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Design and Simulation of an Automated Motion Sensing Sprinkler System

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Abstract

Sprinkler systems are usually found around both corporate and industrial areas, where they are often used to water lawns. At most times, sprinkler systems operate during working hours. Hence the sprinklers tend to disturb the everyday movement of by-passers (workers and students) by spraying them with water ('water jetting'). This poses a problem to workers' daily activities as they must opt for alternative routes to avoid areas with sprinklers, which is a tedious and inconvenient process. This paper presents the design and simulation of an Automated Motion Sensing Sprinkler System (AMSSS), which automates controlling the spray distance and tilting of water sprinklers upon motion detection to prevent water jetting of workers and students. The presented work is designed to interface between sprinklers and their water supply via water pumps to control the water flow rate and the sprinkler spray distance. Furthermore, it uses a tilt mechanism actuator controlled by a motor to direct water spray area or location. The system is based on Passive Infrared (PIR) sensors, NE 555 timers, and SR latches to detect motion and provide the signals used to control and coordinate the sprinkler spray patterns. The circuit was designed, simulated, and tested in Proteus with positive results.

Keywords: Motion Detection; PIR sensors; Sprinklers; Bi-directional motor control

I. INTRODUCTION

The agricultural sector forms the majority of self-sustaining world economic strategies, which Botswana is of no exception to [1]. However, the sector is not as fruitful primarily due to the semi-arid climate of the country, hence why most farmers have resorted to irrigation systems to supplement the dwindling rainfed agriculture. Botswana's use of irrigation systems dates as far back as the early 1900s, where the drip irrigation was very prominent [1]. The improvement of this sector over the years has enhanced the irrigation systems to not only use the drip type of irrigation but to include the sprinkler, surface, and centre pivot irrigation types. Irrigation systems of late do not solely apply to the agricultural sector but also applicable in most corporate and industrial spaces. As such, it is common to find lawns and fauna in everyday working environments. Since we live in a fast-paced world, we require irrigation systems that can keep plants healthy and hydrated during working hours without hindering the work process in business areas. The two most common irrigation systems used locally are the sprinkler and the drip type irrigation.

Sprinkler systems consist of a network of pipes that contain water under a certain pressure to provide constant water flow. The different mechanical build-up of various sprinklers is determined upon their primary functions in their designated fields. Traditionally sprinkler heads are grouped into two types based on the method they use to distribute the water; spray type and rotor type sprinklers. Also, a sprinkling system may either be above ground head set up where a sprinkler head is simply inserted onto a hose or an in-ground and automated [2], [3]. A typical sprinkler irrigation system has a pump unit propelled by a running motor, transmission lines, and sprinklers. A pump unit takes water from the source and provides adequate pressure for delivery into the pipes or transmission lines until it reaches the sprinklers. Moreover, some systems offer a tilting detector to adjust the direction of motion [4]. The mostly used sprinkler is the rotary because it covers a greater area and provides good water retention into the plants [5]. Existing motion-sensing sprinklers are the pest deterrent type, designed to scare pests away. They work by detecting motion and/or heat passing through their sensor range. Automatic sprinklers are fundamentally simple in their design [6]. They consist of a base, a garden hose, an infrared motion sensor, and some night detection modes. These sprinklers may either be battery-operated or solar-powered, where they store energy in the rechargeable batteries [7], [8].

Figure 1: A wet walkway in BIUST

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The Botswana International University of Science and Technology (BIUST) is a corporate institution refurbished with lawns and plants for aesthetics. These lawns are usually found along pavements that lead to significant buildings within the school, such as the Administration Block and Cafeteria, and are accompanied by sprinkler systems. At most times, sprinkler systems operate during working hours tend to disturb the everyday movement of by-passers (workers and students) by spraying them with water ('water jetting'). This poses a problem to the daily activities of workers as they must opt for alternative routes to avoid areas with sprinklers, which is an inconvenience and wastes time. Fig. 1 shows an example of wet water sprayed walkway in BIUST.

This research aimed to design and simulate an Automated Motion Sensing Sprinkler System (AMSSS), which can automate the process of controlling the spray distance or area and tilting of water sprinklers upon motion detection to prevent water jetting of workers and students.

The system was intended to interface between sprinklers and their water supply via water pumps to control water flow rate and hence the sprinkler spray area. It also uses a tilt mechanism actuator controlled by a motor to direct water spray area and Passive Infrared (PIR) Sensors to detect motion and provide the signals used to control the sprinkler spray pattern.

The remainder of the paper is organized as follows. Section 2 discusses materials and methods, with emphasis on technical specifications and the design of the automated motion-sensing sprinkler system. Section 3 presents the results of how the system works, using different scenarios, while Section 4 concludes the paper.

II. MATERIALS AND METHODS

The Automated Motion Sensing Sprinkler system (AMSSS) is designed to prevent water jetting of workers and students by controlling sprinklers' spray pattern based on people's motion as they pass by the operating water sprinklers. The system comprises five sub-systems: power supply, sensor system, timing system, switching system, and motor controller system, as shown on the block diagram in Fig 2. The method of operation of the AMSSS is centered around changing the spray pattern of sprinklers based on; 1) Use of motion detection sensors to detect human motion, 2) A water pump motor to vary the water spray area of a sprinkler by reducing water pressure going to the sprinkler head, 3) A sprinkler head tilt mechanism to change the spray location being targeted by the water sprinkler and 4) Timers to control how long each operation takes. Fig. 3 shows the spray pattern used by AMSSS to prevent the water jetting of workers and students.

