VE373 Design of Microprocessor Based Systems

Project Proposal

Automatic Irrigator

SU2022

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UM-SJTU Joint Institute

In this project, we are going to develop a system that simulates automatic drip irrigation. It will detect the humidity in the soil and drip water to provide suitable humidity for agricultural purposes.

1 Objective

- The user can know the humidity in the soil.
- The irrigator will automatically drip water to the soil if the humidity is below a certain threshold. Some basic algorithms related to dripping will be researched and implemented into the system.
- If time permits, the system can record the humidity change over a day, the amount of water dripped into the soil, the timestamps that the dripping is happening, and transmit the data to the laptop for visualization.

2 High Level Description

In this project, PIC32 development board is the core of the whole system which will control and be connected to several peripherals such as humidity detector and water valve. The schematic diagram is shown in Fig. 1. Humidity detector ① will detect the humidity in the soil and send the signal to PIC32 micro-controller ②. After receiving the signal, the micro-controller will sample the signal by Analog to Digital Converter (ADC). Next, the micro-controller will decide whether the humidity has gone below a certain threshold. If so, it will send a Pulse-width Modulation signal (PWM) to the water valve ④ connected to a water tank, and water will be dripped to the plant. In this process, the duty cycle of PWM signal of determine the openness of the valve and the water flow rate. Besides, the micro-controller will transfer the humidity from memory to UART Transmit Buffer using Direct Memory Access (DMA) module and the humidity will finally be received by laptop ③.

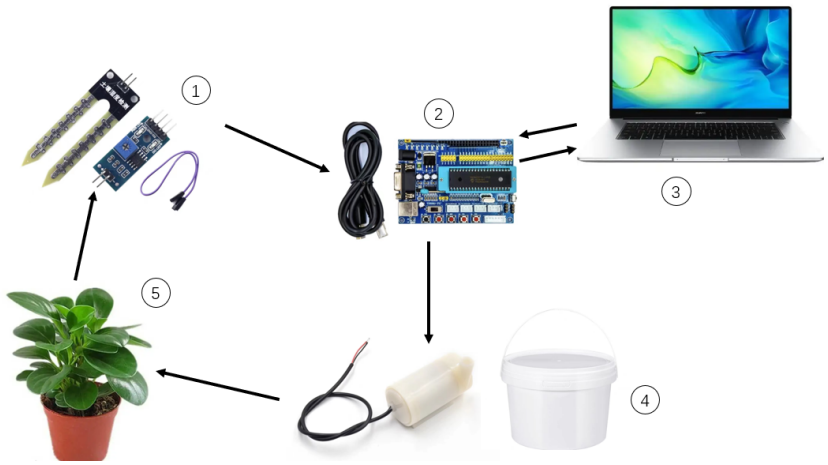

Figure 1: Schematic Diagram

The whole process is summarized in Fig. 2.

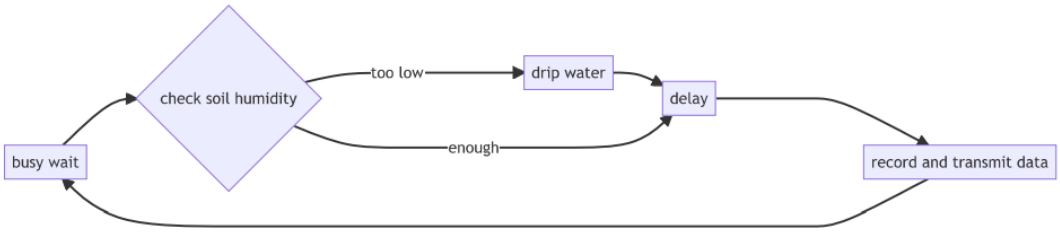

Figure 2: Flow Diagram

3 Analog to Digital Converter

Analog to Digital Converter is used to convert the analog humidity signal collected by humidity detector to a digital signal. After conversion, the micro-controller will decide whether the humidity in the soil has gone below a certain threshold and whether the water valve should be triggered.

