Water level control system using silicon controlled rectifier

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Abstract. The purpose of this paper is to analyse a circuit of system water level control system using a Silicon Controlled Rectifier (SCR) as an active component. WLC circuit is composed of the SCR that is connected to the NPN transistor 2, the relay is connected with a lamp 5 watt / 220 volt electric motor as a simulator. Detection of water uses a sensor that consists of three sensors namely S1, S2, and S3 in the water tank. The experimental results indicate that when water touches the S3 then lights on/ simulator motor works with Vbe transistor1 voltage at 0.4 volts, the voltage at the Vbe transistor2 0 volts and the voltage on the SCR Vak of 0.4 volts. The lamp to simulate an electric motor simulator will be off if S1 touched the water with transistor1 Vbe voltage at 0.4 volts, the voltage at the Vbe transistor2 of 1.8 volts and the voltage on the SCR Vak 0.75 volts.

1. Introduction

Development in science and technology today is very rapid. This development is supported by advances in electronics and information technology. Work performed can be run effectively and efficiently in line with emerging technology [1].

Electric power is currently the basic needs of every human being. Without electricity people will experience difficulties in day-to-day survival. Therefore, the need for electric power from generation to generation will increase. The need for the development of systems that use electricity more affordable [2].

Water is a basic need for every household. If the water is not used properly it can end the world's water shortage. Need ideas on methods to reduce water consumption and waste water [3]. Water supplies are often stored in a tank taken from the well. The problem that often happens that, when the water storage tank is empty then it should turn on and off the water pump manually [4]. This means there must be a guard / observation so that water does not overflow because of the absence of control automatically [5]. Sometimes the motor coil burned because of undetected presence / absence of the flood in [6].

One of the equipment that has evolved is the control of water level. This control circuit using a microcontroller that controls the functions of a circuit and control the switch to turn on the water pump automatically [7]. Water height position output signal is indicated by a LED flame. Control of the water level utilizing the conductivity of water to give a signal in the form of water positions are further Mikrokontrol will give instructions to the switch to turn on the water pump. The test results showed that working water pump depending on the water level in the tank as designed [8].

Furthermore, a microcontroller can use additional components like a seven segment to show the water level in a decimal number [9]. Port 1 is used to detect the level of water. Ranging from 1.0 ports as a bookmark highest level of water up to 1.5 port as a bookmark lowest level of water. Port 2 is used for indication of water using the seven segment. Seven segment would show number of 0 when water levels are at their lowest level. When the water level reached the lowest level microcontroller will send a signal to the relay to turn on the motor. As a sign of an increase in the water level, seven segment would show the numbers of 0 to 5 according to a predetermined water level. When the seven segment shows the number 5 means the water level is at its highest level, so Mikrokontrol gives a signal to turn off the motor [3].

Height of the water level detection can also use LM339 IC as IC Op-Amp. This detection circuit using additional transistors that act as switches. LM339 works control transistor that drive a relay to start / stop the water pump. The test results showed that the working voltage comparator Op-Amp circuit between 7-8 volts and the reference voltage level of 4.85 volts [10].

Control of the water level another using fuzzy logic. Using the principle of the switching transistor to detect the water level in the tank which is then fed to the PIC16 microcontroller [11]. The model system used in designing a closed loop control system. Closed loop systems are used to minimize errors. Figure 1 shows the closed-loop system used in designing the control system.

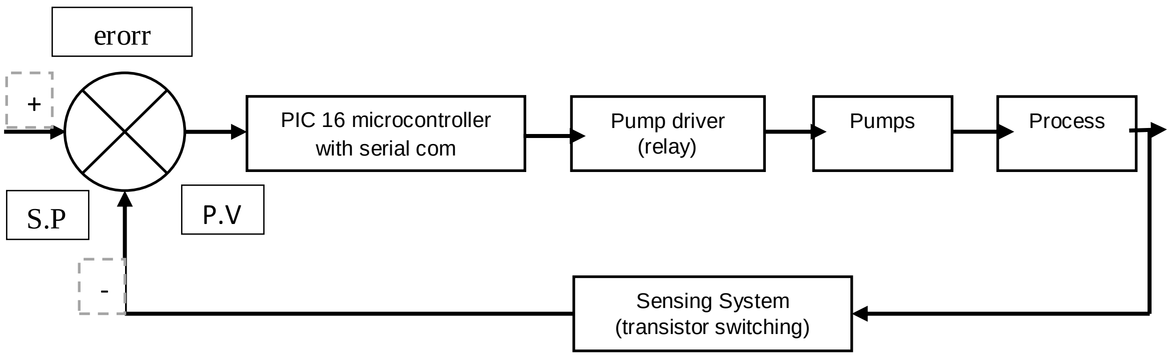

Figure 1. Functional block closed loop system.