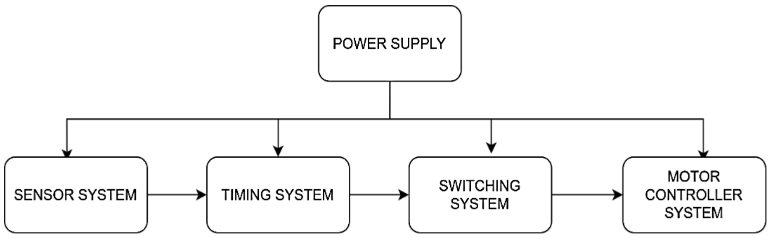

Figure 2: Block Diagram for the AMSSS Primary Sub-systems Composition

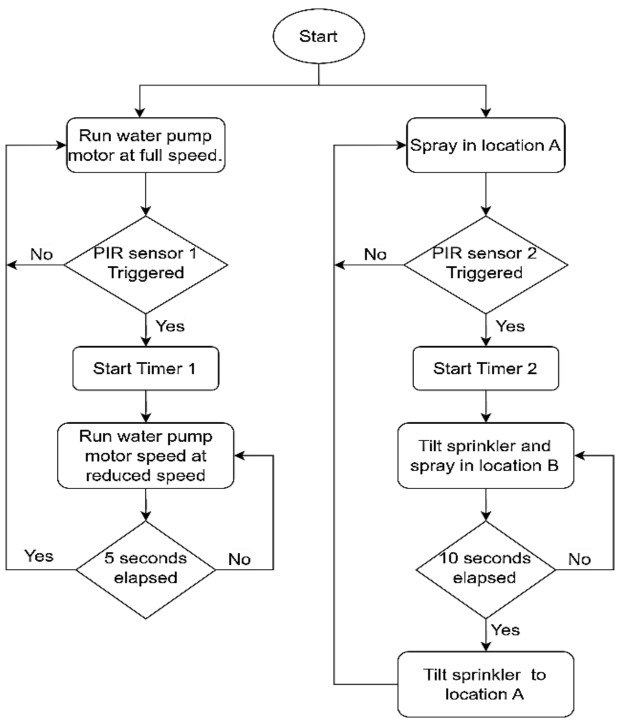

Figure 3: AMSSS sprinkler spray pattern

I. Power Supply

The power supply is a dual power supply with two 12V batteries connected in series with the centre tap as ground. It provides +12V (VDD), ground (GND), and -12V (VEE) DC power to the sub-systems in the circuit. The negative voltage, -12V, is a requirement to power the Half H-bridge motor driver that is used to control the spinning direction of the system's motor. The power supply circuit is shown in Fig. 4.

II. Sensor System

The function of the Sensor Circuit is to detect motion and trigger (initiate) the spray patterns required to prevent water jetting of workers and students when they pass by operating sprinklers. It consists of two Passive Infrared (PIR) sensors; PIR sensor 1 and PIR sensor 2, as shown in Fig. 3 and Fig. 4. The Automated Motion Sensing Sprinkler system uses PIR Motion Sensors because they are economically efficient, have low power usage, and are easy to interface with [5]. Each PIR motion sensor has three terminals; the first for the positive power supply, VDD, the second for the ground, GND, and the last pin is to output the signal given off by the sensor. The amount of heat radiation emitted by a body or object to the sensors induces current to flow, and a positive differential change is induced [7], [9]. When any object passes near the sensor, its resistor voltage spikes up, and a high signal from the sensors is given out. Therefore, the two PIR sensors function as switches to the overall circuit once motion is sensed.

III. Timing System

The Timing System of AMSSS has two timing circuits, Timer circuit 1 and Timer circuit 2, as shown in Fig. 4 and Fig. 5, respectively. The two-timer circuits are used to coordinate and time the water sprinkler's spraying patterns based on the flow chart in Fig 3.

Both circuits are based on the use of a 555 timer in the monostable state to provide a timed one-shot voltage pulse signal to indicate the elapse of a specified amount of time-based on calculations using Equation 1.

$$\tau = 1.1RC \tag{1}$$

i. Timer Circuit 1

The role of Timer circuit 1 is to control how long the sprinkler water pump runs at a reduced speed and hence the size of the water sprinkler spray distance. A signal triggers timer circuit 1, PIR_1 from PIR sensor 1, and its output signal, RELAY_1, is used by Motor 1 Speed Controller to select the water pump motor speed. The time taken to run the water pump at reduced speed is calculated using Equation 1 as:

$$\tau = 1.1 \times 100K \times 45uF$$

$$\tau = 5seconds$$

Where; R is the resistance, R13

C is the capacitance, C8

ii. Timer Circuit 2

The role of Timer circuit 2 is to control how long the water sprinkler stays tilted before returning to the initial tilt position, and hence it affects the water spray location. A signal triggers timer circuit 2, PIR_2 from PIR sensor 2 and its output signal, TRO is used by Motor Start_Stop to control when the tilt mechanism tilts the motor. Before the signal timer circuit 1 reaches the relay, it passes through a falling-edge detection circuit, an inverter, and a transistor switch to ensure that the motor only starts tilting after PIR sensor 2 is triggered. The calculated time for the tilt mechanism motor is shown as:

$$\tau = 1.1 \times 100K \times 45uF$$

$$\tau = 5seconds$$

Where; R is the resistance, R5

C is the capacitance, C6

IV. Switching System

The Switching System comprises of three sub-systems; Motor 1 Speed Controller, Motor Start Stop, and Switching Sub-Circuit. Each sub-system is explained below.

i. Motor 1 Speed Controller

The Motor 1 Speed Controller shown in Fig. 4 is a sub-system responsible for generating and selecting the water pump motor speeds and hence the size of the water sprinkler spray area. Its main components are a NE555 timer IC that is used in a-stable mode and a relay switch. The NE555 Timer generates a Pulse Width Modulated (PWM) signal with an adjustable Duty Cycle which can be adjusted via a potentiometer. The higher the duty cycle, the faster the motor speed, and hence the larger the spray area.

The Duty Cycle [7] of the PWM signal calculated below as:

$$DutyCycle = \frac{ONtime}{ONtime + OFFtime} \times 100\% \tag{2}$$

$$Duty\ Cycle = \frac{0.0708s}{0.0708s + 0.0693s} \times 100\%$$

$$Duty\ Cycle = 50.5\%$$

$$ONtime = 0.693(R_1 + R_2)C \tag{3}$$

$$ON\ time = 0.693\ (2.2K + 100K) \times 1\mu F$$

$$ON\ time = 0.0708s$$

$$OFFtime = 0.693(R_2)C \tag{4}$$

$$OFF\ time = 0.693\ \times 100k\ \times\ 1\mu F$$

$$OFF\ time = 0.0693s$$

The relay switch is used to select between the generated PWM signal of an adjustable duty cycle for low motor speeds and a 100% duty cycle signal based on the 12V power supply for full motor speed. This is achieved by connecting the relay terminals such that the full speed signal is in the Normally Closed (N/C) position. The low-speed signal to the Normally Open (N/O) position, and the output signal, MOTOR_OUT, going to the Motor Controller 1 in the Common (COM) position. By default, the relay is normally closed (N/C); therefore, the water

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pump runs at full speed. When a signal triggers the relay switch, RELAY_1 from Timer circuit 1, the relay contacts switch to the normally open (N/O) position, and the motor runs low.

ii. Motor Start Stop

The Motor Start Stop sub-system, shown in Fig. 5, indirectly controls the motor's starting and stopping to turn the sprinkler tilt mechanism. It comprises of an SR latch and two OR Gates. The OR Gates Set and Reset SR Latch is based on the Switching circuit's input signals, PIR sensor 2, and Timer circuit 2. The output signal, RELAY_2 of the SR latch, is used as an input signal to Motor Controller 2 to start or stop the tilt mechanism motor from turning. The SR latch output signal is Set to high when either PIR sensor 2 is triggered by motion or when the time set on Timer circuit 2 elapses. The output signal of the SR latch is Reset to Low when either Button Left (BL) or Button Right (BR) is of the Switching sub-circuit is pressed.

iii. Switching Sub-Circuit.

