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Original Research Article

Automatic Indoor Water Dispensing Machine

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ABSTRACT

Most water dispensers available at homes, offices and business places use a manual valve (tap) in dispensing water into a container. This method of water dispensing goes with a lot of challenges as disease can be transmitted through the process, and poisoning is also possible through dangerous chemicals and those suffering from arthritis may not be able to operate the dispenser. This current work proposes an automatic process of dispensing water. In this design, an individual only needs to place the container into the system and water starts dispensing and when the container is removed or filled up, water stops dispensing. This design totally eliminates the challenges faced with the manual dispensing system. The system was tested by placing a container in it and it started dispensing water and when the cup was removed or filled up, it stopped dispensing.

1. INTRODUCTION

A water dispenser is a device that dispenses water. It has become a necessary part of our society because it provides easy access to portable drinking water. Water dispensers are used in residential homes, offices and business areas that do not have ideal drinking water from taps (Newair, 2017). There are different types of water dispensers such as: wall-mounted, point of use, bottom load, tabletop and free-standing water dispenser (Newair, 2017). All these various types of dispensers get their water from different sources but deliver water from the source through a tap or spigot by using a button or knob to dispense the water. The free-standing water dispenser is mostly available in homes, offices and business areas. It makes use of bottled water that is placed upside down on a dispensing machine. A probe is used to puncture the cap of the bottle to allow the water to flow into the machine internal reservoir. The dispensing machine is capable of dispensing lukewarm, chilled, warm and hot water in a controlled manner. This type of water dispensers dispenses water manually by simply pressing a button or turning a knob to release the water into a container (Newair, 2017).

There are two methods employed in dispensing water, which are the manual or automated method. In both methods a valve is used. Valves are devices that manage and coordinate the flow of fluids by opening, shutting, or somewhat impeding different entry ways. The easiest valve is just a freely pivoted fold which

drops to impede fluid flow in one direction. It is pushed open by fluid in the other direction. This is known as a check valve, as it avoids or "checks" the flow in one direction (Guy and Friedmann, 1998).

The manual methods involve the use of a manual tap valve to dispense water. The process involves the application of torque force on the valve by pressing or turning to open and close. However, there are some shortcomings associated with this method. Firstly, energy is lost in opening and closing of the water tap valve. Also, diseases infections can be contacted and transmitted through touch as was recently experienced in the Ebola epidemics that broke out in Nigeria and other parts of West Africa (Ogundipe, 2018). Those suffering from arthritis cannot use the manual system because of the stiffness of their hands. Lastly, there is possibility of the risk of sink overflow due to a tap being left open either inadvertently or deliberately.

The automated method involves the use of an electronic valve in dispensing water. This is basically realized by applying electrical voltage to a solenoid valve. The solenoid valve opens when electric current is applied to the coil while it closes when no electric current is applied to the coil (normally closed solenoid valve). Automatic water dispensers were created in the 1950s but were used for commercial purposes in the 1980s at airport lavatories. They are currently used as a result of their assistive characteristics. This automatic system helps saves 70% of the water that would have been wasted and saves 3-5% of the water used by household (Mac Faucets, 2008).

The hands-free automatic water dispenser is a type of automatic dispenser currently available. It is equipped with a proximity or photoelectric sensors and mechanisms that open its solenoid valve to allow water to flow in response to the presence of a hand or hands in close proximity and close its solenoid valve again after a few seconds or when it no longer detects the presence of hands. Most automatic dispensers are battery powered and incorporate an active infrared sensor to detect hand motion. The hands-free automated water dispenser uses the diffused mode of sensing. In this mode, the transmitter and receiver are in the same housing. Light from the transmitter strikes the target, which reflects lights at random angles. Some of the reflected light is sent back to the receiver, and the object is detected. This mode of sensing is affected by the target's color, size, and finish because these directly affect its reflectivity and therefore its ability to reflect light back to the sensor's receiver (Frigyes et al., 2018).

Despite the advantages of the hands-free water automated water dispenser, there are some major limitations with the system. These include its inability to detect black objects (black object absorbs infrared rays) and transparent objects (transparent object allow passage of infrared ray) due to the arrangement of the sensor. Also, the system is only good for objects that are opaque in nature (object that reflect infrared rays).

Hence, the main aim of this research is to develop an automatic indoor dispensing system which will eliminate the above-mentioned disadvantages associated with the manual and automatic dispensing system while incorporating a good sensing method that will be able to detect all types of objects.

