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Automatic Flow Control System Using IC 555 for Pharmaceutical Applications

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Abstract

The pharmaceutical industry is characterized by stringent regulations and guidelines to ensure the quality and safety of products. One critical aspect of pharmaceutical manufacturing is maintaining precise control over the flow of components during various processes. This project aims to design and develop a flow control system that incorporates a timer, utilizing the versatile IC 555, to regulate the flow of components for a predetermined duration. The system will be activated using a non-contact IR motion sensor, ensuring a clean and hygienic process.

Keywords: IC (Integrated Circuits), IR(Infra red) motion sensors.

1. Introduction

The automatic pharmaceutical flow control system using IC 555 represents a significant upgrade to existing systems. The current systems have several limitations, which this new design addresses.

One major drawback of existing systems is their flow control mechanism. They detect the presence of a container or vessel and trigger the pharmaceutical flow, which continues until the container or vessel and trigger the pharmaceutical flow, which continues until the container is removed or manually stopped. However, this leads to unnecessary pharmaceutical waste and equipment wear when a container is accidentally left in place or when the flow is not properly stopped.

To overcome this limitation, our proposed system incorporates a timer using IC 555, specifically a monostable multivibrator circuit. This innovative feature introduces a delay mechanism, ensuring that the pharmaceutical flow is automatically terminated after a predetermined time, even if the container remains in place.

The key benefits of this upgraded system are:

1. Pharmaceutical conservation: By eliminating unnecessary flow, our system helps to reduce pharmaceutical waste and conserve these valuable resources.
2. Equipment efficiency: By automatically terminating the flow, our system also reduces equipment wear and tear, leading to cost savings and extended equipment lifespan.
3. Energy efficiency: By minimizing unnecessary flow and equipment operation, our system reduces energy consumption, leading to cost savings and a more sustainable operation.
4. Improved safety: By preventing accidental overflows or spills, our system enhances laboratory safety and reduces the risk of contamination.

Overall, the Automatic Pharmaceutical Flow Control System using IC 555 offers a more efficient, cost-effective, safe and sustainable solution for modern pharmaceutical processing and packaging applications.

2. Abbreviations and Acronyms

IC (Integrated Circuits), IR(Infra red) motion sensors, R(Resistance), C(Capacitance)

3. Equations

The system here is designed in such a way to be in ON state for 11 seconds from the time of sense.The time of ON state can be varied by varying the RC value according to the formula below,

$$T_{ON}=1.1RC \text{ (seconds)}$$

The above circuit represents the ON state timing of monostable multivibrator using IC 555.

4. System Architecture and Components

The proposed flow control system consists of the following components:

1. IC 555
2. Non-contact IR motion sensor
3. Relay module
4. Flow control valve
5. Power Supply
6. LED
7. Resistors of 1 MΩ and 1 KΩ
8. Capacitor of 10 µF
9. Bread Board
10. Connecting wires

5. Operation of proposed system

a. Circuit Explanation

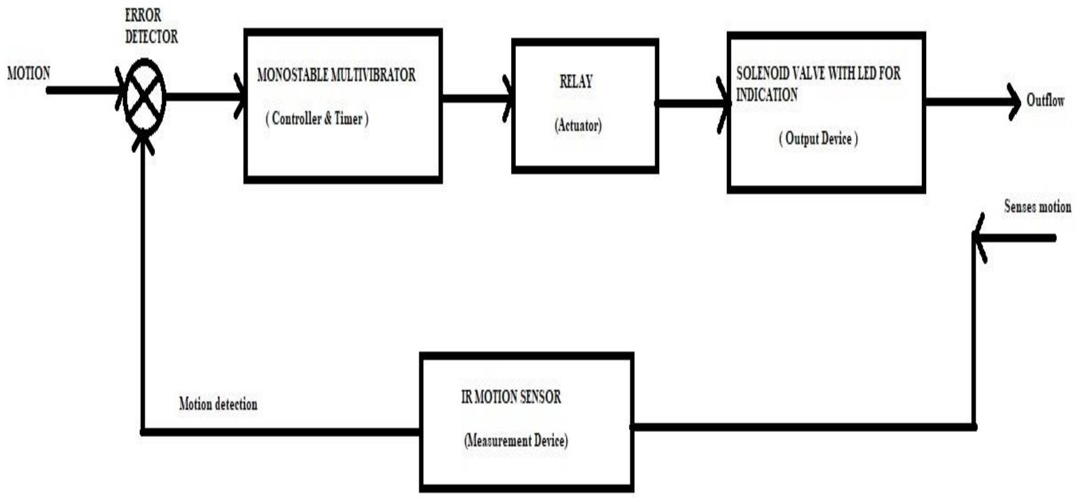
This circuit design utilizes a combination of electronic components to create a motion detection system with an adjustable time-delay relay control mechanism. The power supply provides a stable +5V source, which is essential for the operation of various modules within the circuit, including the Integrated Circuits (ICs) and output devices. The **infrared (IR) motion sensor module** plays a pivotal role in this system, functioning as a non-contact motion detector. It is responsible for sensing the presence of movement within a defined range.