The switching sub-circuit, as shown in Fig. 5 is made up of two pull-down pushbuttons that form part of the tilt mechanism used to control the sprinkler spraying locations. Each button is positioned such that it is pressed and produces a high voltage signal when the motor is rotating the sprinkler tilt mechanism until it has reached one of the two spraying locations: location A or location B.

V. Motor Controller System

The system consists of two motor controllers: Motor controller 1 and Motor controller 2 as shown in Fig. 4 and Fig. 5, respectively.

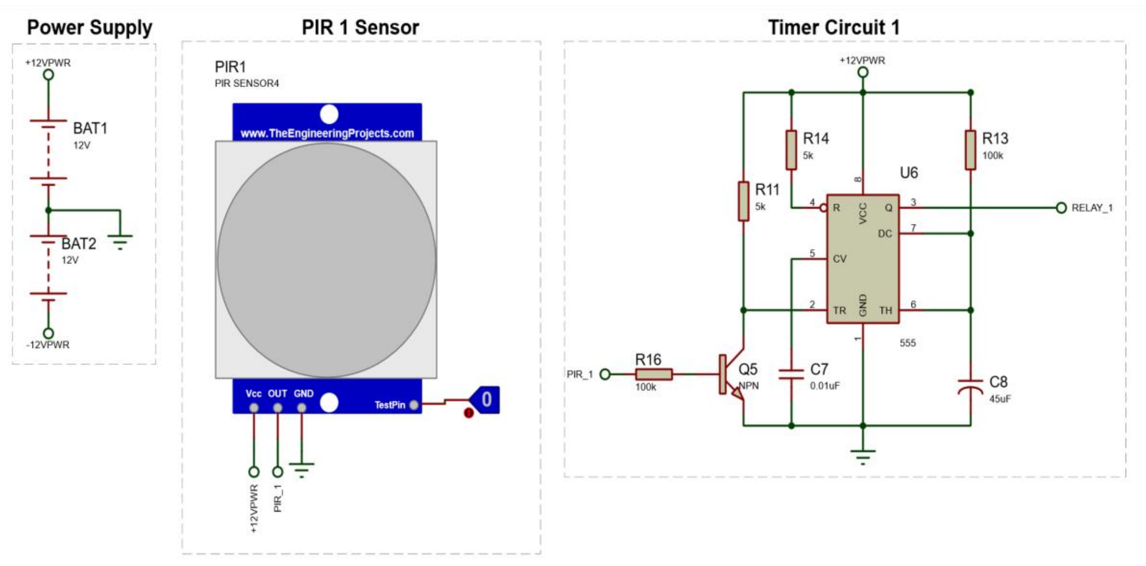
i. Motor Controller 1

Motor Controller 1 is responsible for driving the water pump motor, M1, used to control the water pressure going to a sprinkler head by adjusting the speed of the motor and thereby changing the sprinklers water spray distance. It consists of an NPN transistor working as a switch, a resistor, and a diode to prevents back EMF generated by the motor. The water pump motor's speed depends on the duty cycle of the input signal, MOTOR_OUT from Motor 1 speed controller. When the input signal duty cycle is low, the motor speed is also low. Hence the pump speed is reduced and the sprinklers disperse water at a lesser distance.

ii. Motor Controller 2

Motor Controller 2 is responsible for driving the motor, M2, used in the sprinkler tilt mechanism. The motor controller consists of an SR memory Latch, a half H-Bridge motor driver, a relay switch, and two LEDs. The combination of an SR latch and half H-bridge motor driver controls the direction in which the tilt mechanism motor turns. The relay switch turns the motor ON or OFF based on the input signal, RELAY_2, from the Motor start-stop circuit. The input from the Switching Sub-Circuit either Sets or Resets the Latch output. The half H-Bridge motor driver is used to direct current flow to the tilt mechanism motor based on the driving gate voltage. It comprises two metal-oxide-semiconductor field-effect transistors (MOSFETs). The PMOSFET connects to the positive power rail VDD while the NMOSFET connects to the negative power rail VEE [10], [11], [12], [13], [14].

When the gate voltage is low, the PMOSFET switches ON, and current flows from VDD to GND. Therefore the motor turns clockwise (sprinkler head tilts towards location B). When the H-bridge's driving voltage is high, current flows from GND to VEE and turns the motor in a counter-clockwise direction (reversing sprinkler head to default position; location A). The ability of the Half H-bridge to carry out the latter tasks depends on the SR Latch output. When the SR latch is Set (high output state), its output propels the motor to run in one direction, and when Reset (low output state), it runs in the opposite direction. The Motor Start and Stop Circuit connects to the second part of the relay and drives the motor. The second relay then runs the motor when it is normally open (N/O). The two LEDs are driven along with the motor and indicate whether current is flowing in the circuit or the direction in which the motor is turning.