2. METHODOLOGY

Figure 1 shows the block diagram of the automatic water dispenser system. It consists of the following major units: power supply unit, object sensing unit, overflow sensing unit, microcontroller unit and the output unit.

2.1. Power Supply Unit

The power supply unit in Figure 2 consists of a step-down transformer, bridge rectifier, filter and a voltage regulator. The step-down transformer steps down the 220 volts alternating current (AC) from the mains supply to 12 volts AC. The 12 volts AC is rectified to 12 volts direct current (DC) and then filter and

regulated to give a 5 volts DC supply to power the microcontroller and sensors. The 12 volts DC gives power to other parts of the circuit.

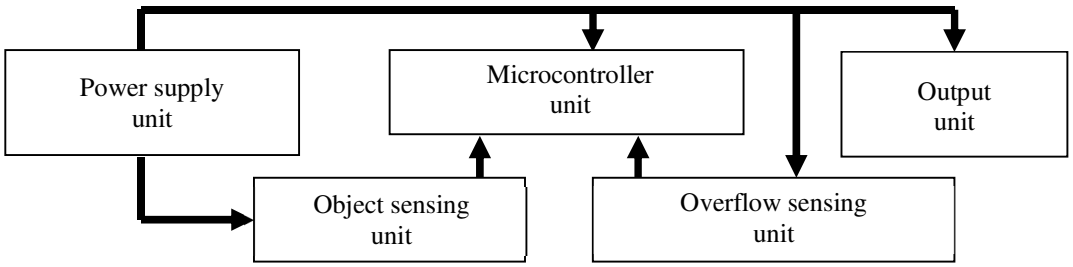

Figure 1: Block diagram of the automatic indoor dispensing system

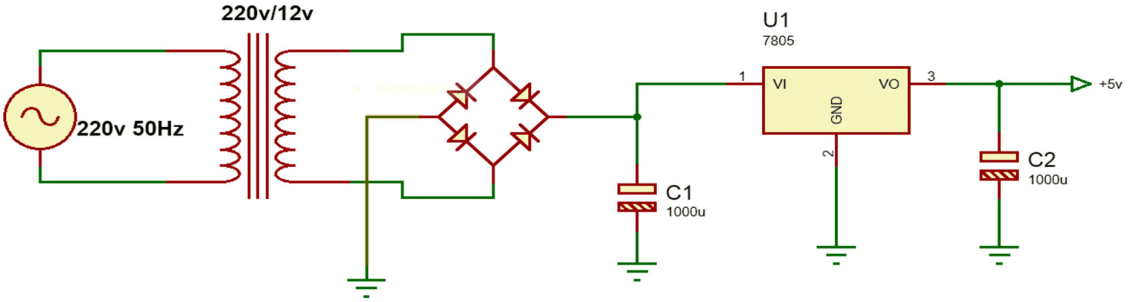

Figure 2: Power supply circuit

2.2. Object Sensing Unit

The object sensing unit comprises of an infrared light emitting diode (LED) and a photodiode as shown in Figure 3. The infrared LED emits ultraviolet rays and transmits it to the photo diode that detects it.

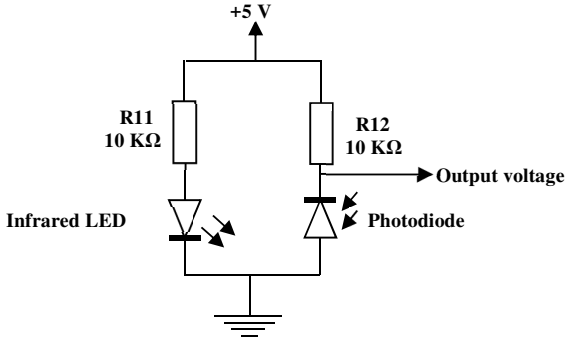

Figure 3: Infrared LED and photodiode arrangement

2.3. Overflow Sensing Unit

The overflow sensing unit Figure 4 consists of flat copper bars that form a complete circuit when water pours on them. When there is an overflow from the container, current flows in the circuit and send a voltage to bias the transistor and a HIGH signal is sent to the microcontroller to close the solenoid valve. The conductive property of water is used in designing the sensor.