The output of the IR sensor serves as the trigger signal for the monostable multivibrator configuration of the **555 timer IC**, which is constructed using a 1 MΩ resistor and a 10 µF capacitor. In this configuration, the 555 timer generates a single pulse of a predetermined duration when triggered by the IR motion sensor. The pulse duration, or **TON**, is governed by the formula TON=1.1RCTON = 1.1RC, resulting in a time delay of approximately 11 seconds, based on the selected component values. This time delay, which can be adjusted by modifying the resistor and capacitor values, is then used to control the relay module.

The relay acts as a switch, activating an output device (such as a light or motor) for the duration of the time delay. A **1kΩ resistor** is employed in series with an LED to limit the current flowing through it, ensuring that the LED operates within safe current limits, thus preventing potential damage.

The LED serves as an indicator to visually represent the on/off status of the output device, providing feedback to the user. The time delay, governed by the 555 timer, can be modified by altering the resistor and capacitor values, enabling flexible control over the activation period of the relay. In conclusion, this circuit offers an efficient solution for applications requiring motion detection with a timed output, such as automated lighting systems, security devices, or other automation applications.

Figure 1:- Block diagram



b. Circuit Implementation

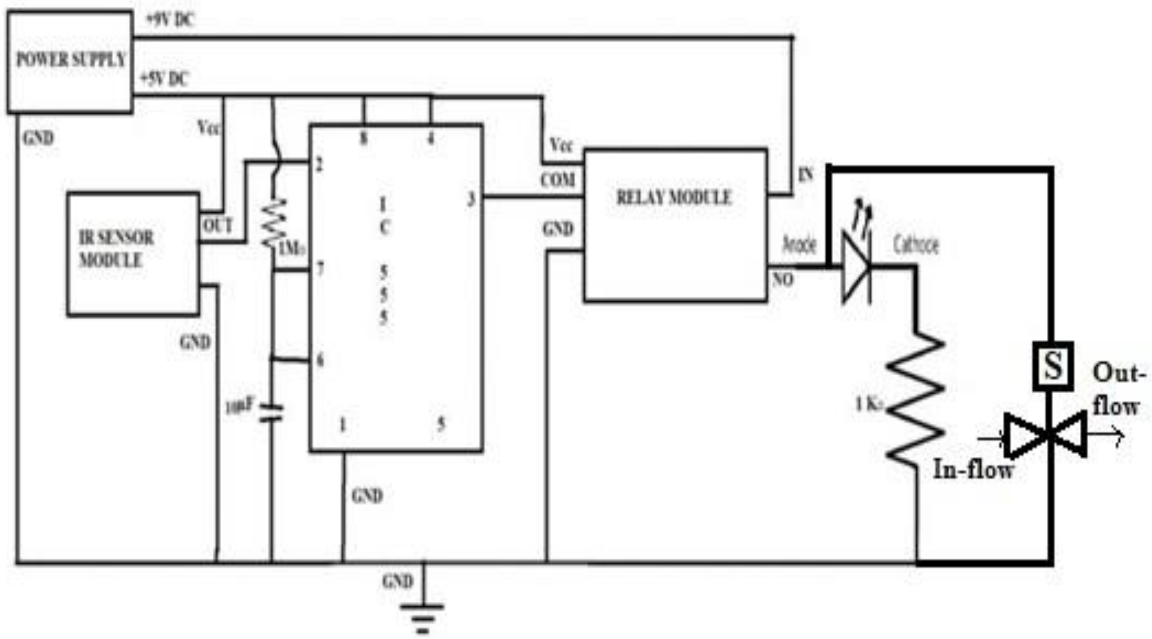
The +5V power supply is distributed to various components, providing the necessary voltage for their operation. Specifically, the +5V is connected to the V_{cc} pins of the IR motion sensor, relay module, and the 4th and 8th pins of the IC 555, which is configured as a monostable multivibrator.