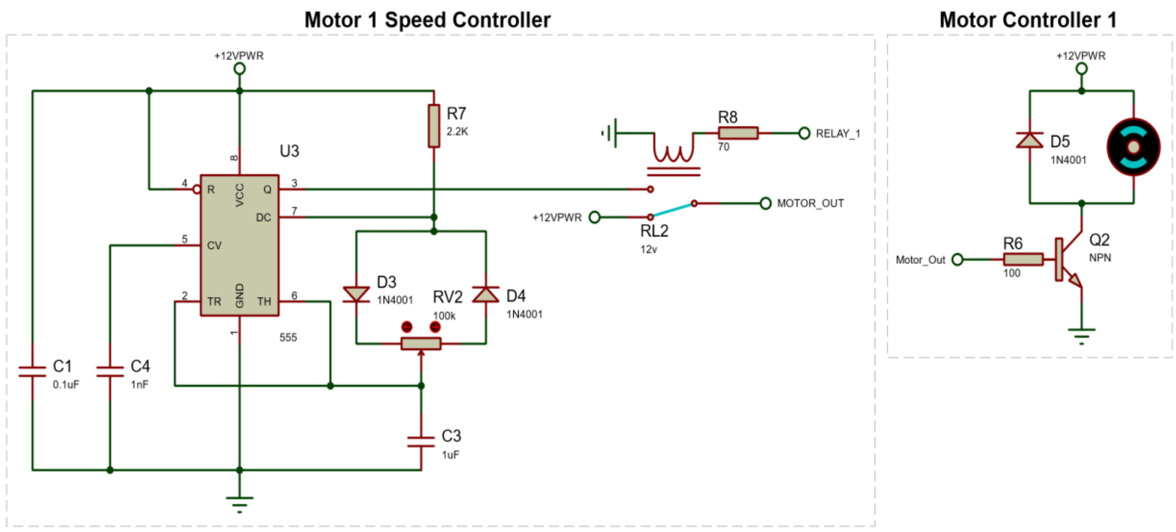


Figure 4: Complete circuit diagram for the AMSSS A

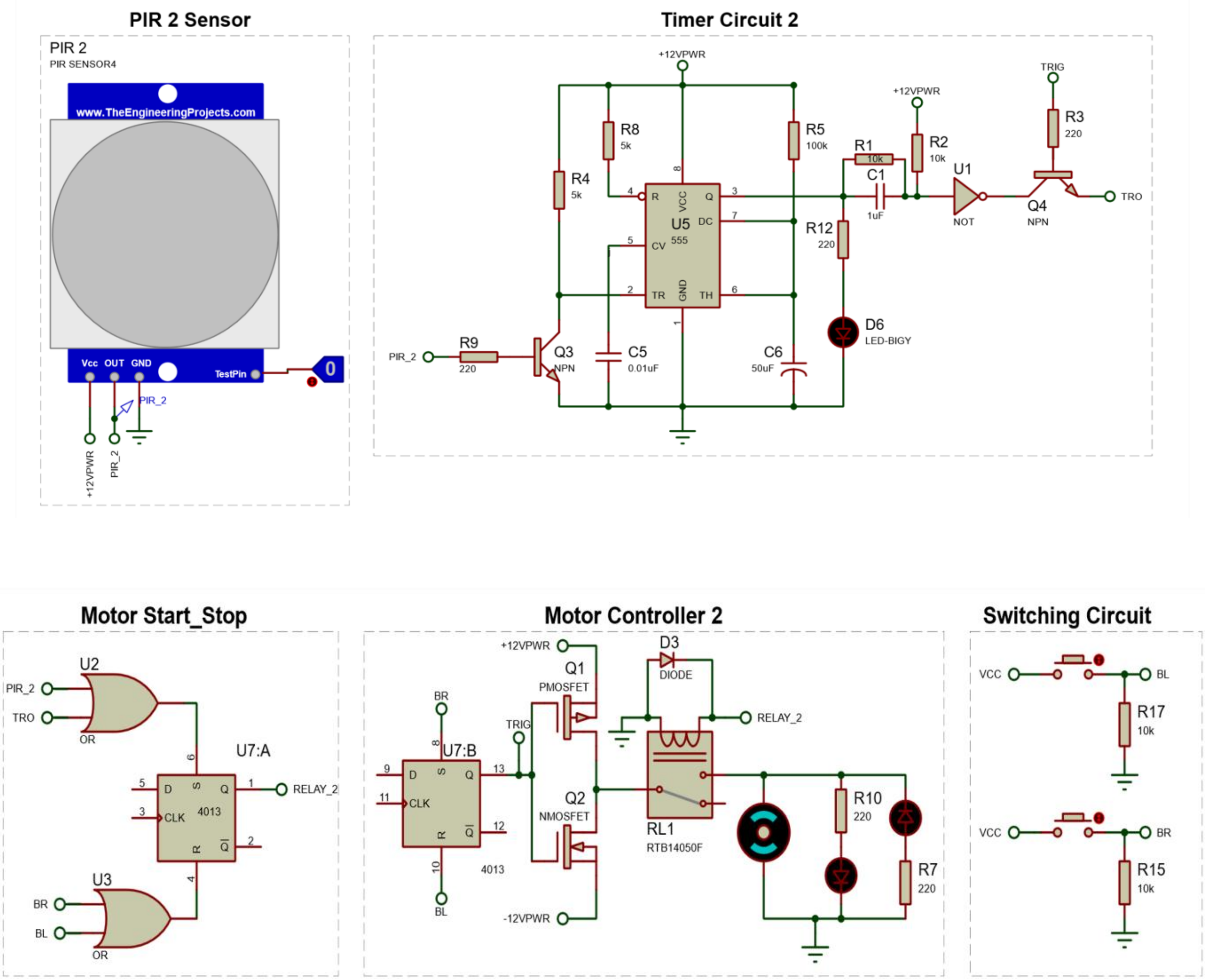


Figure 5: Complete circuit diagram for the AMSSS B

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III. RESULTS AND DISCUSSION

The aim of the work was to design a system that could interface between the water supply and a sprinkler to control its spray distance and its spray location upon motion sensing. In the implementation of the system, it is anticipated that the two PIR sensors are placed some distance apart and such that each sensor can detect human motion on a selected pathway. Furthermore, PIR sensor 1 is placed such that it detects motion before PIR sensor 2. The AMSSS operates as follows:

i. PIR 1 Inactive State (No Motion Detected)

When there is no heat signature is detected across PIR Sensor 1, its output signal, PIR_1, is expected to be less than the biasing voltage, 0.7V required to turn on the BC547 NPN transistor in Timer circuit 1. The transistor is, therefore, in the cut-off region (OFF) and acts as an open switch. When the transistor is OFF, the voltage at the trigger pin (Pin 2) of the NE555 monostable Timer is pulled up by resistor R11, and the voltage is expected to be higher than 2/3 of VCC, hence the output signal at pin 3 of the Timer circuit 1, RELAY_1 is expected to be low (OFF).

Subsequently, the Motor 1 speed controller's relay is OFF, and the signal on the N/C terminal is connected through the relay contacts to the COM terminal. Consequently, this connects the input signal, MOTOR_OUT, of Motor controller 1 to the 100% duty cycle signal based on the 12V power supply. This leads to the controller driving the water pump continuously at full speed, hence the water sprinkler spraying water at the normal (large) spray distance.

towards the relay.

ii. PIR 1 Active State (Motion Detected)

Heat signatures are detected across PIR Sensor 1 and its output signal, PIR_1 is expected to be much higher than the biasing voltage, 0.7V required to turn on the BC547 NPN transistor in Timer circuit 1. Therefore, the transistor is in the saturation region (ON) and acts as a closed switch. When the transistor is ON, the voltage at the trigger pin (Pin 2) of the NE555 monostable Timer is connected to the ground through the transistor, and the voltage is expected to be less than 1/3 of VCC. Hence the Timer is triggered, and the output signal at pin 3 of the timer circuit 1, RELAY_1, is expected to be momentarily high (ON) for 5 seconds. Subsequently, the Motor 1 speed controller's relay is turned ON, and the signal on the N/O terminal is connected through the relay contacts to the COM terminal. Consequently, this connects the input signal, MOTOR_OUT, of Motor controller 1 to the PWM signal generated by the NE555 Timer in Motor 1 speed controller. The generated signal is expected to have a duty cycle of less than 100%, and this leads to the controller driving the water pump at low speed hence the water sprinkler spraying water at a smaller spray distance. The motor is expected to run at low speed until the 5 seconds have elapsed and then switch back to full speed, hence normal spray distance.