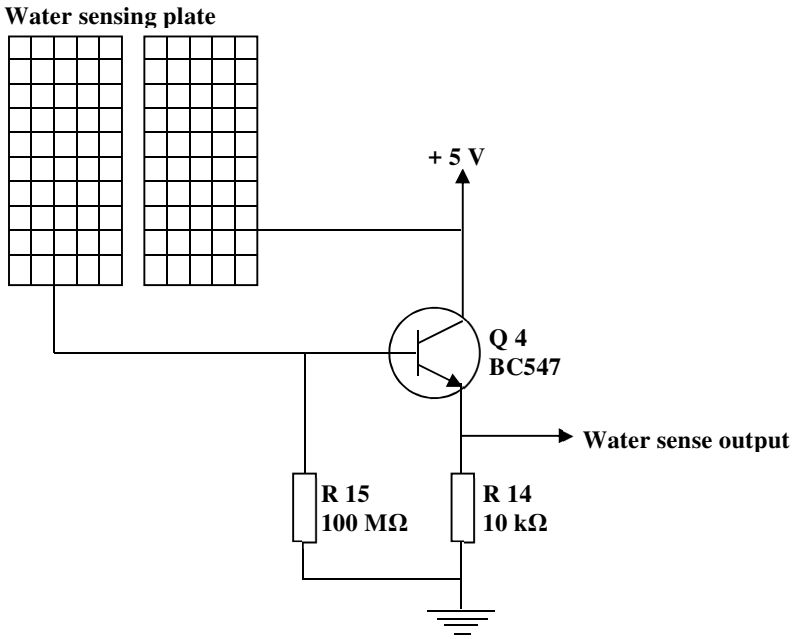

Figure 4: Overflow sensing unit

2.4. Microcontroller Unit

The microcontroller unit interfaces the object sensing unit and output unit. The PIC16f84A microcontroller in Figure 5 was used in this work and it was programmed to receive input from the object sensing unit and act on the input based on the installed program and send signals to operate the output unit.

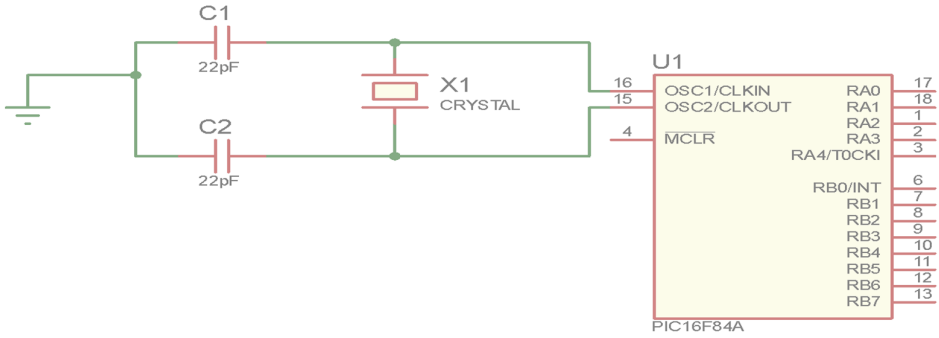

Figure 5: Microcontroller unit

2.5. Output Unit

Figure 6 shows the output unit which is made up of a solenoid valve that is made to open when it receives a high signal and closes when it receives a low signal. The solenoid valve is powered through a relay since the microcontroller cannot deliver the required current directly.

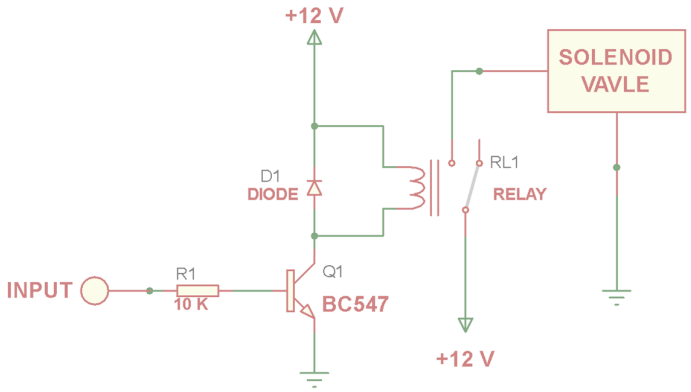

Figure 6: Output unit arrangement

2.6. Flow Chart

The working algorithm of the automatic water dispenser system is represented by the flow chart shown in Figure 7.

