Automatic Controlled System for Crop Irrigation

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نظام التحكم الآلي لري المحاصيل

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المستخلص:

كان التركيز في هذه الورقة على تصميم نظام تشغيل يتحكم في عملية الري التلقائي للمحاصيل الزراعية بغية الحفاظ على استهلاك المياه في الري. بمجرد توصيل مكونات النظام معًا تم فحص وتنفيذ التصميم المقترح وتبين أن أداءه يتمتع بقدرات تشغيل مرضيه.

الكلمات المفتاحية: *ري تلقائي، تشغيل أوتوماتيكينا، خصائص التشغيل.*

Abstract:

Driven by the desire to conserve water in agriculture, this paper explores the design and implementation of an automated irrigation system. The system underwent comprehensive testing following its assembly and component sampling. The results confirmed its satisfactory performance and operating capabilities.

Keywords: *Irrigation, Automatic system, operating characteristics.*

Introduction:

Irrigation plays a crucial role in agriculture as it helps ensure that crops receive adequate water for their growth and development. Farmers often determine the irrigation needs of their crops. According to the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD), and the World Food Programme (WFP) report (2015), over 90% of farmers in Sub-Saharan Africa rely on rain-fed agriculture for their livelihoods. Increasing water productivity or water use efficiency has been one of the main approaches to overcome the impacts of water shortage on agricultural production (Boutraa et al., 2011). Automated systems can be programmed to deliver water in precise amounts and at optimal times, based on factors such as soil moisture levels, weather conditions, and plant requirements. This improves water use efficiency and avoids over- or under-irrigation, leading to better crop growth and yield (AQUASTAT, 2016), (Hanjra & Qureshi, 2010). To achieve possible water savings, it is critical to select the appropriate technology for the scenario. Irrigation timer can be set for days when watering is permitted. Climate-based controllers and soil moisture-based controllers are the two basic types of irrigation controllers (Dukes et al., 2009).

Implementing water-efficient irrigation techniques, such as drip irrigation, micro-irrigation, or precision irrigation, can significantly reduce water consumption. Drip irrigation is a method of irrigation where water is applied to the soil at very low rates through a network of small-diameter plastic pipes that have outlets known as emitters or drippers (Susmitha et al., 2017). These methods deliver water directly to the root zone of plants. They also allow for precise control of water application, matching it to the crop's actual water requirements.

Automation technologies enable real-time monitoring and control of irrigation systems. Connected devices, such as sensors, actuators, and controllers, can communicate with each other and with central systems to automate irrigation processes, adjust water flow, and optimize water use efficiency.

Automation enables farmers to align irrigation with the actual water needs of crops. By using automated systems can adjust water application based on factors such plant growth stages. This leads to improved water-use efficiency and reduced water loss due to over-irrigation. In general, most of the irrigation systems are manually operated (Florke, 2013). These traditional techniques can be replaced with automated techniques of irrigation to use water efficiently and effectively (Severino, 2018).

This paper presents a prototype for a fully automated irrigation system.

Main objective:

This study proposes an automated irrigation system design that solves the current problem by creating the circuitry for an irrigation system that would start on its own.

Description of the Design:

The goal of this paper is to create an automated irrigation system that can turn on and off on its own for a predetermined amount of time, depending on the requirement for irrigation.

Through the use of a wave shaper amplifier, the input device, Clock #1, is interfaced with 555 timer #2, which receiving a signal from clock #1.

The information from timers U4 and U3 is included into the circuitry that regulates the pump-when the 555 timer #2 is interfaced with timers #3 and #4.

The signal is enhanced by transistors Q1 and Q2. Using a wave shaper amplifier, Clock #2 will interface with 555 timers #9 and #10, providing data that will be included into the logic.

The design considered in this paper consisted of three parts:

Part one: consists of clock #1, wave shaper amplifier, transistor, relay, 555 timer, logic and pump.

Part two: consists of clock #2, wave shaper amplifier, transistor, relay, 555 timer and logic.

Part three: consists of the power supply source which will supply the entire circuit.

A functional diagram for the proposed automated irrigation system is shown in figure 1.

Design Operation:

The clock (Clock #1) is a regular clock that generates a periodic signal. It serves as the input device for the circuit, providing a timing reference or synchronization signal.

The one-shot unit (555 timer #2) is a timer circuit that receives the clock signal and produces a pulse of a specific duration when triggered. This pulse is used to control the subsequent logic devices in the circuit.

The circuit includes three logic devices: a 7404 inverter chip, a 7486 exclusive OR gate chip, and a 7408 AND gate chip, linked in a way that allows for the simultaneous sending a signal that goes to the pump through the relays. These logic devices manipulate and process the signals to generate the desired output signals.

The 7404 inverter chip contains multiple inverters. An inverter takes an input signal and produces its logical complement as the output. It can be used to invert or change the logic level of a signal.

The 7486 exclusive OR gate chip contains multiple exclusive OR gates. An exclusive OR gate (XOR gate) produces a high output signal if the number of high input signals is odd; otherwise, it produces a low output signal. It is commonly used for combining or comparing binary signals.

