Cairo University

Faculty of Engineering

Systems and Biomedical Department

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Digital Electronics and Processors (ELC2242)

<u>Task 2</u>

Team 18

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- ## Overview:

Our application is Automatic Irrigation System and the objective is to automate the process of watering plants or crops in order to achieve the following goals:

1. **Efficient Water Usage:** The system aims to use water efficiently by providing the right amount of water based on plant needs and environmental factors. It helps avoid water wastage and promotes conservation of this valuable resource.
2. **Optimal Plant Health:** The system ensures that plants receive adequate water at the right time to maintain their health and promote optimal growth. It prevents under-watering or over-watering, which can lead to plant stress, diseases, or reduced crop yields.
3. **Watering Automation:** The system automates the irrigation process, eliminating the need for manual watering. It can be programmed to operate on a schedule or based on sensor inputs, providing consistent and timely watering without requiring constant human intervention.
4. **Customization and Flexibility:** The system offers customization options to tailor watering schedules, durations, and frequency based on specific plant types, soil conditions, and climate. It allows users to adjust parameters to meet the unique requirements of their garden, landscape, or agricultural fields.
5. **Water Conservation:** By efficiently managing water usage, the system contributes to water conservation efforts. It helps reduce water consumption by avoiding unnecessary watering and preventing water runoff or oversaturation.
6. **Time and Labor Savings:** Automating the irrigation process saves time and reduces the labor involved in manually watering plants. Users can focus on other gardening tasks or attend to other responsibilities while the system takes care of watering.
7. **Environmental Sustainability:** The system promotes sustainable gardening and farming practices by optimizing water usage and minimizing environmental impact. It helps maintain a healthy ecosystem by preventing water runoff and soil erosion.

Overall, the objective of an Automatic Irrigation System is to simplify and enhance the process of plant watering, ensuring water efficiency, promoting plant health, and providing convenience to users while maintaining environmental sustainability.

- ## How our circuit works?

The automatic irrigation system circuit operates based on a finite state machine (FSM) that controls the pump based on the soil moisture level. We used a Mealy finite state machine:

In a Mealy FSM, the outputs are associated with the transitions between states. In this circuit, the output ‘pump’ (control signal for the pump) is determined based on the current state and the input conditions. The pump output is not solely dependent on the current state, but also on the sensor input and the counter value.

Here is an overview of how the circuit works:

1. **States:** The circuit has three states defined as IDLE, PUMPING, and WAITING. These states represent different stages of the irrigation process.
2. **Inputs:** The circuit takes the following inputs:

- ‘clk’: The clock signal used for synchronous operations.
- ‘reset’: The reset signal to initialize the circuit.
- ‘sensor’: The input from the soil moisture sensor that measures the moisture level in the soil.

3. **Outputs:** The circuit has one output:
   - ‘pump’: The control signal for the pump, indicating whether it should be turned on or off.
4. **State Transition:** The state transition logic determines when to switch between states based on the current state and the input conditions. The state transition logic considers the sensor input and the current state to decide the next state.
5. **Next State Logic:** The next state logic assigns the next state based on the current state and the input conditions. It also handles the actions to be performed during the state transitions.
6. **Counter:** The circuit uses a counter to introduce a delay between state transitions. The counter value is decremented on each clock cycle, and the state transition occurs when the counter reaches zero.
7. **Operation:**
   - In the IDLE state, if the sensor input indicates that the soil moisture is below the threshold, the circuit transitions to the PUMPING state. The pump is turned on, and the counter is set to a delay value.
   - In the PUMPING state, if the sensor input indicates that the soil moisture is above or equal to the threshold, the circuit transitions back to the IDLE state. The pump is turned off, and the counter is reset.
   - If the sensor input in the PUMPING state remains below the threshold, the counter is decremented on each clock cycle. When the counter reaches zero, the circuit transitions to the WAITING state. The pump remains on, and the counter is set to the delay value.
   - In the WAITING state, when the counter reaches zero, the circuit transitions back to the PUMPING state. The pump is turned on, and the counter is set to the delay value.
8. **Reset:** The circuit can be reset by asserting the reset signal. When the reset signal is active, the circuit goes to the IDLE state, turns off the pump, and resets the counter to zero.

By implementing this FSM-based logic, the circuit ensures that the pump is activated when the soil moisture is below the threshold and turns off the pump when the moisture level is sufficient. The delay introduced between state transitions helps prevent rapid switching and provides stability to the irrigation process.

- ## Problems and challenges:

  Resources for automatic irrigation system circuit was not really available to help us with writing the Verilog code because this idea was implemented mostly using Arduino, it was difficult but we figured to build the code on our own from scratch based on what we learned after studying and practicing Verilog on ModelSim.