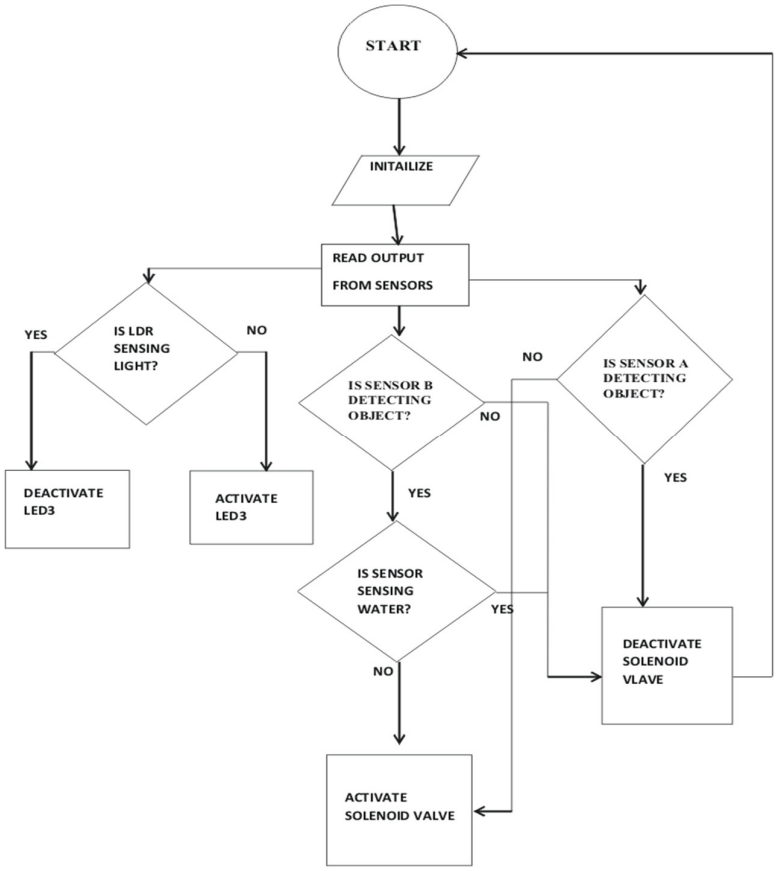

Figure 7: Flow chart of the dispensing machine

2.7. Principle of Operation

The complete circuit diagram of the automatic indoor water dispenser unit is shown in Figure 8. The 12 V AC from the transformer is rectified to 12 V DC and regulated to 5 V DC by a voltage regulator LM7805 (U5) and smoothing capacitor C1 and C2 which help to filter any ripples in the power supply to the microcontroller. Connected to the microcontroller is an 8MHz crystal oscillator which sets the frequency of operation. Pin 1, Pin 17, and Pin 18 of the microcontroller are programmed as input ports. Pin 17 and Pin 18 are connected to the output from the comparator through a pull down 10 kΩ resistor to ground. Pin 1 was connected to the emitter of the transistor Q2 which is the light sensing circuit through a pull down 10 kΩ resistor to ground. The function of the pull-down resistors is to prevent the current from flowing to ground.