4 Pulse-width Modulation

Pulse-width Modulation signal is the critical signal to control the water valve. Depending on the humidity we measure from the soil, corresponding amount of water should be dripped into the plant. By configuring the duty cycle of PWM signal, we can control the openness of the water valve and therefore the water flow rate. To be more specific, a higher duty cycle will lead to a larger openness of the valve and a larger water flow rate, and vice versa.

5 Direct Memory Access & Serial Communication

Direct Memory Access is applied in the system so that the data can be directly read from PIC32 and following calculations and decisions can be performed in an efficient way.

In the whole system, PIC32 micro-controller is at the center of communication, as shown in Fig. 3. Here we apply serial communication to enable data transmission. Since we sometimes want to know the real-time humidity in the soil, we apply UART/SPI/I2C to continuously transmit the data from PIC32 to laptop. We also need a converter from UART/SPI/I2C to USB, which can be identified by the operating system on laptop. In real practice, power consumption should also be taken into consideration.

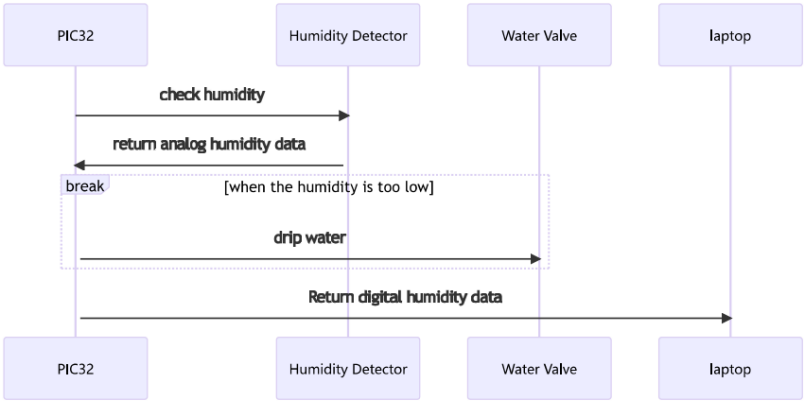

Figure 3: Serial Communication

6 Schedule

The Gantt chart of our schedule is shown in Fig. 4. Details of three milestones of the project are shown below.

- Milestone 1: Relevant devices should be purchased. The dripping algorithm should be successfully simulated with a C program on PC.
- Milestone 2: The humidity detector should be implemented and corresponding humidity signal can be correctly sent to PC.
- Milestone 3: The water valve should function correctly. The whole structure of the project should be completed. Test and debug should be started.

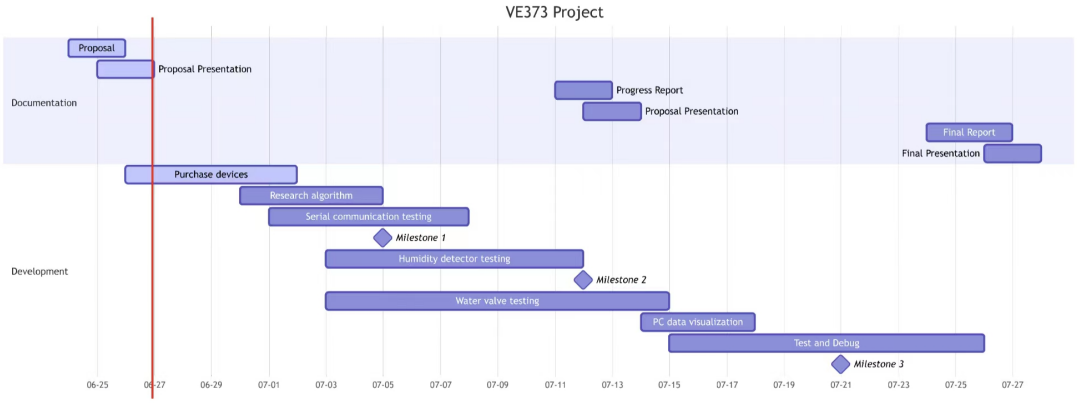

Figure 4: Schedule