levels in the production process and prefer to use level switches [2]. The design of percol chemical liquid level control instruments using the HC-SR04 ultrasonic sensor as a reader or percol chemical fluid level detector, by implementing the Atmega16 microcontroller as a chemical fluid level controller [3-9]. Drivers to run the motor when filling Percol chemical liquid tanks are run manually or automatically [10-12].

### 1.1. AVR Atmega16

AVR is an 8-bit Complementary Metal Oxide Semiconductor (CMOS) microcontroller made by Atmel based on RISC (Reduced Instruction Set Computer) architecture. Almost all instructions in the program executed in one clock cycle. AVR has 32 general-purpose registers, flexible timers / counters with



compare mode, internal and external interruptions, UART serials, programmable Watchdog Timer, power saving mode, ADC and PWM. AVR also has an on-chip In-System Programmable (ISP) Flash that allows the program memory to be reprogrammed (read / write) with a serial connection called Serial Peripheral Interface (SPI). AVR has an advantage compared to other microcontrollers, the advantage of AVR microcontroller is that it has a speed in executing programs faster, because most of the instructions are executed in 1 clock cycle (faster than the MCS 51 family of microcontrollers that has the Complex Instruction Set Compute architecture). ATMEGA16 has a value close to 1 Million Instruction Per Second (MIPS) per MHz, thus making power consumption low to the speed of the command execution process.

### 1.2. Ultrasonic sensors

The ultrasonic sensor is a series of electronics that are able to convert electrical energy into mechanical energy in the form of ultrasonic sound waves. This sensor consists of an ultrasonic transmitter circuit called an ultrasonic transmitter and receiver called a receiver. This tool is used to measure ultrasonic waves. Ultrasonic waves are mechanical waves that have longitudinal characteristics and usually have frequencies above 20 kHz. Ultrasonic Waves can propagate through solid, liquid or gas. The physical shape of the ultrasonic sensor and its circuit diagram are shown in Figure 1.

### 1.3. AC and DC motors

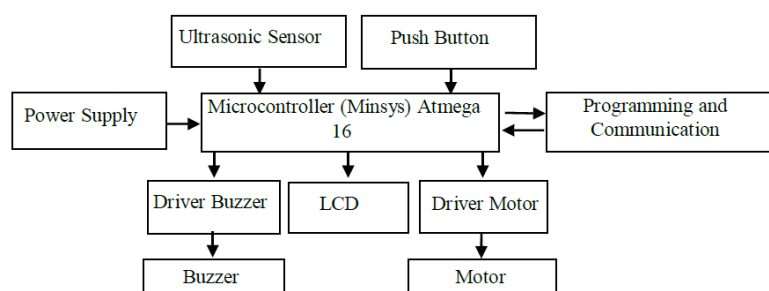
Single phase induction motor construction consists of two components, namely the stator and rotor. The stator is the part of the motor that is not moving and the rotor is a moving part that rests on the bearing shaft against the stator. Direct current motor (DC motor) is a machine that converts direct current electrical energy into mechanical energy in the form of rotation. Based on physical direct current motors generally consist of a stationary part (stator) and a rotating part (rotor).

## 2. Method

To implement ultrasonic sensors as a control level of Atmega16-based chemical percol fluid is explained in the form of a system block diagram and mechanical design.

### 2.1. System block diagram

Microcontroller-based PLC consists of several important parts in order to work as expected [4]. The following is a picture of a system block diagram. A microcontroller-based block level control diagram is shown in Figure 1.



**Figure 1.** Microcontroller based level control block diagram.

Information:

- Power Supply as a power supply that provides regular DC (direct current) voltage of 5 V-30 V to the chemical liquid level control circuit
- Ultrasonic Sensor, this tool is used to measure ultrasonic waves. Ultrasonic waves are mechanical waves that have longitudinal characteristics and usually have frequencies above 40 KHz.

- Push Button, the switch is used to provide input into the controller circuit and settings. This switch works with the NC or NO contact point principle only, this contact has 2 bolt terminals as connection contacts.
- Microcontroller AVR Atmega16, as the main controller gets an order from the ultrasonic sensor to start the Automatic Percol Chemical Fluid Level Control process.
- Programming and Communication, used to program and provide input control settings on the control system.
- Liquid Crystal Display, functions to display a sensor value, display text, or display a menu on the microcontroller application
- Buzzer is used to alert the level of Chemical Percol fluid level with sound and alarm. 8. The motor is used as a pump drive and a percol chemical liquid mixer.

## 2.2. Mechanical design

Mechanical planning is a prototype sketch of chemical percol fluid level control using ultrasonic sensors. The sketch of the prototype is shown in Figure 2. Where in the mechanical design planning consists of 3 tanks used. 2 tanks for chemical liquid storage and 1 tank for clean water storage. In tank 1 the chemical liquid level is only displayed on the display without being controlled while the tank 2 is a distribution / usage tank, this distribution tank will then be controlled for the liquid level. Clean water is used for flushing/rinsing the pipe when the chemical pump will stop, with the aim that the pipe does not clog up or the pump does not jam when the process is run again.