The output pin of the IR motion sensor is linked to the trigger input (pin 2) of the IC 555 to initiate the monostable multivibrator operation. Pins 6 and 7 of the IC 555 are connected together, forming the timing section of the circuit. A 1 MΩ resistor is placed between pins 8 and 7 of the IC 555, and a 10 µF capacitor is connected between pin 6 and ground, determining the pulse duration of the monostable multivibrator.

The output from pin 3 of the IC 555 is routed to the common pin of the relay module, allowing the time delay to control the relay's activation. The voltage used to power the output device is supplied to the input pin of the relay module, while the output is taken from the Normally Open (NO) pin of the relay. To visually indicate the relay's status, the anode of an LED is connected to the NO pin of the relay module, with its cathode connected to a 1 kΩ resistor.

Finally, the ground terminals of the power supply, IR motion sensor module, IC 555 (pin 1), relay module, and the second terminal of the 1 kΩ resistor are all interconnected, establishing a common ground reference for the entire circuit.

Figure 2:-Circuit Diagram



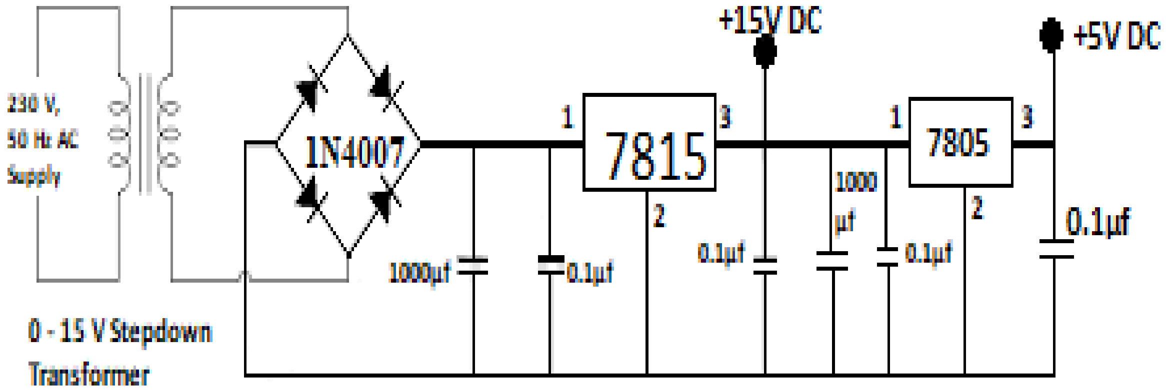
c. Design of Power Supply

The regulated power supply system consists of several key components, including a step-down transformer, a bridge rectifier, electrolytic capacitors, and voltage regulator ICs (7805 and 7815), as depicted in the diagram. The system begins with a **230V, 50Hz AC supply**, which is applied to the primary side of a **15-0-15 step-down transformer**. The secondary side of the transformer provides a **15V AC** output. This alternating voltage is then fed into a **bridge rectifier**, constructed using **four 1N4007 diodes**, which converts the AC voltage into **DC voltage**. Following rectification, the 15V DC passes through two capacitors: a **1000µF electrolytic capacitor** and a **0.1µF capacitor**. These capacitors serve to filter and smooth the DC output, reducing ripple and noise.