Fig. 6 and Fig. 7 show the state of the Motor controller 1 when no motion is detected across PIR sensor 1 and when the sensor has detected motion.

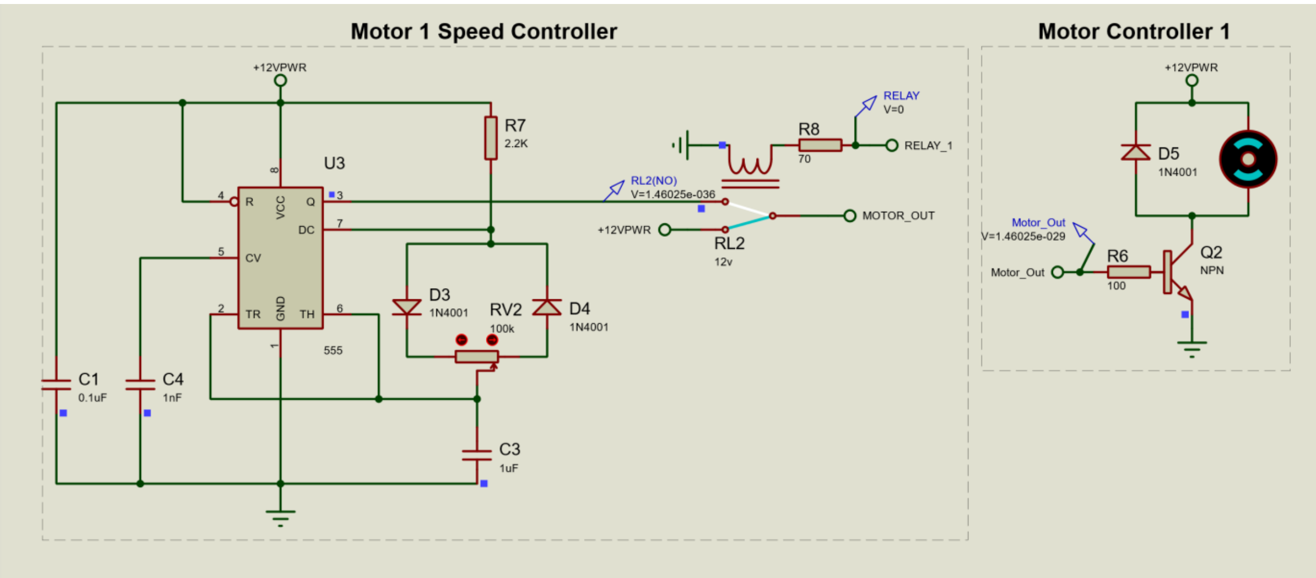

Figure 6: Motor Running at Full Speed (No Motion Detected)

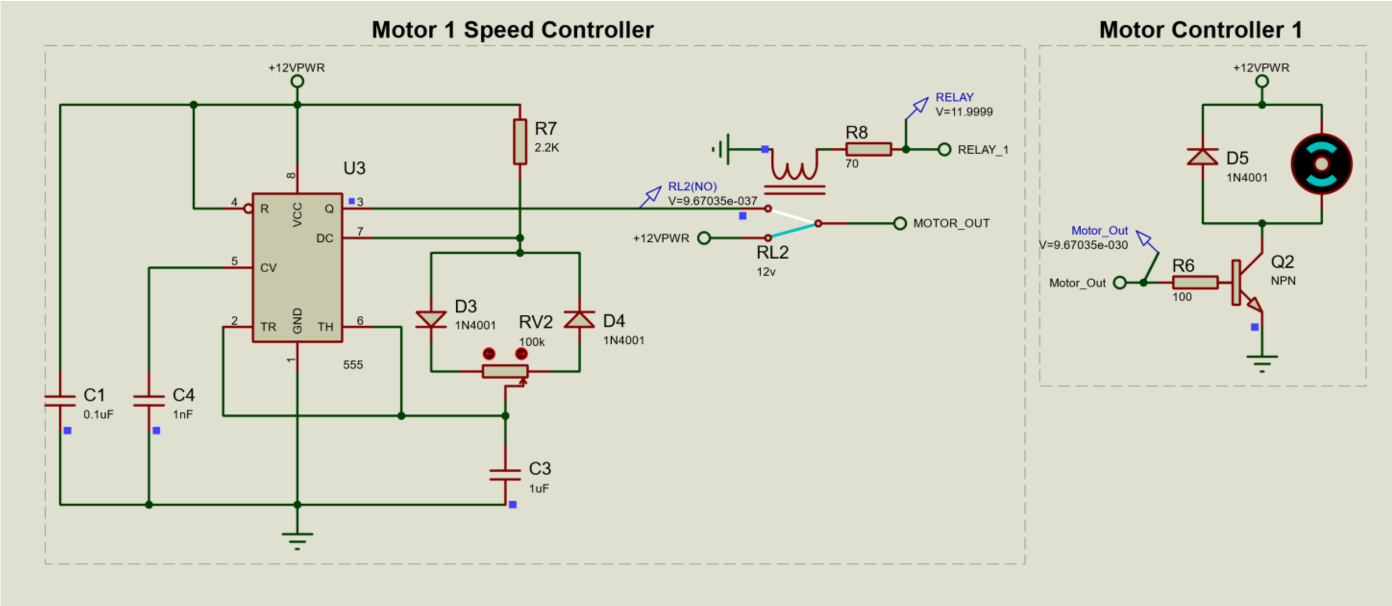

Figure 7: Motor Running at Modulated Speed (Motion Detected)

iii. PIR 2 Inactive State (No Motion Detected)

It is assumed that all SR latches are RESET at first powering on of the AMSSS; hence their output signals are low. Consequently, at power on, the output signal, TRIG of the SR latch in Motor Controller 2 is low, and the output signal, RELAY_2, of the Motor Start Stop circuit, is also low. When there is no heat signature detected across PIR Sensor 2, its output signal, the voltage at the PIR_2 is expected to be less than the voltage required to SET the SR latch in the Motor Start_Stop circuit. Also, less than the biasing voltage (0.7V) needed to turn on the BC547 NPN transistor in Timer circuit 2. The transistor is, therefore, in the cut-off region (OFF) and acts as an open switch. When the transistor is OFF, the voltage at the trigger pin (Pin 2) of the NE555 monostable Timer is pulled up by resistor R4 and the voltage is expected to be higher than 2/3 of VCC, hence the output signal at pin 3 of the NE555 Timer circuit 2 is expected to be low (OFF). The signal then passes through a falling edge detector and is inverted by the NOT gate. The combination of the falling edge detector and the NOT gate ensures that the emerging signal is momentarily high only when the NE555 timer signal has a falling edge. Furthermore, since the output signal, TRIG, of SR latch in Motor Controller 2 is low, the transistor switch in Timer circuit 2 is in the cut-off region (OFF). Hence the emerging signal from the NOT gate is blocked, and TRO is expected to be low. Both the Motor Start Stop circuit SR latch inputs are low; hence, the signal RELAY_2 remains low. Consequently, relay RL1 of Motor Controller 2 is not magnetized and remains in an N/C state, failing to turn on the motor. Therefore, the sprinkler head remains in its default position, spraying water in location A.