[12] have conducted experiments on water level control using fuzzy logic. Experiment result show that the fuzzy logic control has 7 fuzzy sets for input error, 3 fuzzy sets to change error and 21 fuzzy rules to control the action. Error "steady state" produced 37.5% less than conventional controllers PI / Proporsioal and Integral (as a control comparison). The response of the water level, a fuzzy logic control fairly quickly but 55.5% slower than the PI controller.

Control of water level can also be controlled using a combination of overload, MCB, magnetic kontactor and other supporting components. Automatic switching ON / OFF of the water pump depending on the water level in the storage tank being monitored using a mercury float switch that works using the principle of Archimedes. When water is at its lowest position, the liquid mercury transferred to the counter and the float ball so flip the switch and the water pump motor moves. The process of filling the water move the ball floating up to the specified limits. When the water has reached the upper limit, float and a counter weight on the same side moved in the liquid, causing the switch dangling to the side of the single counter weight heavier than the counter weight and the float ball. This condition mercury flowing to decide the switch so that the water pump motor becomes dead [13].

2. Experimental design

WLC system is designed from a few electronic components. The components consist of a relay associated with lamp 5 w / 220 v as a simulator of electric motor, SCR connected with an NPN transistor, the SCR and the NPN transistor 2 is connected with water level detection (sensor). Electronic control circuits WLC system can be seen in Figure 2.

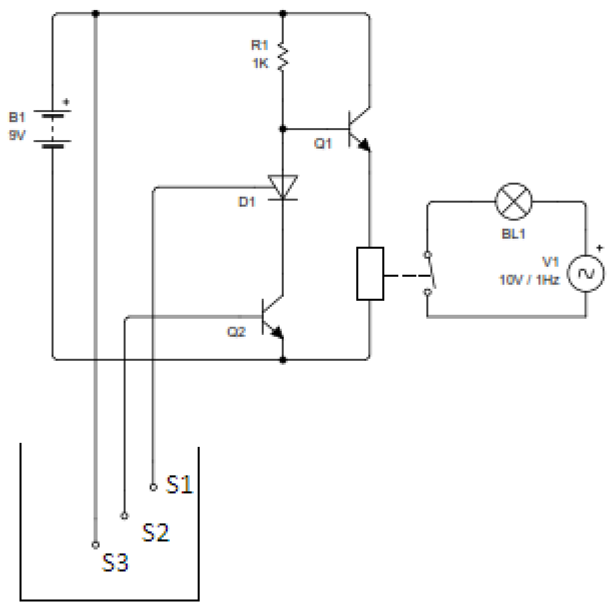

Figure 2. Water level control circuit.

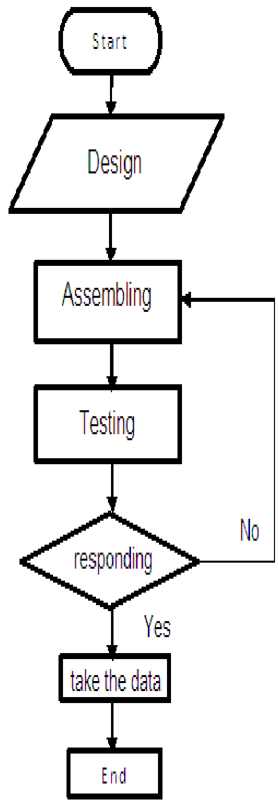

Figure 3. Flowchart water level control circuits.