The 7408 AND gate chip contains multiple AND gates. An AND gate produces a high output signal only if all its input signals are high; otherwise, it produces a low output. It is used for logical conjunction.

The circuit uses relays and other components to control the solenoid relay, and the pump. Once the system is started, it will work for a programmed time. This duration can be controlled by Clock #1 and Clock #2 which is also a regular clock. Clock #2, a separate clock, is interfaced with the one-shot unit (555 timer #9). This connection suggests that Clock #2 will initiate a signal to the one-shot unit, which will subsequently trigger an action. After the programmed time (one hour in this case), Clock #2 will send a signal to the one-shot unit (555 timer #9) to disconnect the power, leading to the system's cessation.

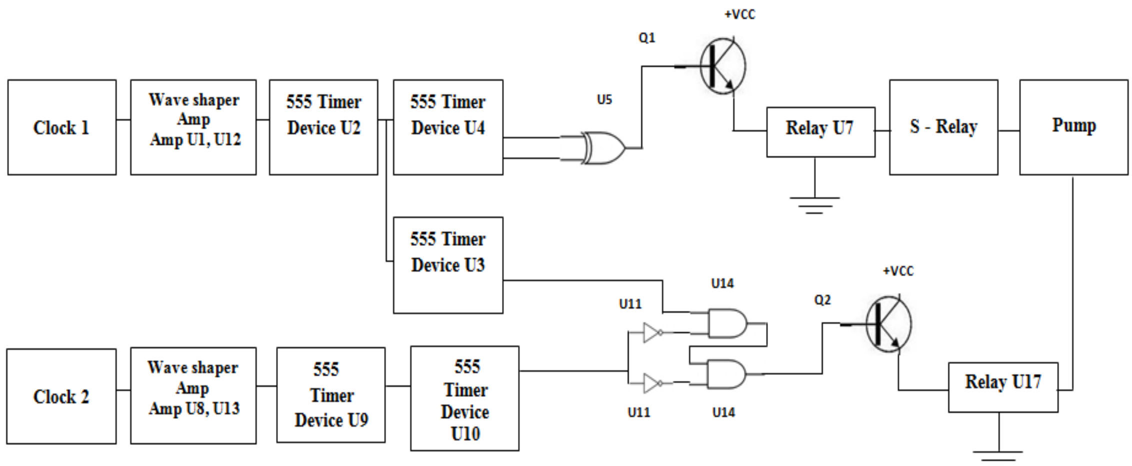

Fig (1) Block diagram of the proposed automated irrigation system

By using a comparator in this way, we can convert the sine wave signal from the clock into a square wave signal so that the design will work, which has clear transitions between high and low logic levels. This square wave signal is often preferred in digital circuits as it is easier to interpret and process.

It's important to note that the specific choice of comparator and the values of the reference voltage and other components will depend on the specifications and requirements of the design. Additionally, proper circuit design considerations, such as biasing and signal conditioning, may be necessary to ensure accurate and reliable operation. The two 555 timers in the circuit are utilized as one-shot multi-vibrators.

A one-shot multi-vibrator, also known as a mono-stable multi-vibrator, is a timing circuit that produces a pulse of a specific duration when triggered. The two 555 timers are likely used to control the timing and duration of certain operations within the circuit.

The first 555 timer is configured as a mono-stable multi-vibrator to generate a one-shot signal. In this mode, a trigger signal initiates a fixed-duration output pulse. The duration of the pulse is determined by the values of an external resistor and capacitor connected to the timer's pins. By adjusting these values, we can control the duration of the output pulse.

The clock generates output signals that last for 60 seconds. To control these signals, a one-shot multi-vibrator (configured with the first 555 timer) is used. The time of this one-shot should be greater than the output signals of the alarm clock, so it is set to 62 seconds. This way, when the alarm clock generates a signal, the one-shot multi-vibrator will generate a pulse lasting for 62 seconds.

The second 555 timer is used in a different part of the circuit to control the time of the pump. The time is controlled by a capacitor and resistor in the circuit. The second 555 timer used to generate a specific timing sequence based on the values of the external components.

Clock #2 triggers the turn-off process for the system. The signal from clock #2 is sent through the first and second 555 timers, inverters, AND gates, transistor, relay, and finally turn off the system.

Assuming that the system will run for one hour at most, Clock #1 will transmit a signal that triggers the system to start. Clock #2 will send a signal to disconnect the power after one hour has passed which will shut off the system.

Conclusion:

This paper presents the development of an automated irrigation system for agricultural crops. The design components were interconnected and thoroughly evaluated, resulting in a successful testing of the automatic system on multiple occasions, the system ran for at least one hour in every occasion. The implementation of this system offers a valuable addition to the agricultural community, particularly for countries like Libya that experience water scarcity. By utilizing this system, water conservation is achieved; addressing a significant challenge faced by numerous farmers especially during the summer season, also the cost of this system is affordable by middle class farmers.

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