iv. PIR 2 Active State (Motion Detected)

It is assumed that at first powering on of the AMSSS, all SR latches are RESET. Hence their output signals are low. Consequently, at power on, the output signal, TRIG of the SR latch in Motor Controller 2 is low, and the output signal, RELAY_2, of the Motor Start Stop circuit, is also low. When a heat signature is detected across PIR Sensor 2, its output signal, PIR_2, is expected to be more than the voltage required to SET the SR latch in the Motor Start_Stop circuit. Hence the output signal RELAY_2 goes high (ON).

Consequently, relay RL1 of Motor Controller 2 is magnetized and switches to N/O state hence connecting the motor to the half H-bridge driver. The gate voltage of the half H-bridge is low. Accordingly, the PMOSFET switches ON, and current flows from VDD to GND. Therefore the motor turns clockwise (sprinkler head tilts towards location B). The sprinkler head tilts until it trips an actuator switch (BL pushbutton) and triggers three events. Firstly, it RESETS the Motor Start Stop SR latch, causing the sprinkler to come to a stop and disperse water in location B. Secondly, the SR larch of Motor Controller 2 is SET of which then activates the half H-bridge N-MOSFET and thereby preparing the tilt mechanism motor to spin in the anticlockwise (sprinkler head tilts towards location A) direction. Thirdly, it turns on the transistor switch that connects the signal TRO of Timer circuit 2 to the NOT gate's output.

Simultaneously, motion is detected across PIR Sensor 2, its output signal, PIR_2, is expected to be more than the biasing voltage, 0.7V required to turn on the BC547 NPN transistor in Timer circuit 2. Therefore, the transistor is in the saturation region (ON) and acts as a closed switch. When the transistor is ON, the voltage at the trigger pin (Pin 2) of the NE555 monostable Timer is connected to the ground through the transistor. The voltage is expected to be less than 1/3 of VCC. Hence the output signal at pin 3 of the NE555 Timer circuit 2 is expected to be momentarily high (ON) for 5 seconds before dropping to low(OFF) after the time elapsed. By the time 5 seconds has elapsed, the sprinkler is spraying in location B and ready to tilt to location A. The falling edge of the NE555 is detected by the falling edge detector and is inverted by the NOT gate. This causes SR latch of the Motor Start Stop to be SET and in turn, start the tilt mechanism motor to spin in the anticlockwise (sprinkler head tilts towards location A) direction.

The sprinkler head tilts until it trips an actuator switch (BR pushbutton) and triggers three events. Firstly, it RESETS the Motor Start Stop SR latch, causing the sprinkler to come to a stop and disperse water in location A. Secondly, the SR larch of Motor Controller 2 is RESET of which then activates the half H-bridge P-MOSFET and thereby preparing the tilt mechanism motor to spin in the anticlockwise (sprinkler head tilts towards location B) direction. Thirdly, it turns OFF the transistor switch that connects signal TRO of Timer circuit 2 to the NOT gate's output. Therefore, the sprinkler head remains in its default position, spraying water in location A until PIR sensor 2 is triggered again.

Fig. 8 shows Motor controller 2 when there is no motion detected across PIR sensor 2, while Fig. 9 and Fig. 10 show the state of the controller when the sensor has detected motion. In both cases, the AMSSS will continuously supply water to the sprinkler and repeat the same spray pattern until the system is manually shut off.

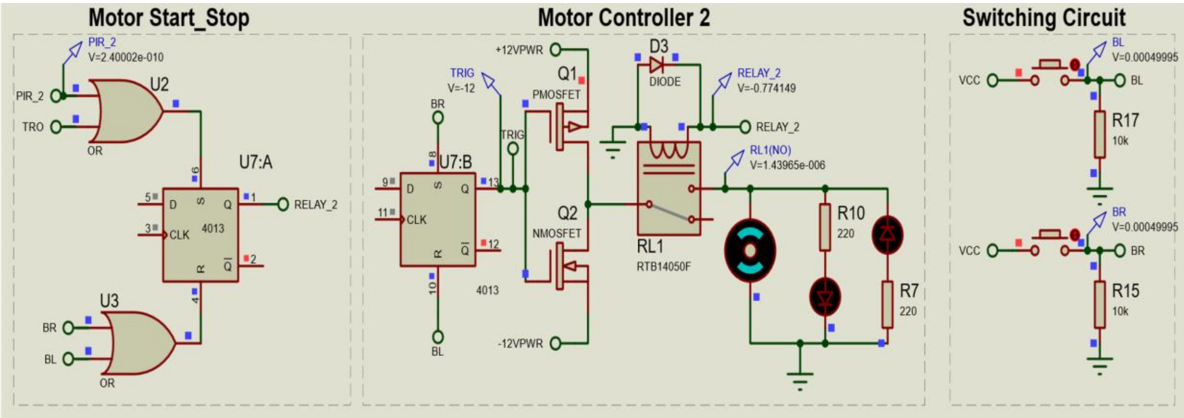

Figure 8: Sprinkler head pointing at location A (No Motion Detected)

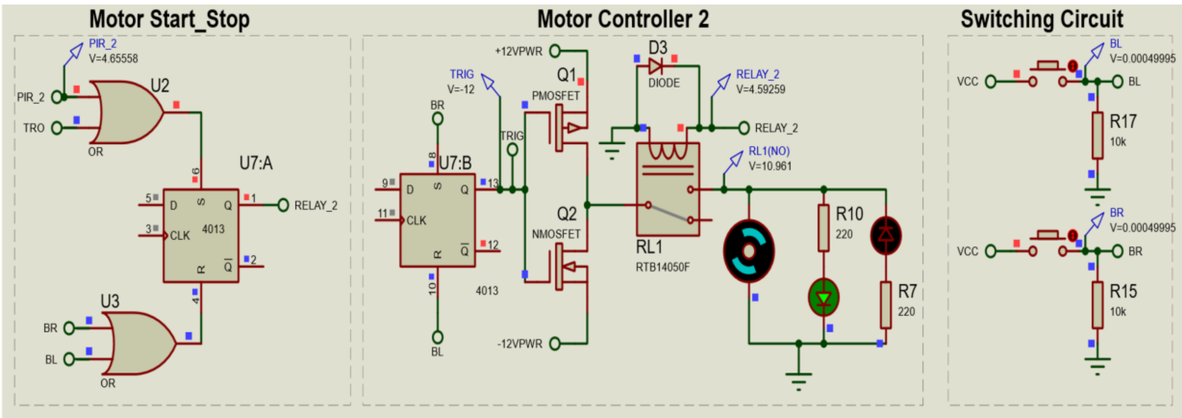

Figure 9: Clockwise Motor Direction Shown by Green LED (Tilting towards location B)