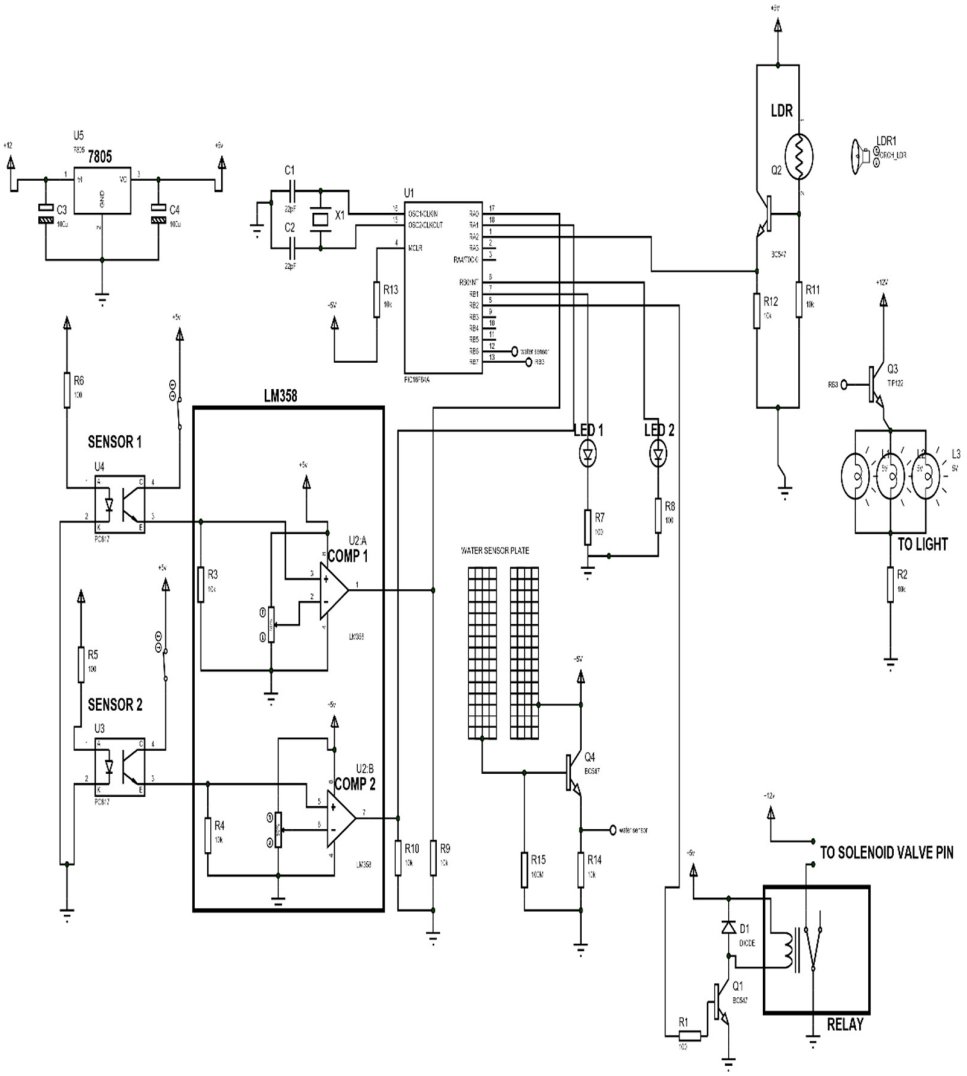

Figure 8: Complete circuit diagram of the automatic indoor water dispenser

Pin 6 and Pin 7 of the microcontroller were configured as the output port to drive the indicator lights LED2 and LED1. Pin 8 of the microcontroller was configured as the output port to bias the base of transistor Q1 which energizes relay RLY1 to switch ON the solenoid valve. Pin 13 was configured as an output port to

bias the base of transistor Q3 which turns ON LED3 when the environment is dark and turns OFF LED3 when the environment is bright. Pin 3 and Pin 5 of the comparator LM358 were used to read analog signal from the sensors. Pin 1 and Pin 7 of the LM358 were used as the digital signal output to the microcontroller. Sensor 1 and Sensor 2 are object detectors, and they detect an object when it is in close range with the sensors. The logic output from the sensors are HIGH when no object is detected and if any of the sensor detect object the logic output is LOW.

When the automatic indoor water dispenser system is switched ON and it is at the default state (state where all the output ports are LOW) and a cup is placed on the dispenser ground level underneath the tap, Sensor 1 and Sensor 2 will be activated and the output Pins 1 and 7 of LM358 send a LOW to the input Pins 17 and 18 of the microcontroller and the microcontroller gives a HIGH at Pin 6 to switch ON LED2. If the cup is raised 2 cm above the dispenser ground level, Sensor 1 is activated and the output Pin 1 of LM358 send a LOW to the input Pin 17 of the microcontroller and the microcontroller gives a HIGH at Pins 7 and 8 to switch ON LED1 and the solenoid valve.

When there is an overflow of water in the container, the water touches the water sensor at the ground level of the dispenser system. The water sensor sends a HIGH signal to the microcontroller through Pin 12 to deactivate the solenoid valve.

Figure 9: Pictorial view of the system under test

3. RESULTS AND DISCUSSION

The system was tested using different containers that fall under three categories as shown in Table 1.

Table 1: Summary of test results

Types of container	Response of the system		
	Inserted	Removed	Overflow
Black	Dispensing	Stop dispensing	Stop dispensing
Transparent	Dispensing	Stop dispensing	Stop dispensing
Opaque	Dispensing	Stop dispensing	Stop dispensing

As seen from the result, when a black container is inserted, the system starts to dispense water into the container and when the cup is removed, it stops. Also, if the black container is allowed to stay in the system till overflow, it will stop dispensing immediately there is an overflow. The same operation is applicable to any other container.

4. CONCLUSION

This work unveils the design and implementation of an automatic indoor water dispensing system. Based on the results obtained from the tests carried out, there is clear evidence that the system will be a better option to the water dispensers presently available in the market that uses manual tap valve. The system when commercialized could be deployed to various areas in the world for usage.

5. ACKNOWLEDGMENT

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6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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