The Figure shows that the sensors S1, S2 and S3 included in the water tank. Sensor S1 is connected to the gate of SCR. The sensor is located at the top of tub. The base of transistor Q2 is connected to S2 in the middle. Q1 collector connected to S3 that is located at the bottom. Relay connected with lamp instead of an electric pump motor. The applied voltage is DC 9 volt and 220 volt AC. The composition of the flowchart in drafting the WLC system can be seen in Figure 3

Flowchart is a flow diagram of the water level control. The design of the flowchart above will form the circuit design and simulate practiced as control of water level. After designing successful / has been created the next step is assembling. This assembly is an assembly of electronic components used in the circuit. The next step after the assembly is test. Testing the circuit that has been assembled. If the test is not in accordance with the parameters that have been determined, the steps taken are to check back a circuit that has been assembled. When in accordance with the specified parameters, it can take the data as needed, and record the results.

Water reservoirs on the WLC system is divided into three sections for the placement of the sensor as well as the reference position of the water. The first section is located at the top, the second part in the middle of the tub and the third sensor is located at the bottom of tub. The top sensor as S1, middle sensor as S2 and bottom sensor as S3. The set of electronic control WLC using electronic circuits with the process of receiving input from sensors, information processing and electronic circuits by directly moving the relay to operate the electric motor as a pump.

Electronic circuit WLC uses, (1) Power Supply 12 volt circuit, (2) a circuit of sensors S1, S2, and S3, (3) a circuit of automatic switch, (4) the circuit actuator. WLC used laboratory scale electronically shown in Figure 4.

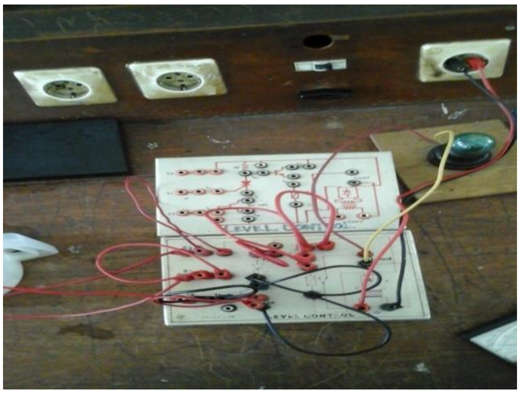

Figure 4. The scale laboratory of WLC circuit

The Figure above is a laboratory scale / real images are arranged in practicing the control of water level. Module used has been provided by the lab and assembled in accordance with the planning. Methods used to connect components to another component using connecting cable. Cable used to connect the active components using the red cable, and for neutral using black cable. The sources used 220-volt AC directly connected to the module. The source then converted by the transformer contained in the module into a 9 volt DC voltage. Water reservoirs simulated using the measuring cup provided in the laboratory.

3. Results and discussion

Experiments performed by measuring electrical quantities related to power supply, sensor detection circuit, the transistor circuit and the SCR as a switch, and the relay circuit to drive an electric pump motor. Lamp 5W / 220V is used as a simulator water pump motor in this experiment.

Testing the overall system is done by testing a circuit of WLC that has been assembled before. WLC consists of three sensors, sensors S1, S2 and S3. S1 is located at the top, S2 located in the middle and S3 located on the bottom. The laying of these sensors has its own function according to the parameters that have been determined. S1 as an indicator that gives a signal that water has been full and S3 as an indicator that gives a signal when the water runs out. Tests conducted to determine how the circuits work, how the transistor active and determine the trigger voltage of the SCR gate.

The transistor will be on when the transistor base get positive currents. When the circuit of works in accordance to the parameters that have been determined, the circuit true. When S3 touches the water, the NPN transistor 1 will be on, current flows and make the relay activate and then the indicator light on. When the NPN transistor 1 is active, the SCR and the NPN transistor 2 off. Table 1 shows the experimental results NPN transistor 1 is active.

Table 1. (Q1 on, Q2 is off, SCR off)

Measuring	Vbe	Vce	Ic	Ie	Vak	Vag	Vkg	Ik	Ig
value	volt		mA		volt			mA	
Q1	0.4	2.5	25	25	X	X	X	X	X
Q2	0	0	0	0	X	X	X	X	X
SCR	X	X	X	X	0.4	0.4	0	0	0

The above table shows that when Q1 on, SCR and Q2 off, the large measurement results on the base-emitter voltage (Vbe) is 0.4 volts, the collector-emitter voltage (Vce) 2.5 volts. The current flowing in the collector and emitter of the same magnitude is 25 mA. The anode-cathode voltage (Vak) and anode-gate (VKG) equal, namely 0.4 volts. While the cathode-gate voltage at 0 volts, and currents cathode and gate 0 mA.