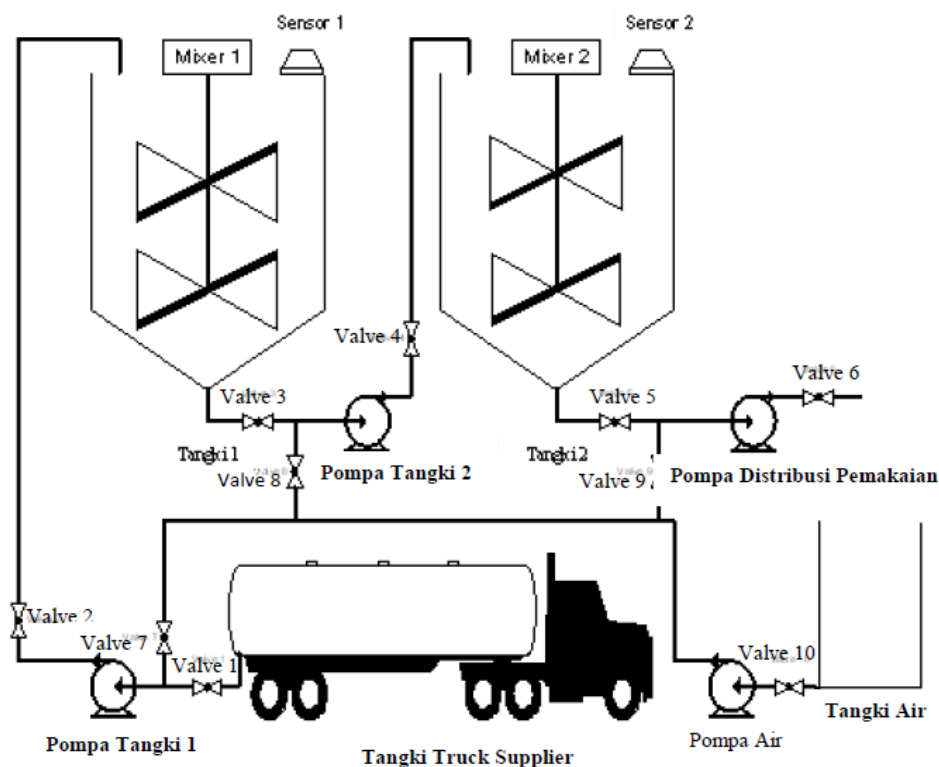


Figure 2. Mechanical planning sketches.

### 3. Results

To find out whether the planned system can run well, it is necessary to test the hardware and software that has been completed. This is to find out which system components can run well and as expected. There are several system tests, including:

#### 3.1. Power supply testing

Power supply testing is carried out at 5 Volts and 12 Volts. Each voltage is shown in Table 1 and Table 2.

#### 3.2. Ultrasonic sensor testing HC-SR04

Testing of ultrasonic sensors in tank one and tank two aims to determine the level of liquid in the tank. The test results are shown in Table 3 and Table 4.

**Table 1.** Test results at 5-volt voltage.

No.	No-load Output	Load (R)	Voltmeter	Ampere meter
1		1 K Ohm	4.82 Volt	4.8 mA
2	4.83	2 K Ohm	4.82 Volt	2.5 mA
3		3 K Ohm	4.76 Volt	1.5 mA
4		4 K Ohm	4.76 Volt	1.1 mA

**Table 2.** Test results at 12-volt voltage.

No.	No-load Output	Load (R)	Voltmeter	Ampere meter
1		1 K Ohm	11.90 Volt	11.83 mA
2	11.93	1 K Ohm	11.82 Volt	5.92 mA
3		1 K Ohm	11.76 Volt	3.8 mA
4		1 K Ohm	11.73 Volt	2.9 mA

**Table 3.** Tank one ultrasonic sensor test results.

No.	Fluid distance with sensor			
	Ruler	LCD	Error	
	1.5 cm	2 cm	0.5 cm	
1				
2	3 cm	3 cm	0 cm	cm
3	4 cm	4 cm	0 cm	cm
4	5 cm	5 cm	0 cm	cm
5	6 cm	6 cm	0 cm	cm
6	7.5 cm	7 cm	0.5 cm	cm
7	8 cm	8 cm	0 cm	cm
8	9 cm	9 cm	0 cm	cm

**Table 4.** Tank two ultrasonic sensor test results.

No	Fluid distance	With sensor	Error
	Ruler	LCD	
1	1.5 cm	2 cm	0.5 cm
2	3 cm	3 cm	0 cm
3	4 cm	4 cm	0 cm
4	5 cm	5 cm	0 cm
5	6 cm	6 cm	0 cm
6	7 cm	7 cm	0.5 cm
7	8 cm	8 cm	0 cm
8	9 cm	9 cm	0 cm

### 3.3. Overall system testing

The test results of the motor amperage used in miniature when run as a whole. The test results are shown in Table 5.

**Table 5.** Ampere measurement results in miniature.

No.	Name	Ampere
1.	Transfer pump one	0.056 A
2.	Transfer pump two	0.051 A
3.	Distribution Pump	0.051 A
4.	Water pump	0.078 A
5.	One Tank Mixer	210 mA
6.	Two Tank Mixer	208 mA

## 4. Discussion

At the time of testing there were some errors that needed to be fixed, including:

- When you first try the distance ultrasonic sensor shown in the LCD is not appropriate because there is an error in the calculation program.
- The length of time required to start the motor is too long because the delay in the program is too long.

## 5. Conclusion

The ultrasonic sensor is implemented as a control level for Percol Chemical's liquid works and functions properly. The average error value on the sensor to detect the liquid level of tank 1 is 0.125 cm while the average error of the sensor to detect the liquid level of tank 2 is 0.0625 cm. In automatic level control in each tank and pump can work optically.

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