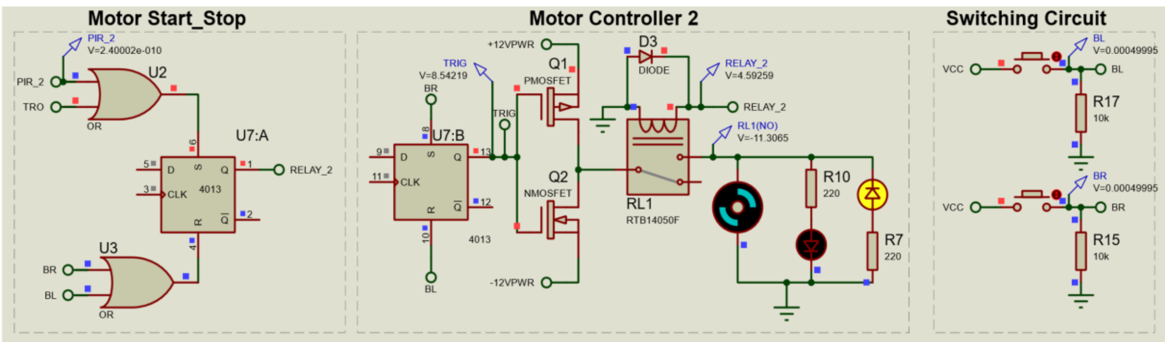

Figure 10: Anticlockwise Motor Direction Shown by Yellow LED (Tilting towards location A)

The designed system was tested in Proteus to determine if it met its intended functions and the design requirements. Different sub-sections were scrutinized in Proteus to determine their capability to meet design requirements, as shown below.

i. Motor Rotation

For the sprinkler head to fulfill its bi-directional control, it was required that it could turn the motor both clockwise and counter-clockwise. Providing a 12V DC battery supply and pressing BL and BR pushbuttons tested the system's capability to power the motor for both rotations.

Fig. 9 shows that the motor was able to rotate clockwise, as shown in the GREEN LED turning ON with a +10.96V, which was different from the expected +12V. Fig. 10 also showed that the motor could rotate counter-clockwise, indicated by the YELLOW LED with a -11.30V, which varied from the -12V expected. Therefore, the requirements of the bi-directional motor control were met but at lower voltage values.

ii. Timer Circuits

The circuits were designed to turn OFF and ON the motor for a pre-set period by using a 555 timer to activate the relay that powers the motor. PIR Sensor 1 was triggered to determine whether the motor turn the motor ON for 5 seconds, and PIR Sensor 2 was triggered to determine whether the motor can be turned from location A to location B and back within the 5-second time frameset.

Fig. 11 shows that the Motor 1 (M1) was able to turn Off for approximately 5.98 seconds. Whereas, Fig. 12 shows that Motor 2, M2 was also able to rotate both clockwise and anticlockwise for 6.77 seconds. The differences between the desired and the recorded were due to the human error experienced when pausing the simulation. Therefore, the performance requirements for both timer circuits were met.