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The conditions when S2 touches the water is, the NPN transistor 2 is almost active, but does not affect the work of the NPN transistor 1, so that the lights stay on. This shows that when the lamp is replaced with a water pump, the water pump will remain on filling the tub. Data experimental results can be seen in Table 2.

Table 2. (ON Q1; Q2 almost ON)

Measuring value	Vce	Vbe	Vrb	Vre	Ic	Ib	Ie
	Volt				mA		
Q1	1.2	0.4	0	2.8	22	0	20
Q2	0	2.8	7.6	10	0	5.5	0

The above table shows that the measurement results in Q1 collector-emitter voltage (Vce) is 1.2 volts, the base-emitter voltage (Vbe) voltage of 0.4 volts and resistor-emitter (Vre) 2.8 volts. The current flowing in the collector is 22 mA and 20 mA current on the emitter. The measurement results in Q2, the base-emitter voltage (Vbe) is 2.8 volts, the voltage across the resistor-base (VRB) 7.6 volts and the voltage-emitter resistor (Vre) 10 volt. The current flowing on the basis is 5.5 mA.

When the water drowning S3, S2 and S1, the gate on the SCR will open. This causes the current flowing in the transistor and transistor NPN1 on NPN2 remaining divided so that the current is not able to activate the relay. Relay inactive cause the lights off, in other words when the lamp is replaced with a water pump, the water pump will stop working. This condition means that transistor NPN1 off, transistor NPN2 on and SCR on. Data from the experiment can be seen in Table 3.

Table 3. \(Q1 off, Q2 on dan SCR on)

Measuring value	Vce	Vbe	Vrb	Vre	Ic	Ib	Ie	Vak	Vag	Vkg	Ik	Ig
	volt				mA	uA	mA		volt		mA	
Q1	9.8	0.4	0	0.3	0	0	0	XX	XX	XX	XX	XX
Q2	0.3	1.8	0.6	0.4	14	4	17.5	XX	XX	XX	XX	XX
SCR	XXX	XXX	XXX	XXX	XX	XX	XX	0.75	1.6	1.8	0.4	0

The above table shows that the measurement results in Q1, colector-emitter voltage (Vce) is 9.8 volts. Base-emitter voltage (Vbe) 0.4 volts, the voltage-emitter resistor (Vre) 0.3 volts. While the resistor voltage-base (VRB), the current collector, base and emitter current currents is 0. The measurement results in Q2, collector-emitter voltage (Vce) 0.3 volts, the base-emitter voltage (Vbe) 1.8 volts, the voltage across the resistor-basis (VRB) 0.6 volts and the voltage-emitter resistor (Vre) 0.4 volts. The current flowing in the collector 14 mA, the base current of 4 mA, and the emitter current 17.5 mA. The results of measurements on the SCR , the anode-cathode voltage (Vak) 0.75 volts, the voltage across the anode-gate (Vag) 1.6 volts, the voltage of the cathode-gate (Vkg) 1.8 volts. The current flowing at 0.4 mA and collector currents at gate 0.

4. Conclusion

Water level control is an electronic circuit that serves to control the water pump that in this study was simulated using lamp for filling water reservoirs using three sensors. These include sensors S1, S2 and S3 will work if the sensor is touched by water. S3 is located at the bottom of the tub, the water touched S3, it will activate the NPN transistor 1 so that the relay works and activates lights (indicator electric motor). When S2 water touches the lights remain on. Furthermore, S1 touched the water causing the current division between NPN transistors 1 and 2, so the current is not able to turn the rest of the relay. Relay does not operate so the lights are off. Results of the experiment showed that light (water pump indicator) will work when the water touched S3 with transistor1 Vbe voltage at 0.4 volts, the voltage at the Vbe transistor2 0 volts and the voltage on the SCR Vak 0.4 volts. Lamp (water pump indicator) would off if S1 touched the water with transistor1 Vbe voltage at 0.4 volts, the voltage at the Vbe transistor2 1.8 volts and the voltage on the SCR Vak 0.75 volts.

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