The filtered DC voltage is then supplied to the input (pin 1) of the **7815 voltage regulator IC**, which regulates the power supply to a stable **+15V DC** output. The **pin 2** of the IC is grounded, and a **0.1µF capacitor** is connected to **pin 3** (the output pin), with the other terminal grounded. This capacitor helps to further stabilize the regulated output. At **pin 3** of the IC, a constant **+15V DC** is obtained.

This regulated **+15V DC** output is then passed through another **1000µF electrolytic capacitor** and a **0.1µF capacitor** for further filtration, ensuring a clean and stable voltage. The filtered **+15V DC** is then applied to the input (pin 1) of the **7805 voltage regulator IC**, which regulates the supply to a stable **+5V DC** output. The **pin 2** of the IC is grounded, and a **0.1µF capacitor** is connected to **pin 3** (the output pin), again with the other terminal grounded to maintain stability. At **pin 3** of the IC, a constant and regulated **+5V DC** is provided. This regulated power supply circuit is crucial for supplying stable voltages for various electronic applications, ensuring reliable performance of downstream components.

Figure 3:- Power Supply circuit diagram



d. Setup and Output

Figure 4:- Output of the system at the 10th second after sensing

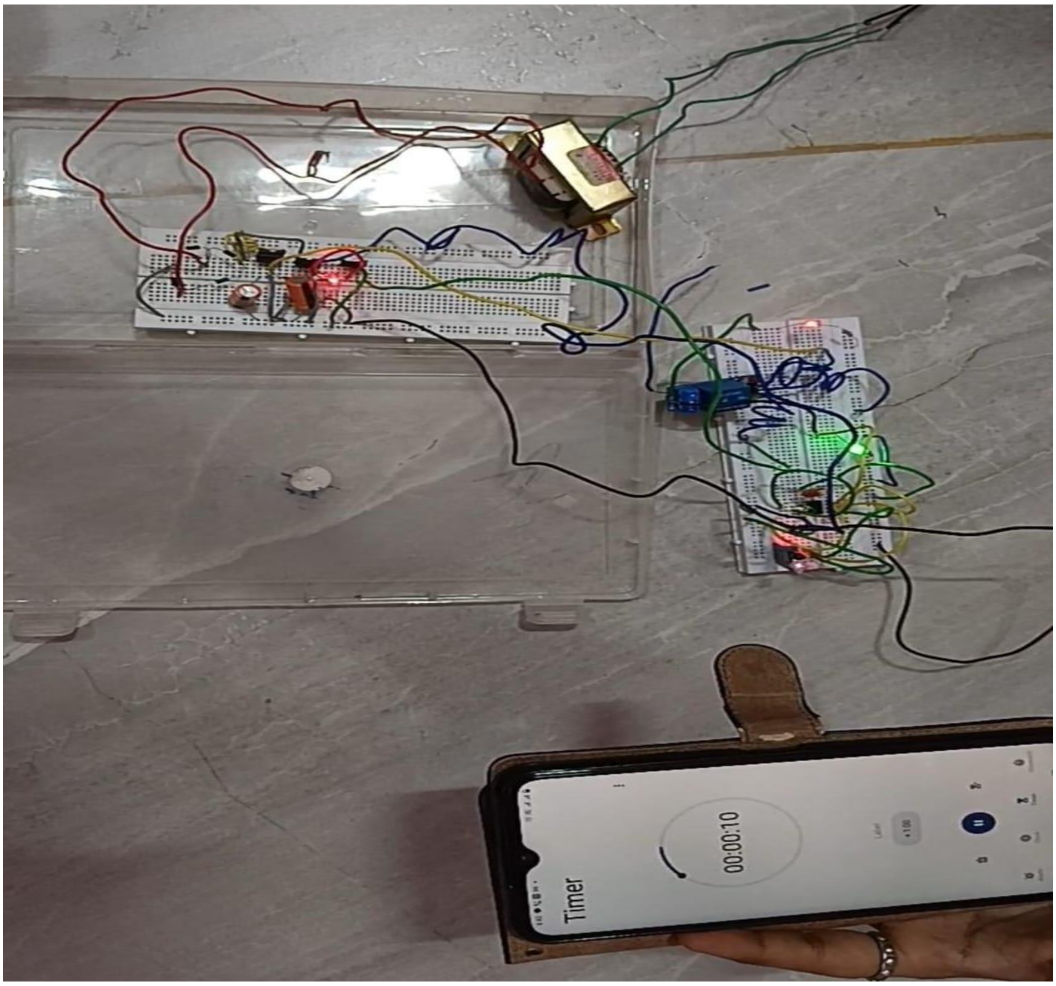
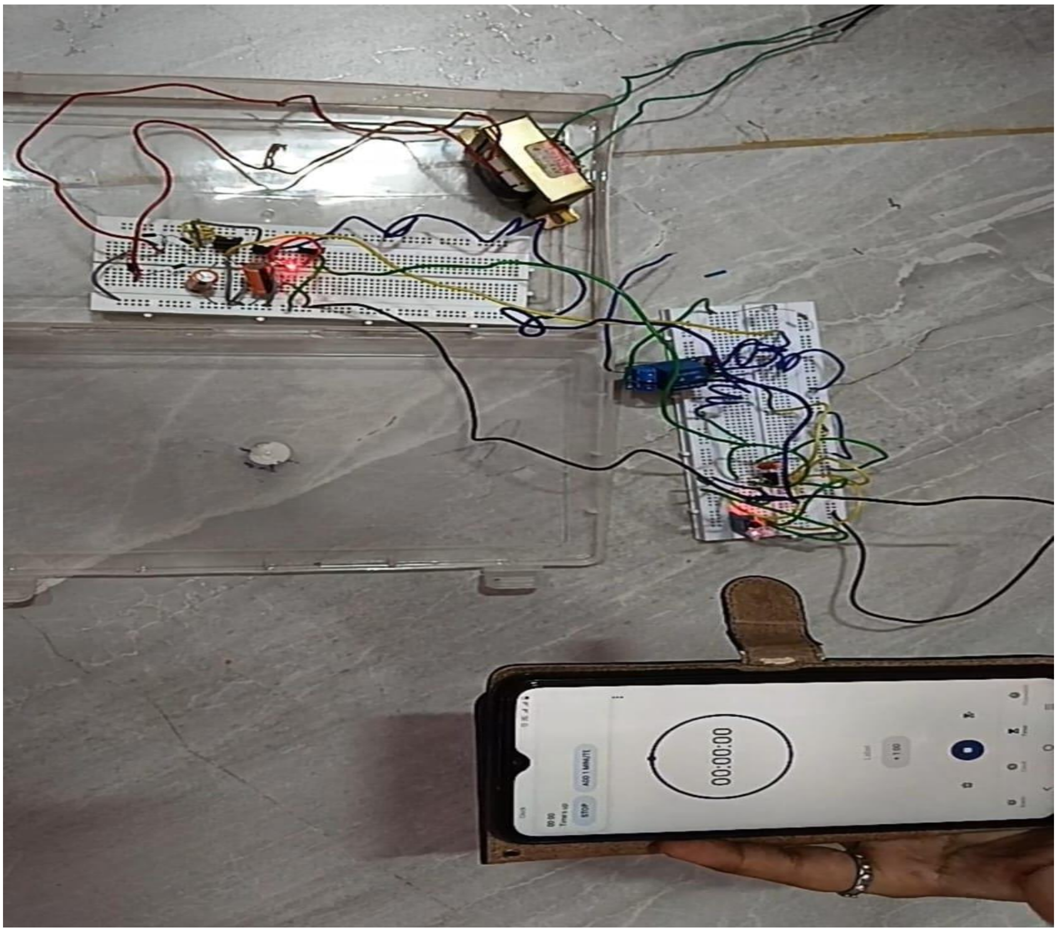


Figure 5:- Output of the system after 11 seconds



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