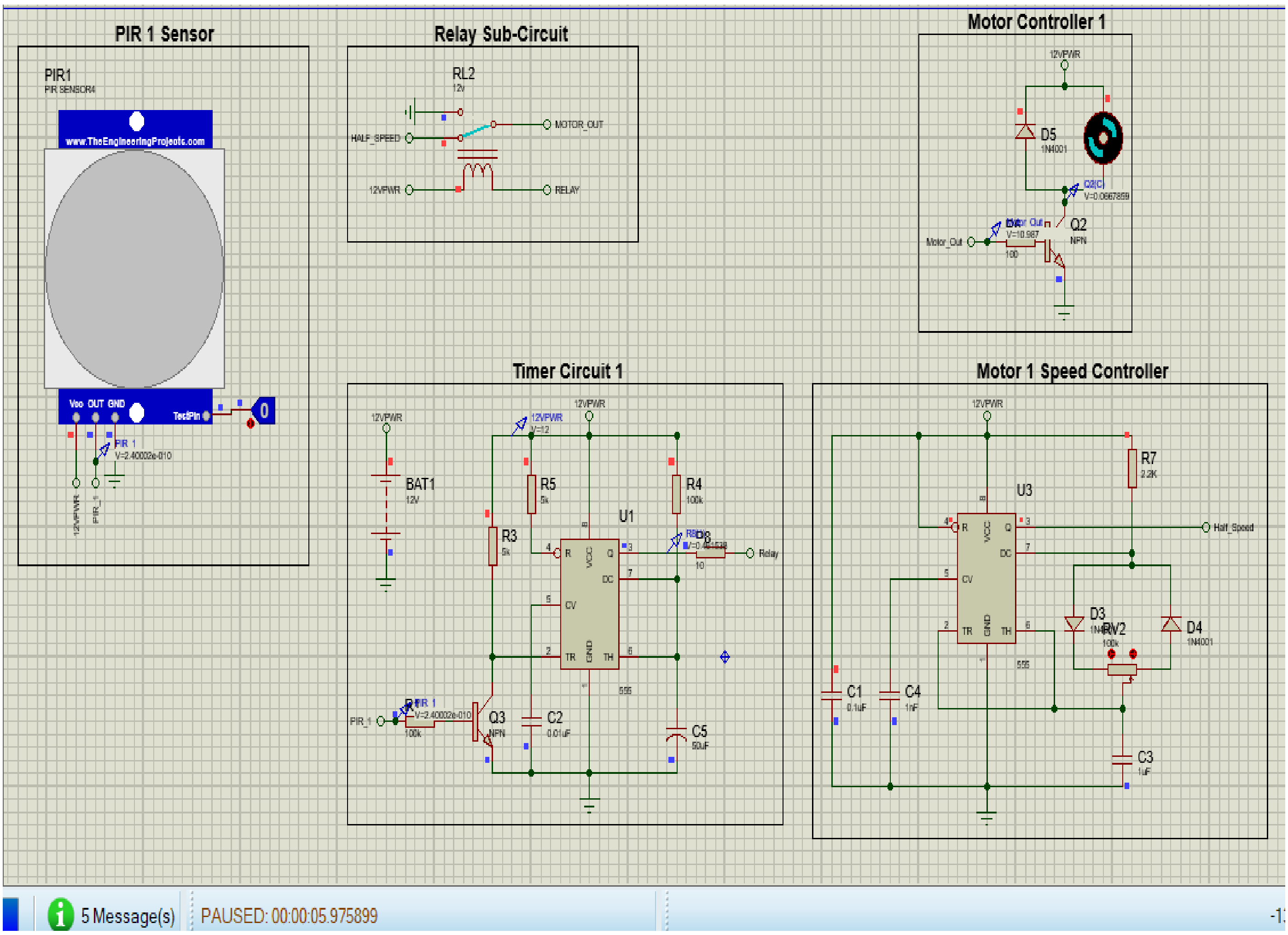

Figure 11: Timer Circuit 1 Used to Run the Motor 1

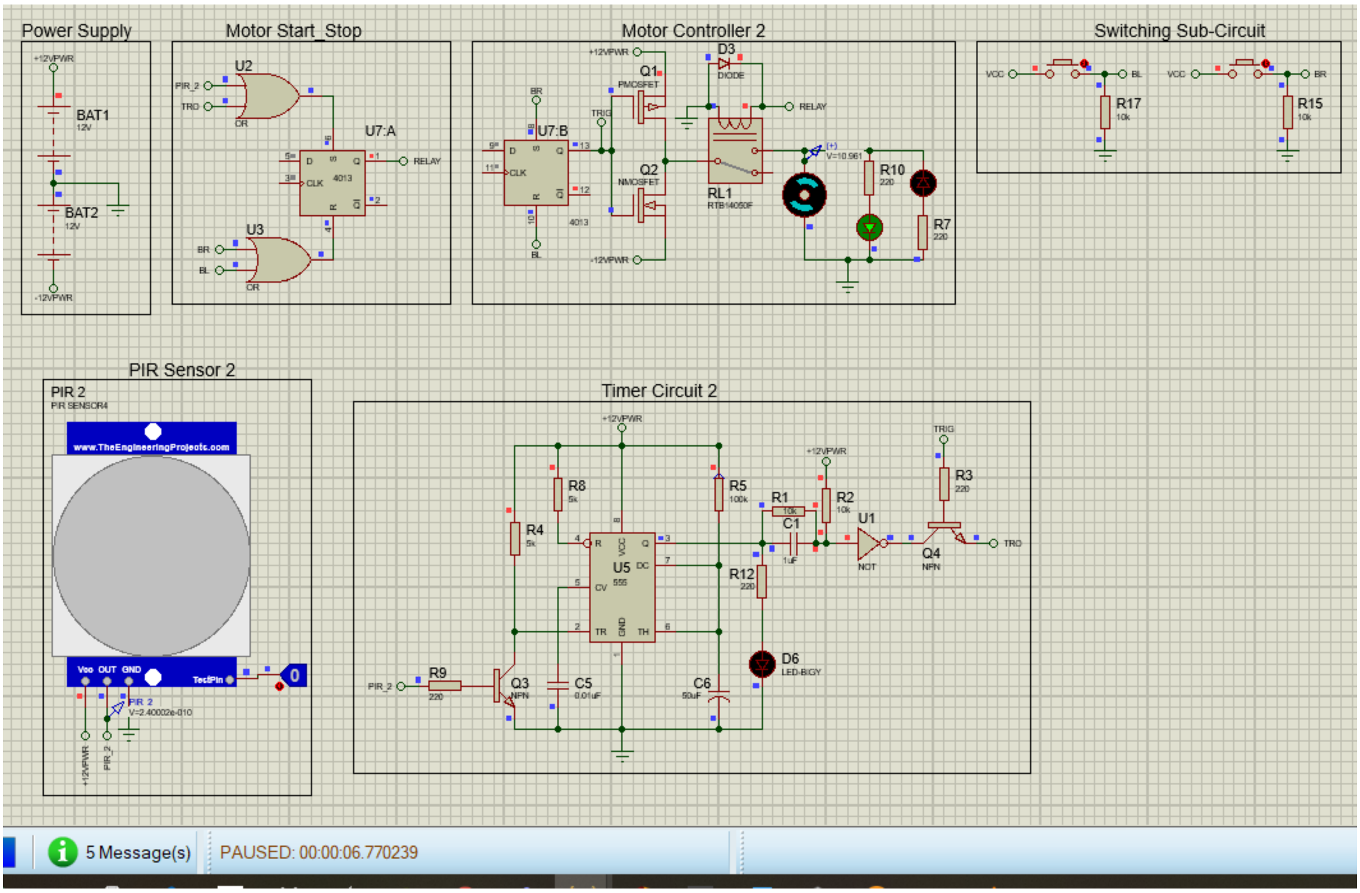

Figure 12: Timer Circuit 2 Used for Motor 2 Bi-directional Control

Table 1: Summary of system tests.

Requirements	Target Value	Test Value	Result Percentage %	Test Method
Timer Circuit 1	5 seconds	5.98 seconds	≈120 (119.6)	Trigger timer with PIR Sensor 1
Motor Speed Controller	12V	10.987V	91.6	Adjusting Potentiometer
Timer Circuit 2	5 seconds	6.77 seconds	135.4	Trigger timer with PIR Sensor 2
Motor Clockwise Rotation	12V	10.96V	91.3	Trigger PIR Sensor 2 and BR Push button to Set SR Latch
Motor Anti-clockwise Rotation	-12V	-11.3046V	94.2	Trigger PIR Sensor 2 and BL Push button to Reset SR Latch

Table.1 shows a summary of the tests that were carried out on the system.

IV. CONCLUSION

This research paper presents the design, simulation, and analysis of an Automated Motion Sensing Sprinkler System (AMSSS). The work's main aim was to design a circuit that would automate controlling the spray distance and tilting of water sprinklers upon motion detection to prevent the 'water jetting' of workers and students. The project would help solve disruptive sprinklers across school grounds and anywhere else that a similar problem may be experienced. Hence, it would ensure that students and teachers can travel within school grounds with minimal disturbances, thus reducing their chances of getting wet and dirty.

The system was intended to interface between sprinklers and their water supply via water pumps to control the water flow rate and the sprinkler spray distance. Furthermore, it uses a tilt mechanism actuator controlled by a motor to direct water spray location and Passive Infrared (PIR) Sensors to detect motion and provide the signals used to manage the sprinkler spray pattern.

The system was designed and simulated in Proteus. Its performance requirements were tested during the simulation, and the results are summarised in Table 1. Based on the result specifications, the AMSSS has achieved its overall objectives. The system can reduce sprinkler spray distance when motion is detected and tilt to sprinkle areas with no movement. Hence, students and workers can travel within school grounds with minimal disturbances as possible.

Therefore, the project can be remodeled to solving other smart-agriculture endeavors, such as irrigation and pesticide control, as well as in fire departments, or even in car washes.

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