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DEPARTMENT: BIOMEDICAL ENGINEERING

COURSE: STRUCTURED COMPUTER PROGRAMMING (ENG 224)

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CONCEPTUALIZATION

This project is to develop an Automated Irrigation Control System, which switches the pump motor ON/OFF on sensing the moisture content of the soil, and has a security system with wireless messaging. The main objectives of this project are to minimize cost of labor, maximize proper use of water, provide alarms for water level, provide security, check moisture content and the temperature of the soil

SPECIALIZATION

Hardware Components

- ❖ **Sensors (light, moisture, water level and temperature):** These sensors will be placed in the soil to detect the light, moisture, water and temperature of the soil.
- ❖ **Voltage regulator:** This is an electrical device that maintains the voltage of a power source within acceptable limits. The voltage regulator is needed to keep voltages within the prescribed range that can be tolerated by the electrical equipment using that voltage.
- ❖ **Sprinklers:** Sprinklers are devices used to irrigate agricultural crops, lawns, landscapes, golf courses, and other areas. They are also used for cooling and for the control of airborne dust. The sprinkler used here is dramm turret sprinkler. Dramm Turret sprinkler has nine water patterns that provide a variety of functions. It is made with a heavy-duty metal base, and moulded hook for convenient display and storage, and it covers up to 575 sq. ft. It is also up to 90 PSI.
- ❖ **LCD:** A liquid-crystal display (LCD) is a flat panel display, electric visual display, or video visual display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images, such as preset words, digits, and 7-segment display as in a digital clock.
- ❖ **Decoder:** The decoder IC used here is HT 12D. This 212 decoder is a series of CMOS LSIs. The decoders receive serial addresses and data from a programmed 212 series of encoders that are transmitted by a carrier using a RF transmission medium. They compare the serial input data three times continuously with their local addresses. If no error, or if unmatched codes are found, the input data codes are decoded and transferred to the output pins. The 212 decoder series of decoders are capable of decoding information that consist of N bits of address and 12_N bits of data. This decoder decodes the message signal received from the RF receiver and sends it to the microcontroller to display the message on the LCD.
- ❖ **Radio Frequency Transmitter and Receiver:** The RF module operates at radio frequency. This RF module comprises of an RF transmitter and RF receiver (Tx/Rx) pair operate at a frequency of 433MHz. an RF transmitter receives serial data and transmits it wirelessly through RF, through

its antenna. The transmitted data received by an RF receiver operations at the same frequency as that of the transmitter.

- ❖ **Encoder:** The encoder IC used here is HT 12E. This 212 encoder is a series of CMOS LSIs. They are capable of encoding information which consists of N address bits and 12_N data bits. Each address/data input can be set to one of the two solenoid valves. The programmed addresses/data are transmitted together with the header bits via an RF transmission medium upon receipt of a trigger signal. This encoder encodes the message signal received from the central microcontroller and sends to the RF transmitter.
- ❖ **Water pumps:** A pump is a device used to move fluids. A submersible pump is device which has a hermetically sealed motor, close-coupled to the pump body. The whole assembly is submerged in the water to be pumped. The main advantage of this kind of pump is that it prevents pump, a problem associated with high elevation difference between the pump and the water surface.
- ❖ **Reservoir:** This is an enlarged artificial lake created using a dam to store water.
- ❖ **Microcontroller Unit:** A microcontroller (also known as MCU) is a functional computer system on a chip. Microcontroller is a n integrated chip that performs controlling function. It is also referred to as a one-chip microcomputer used to control a wide range of electrical and mechanical appliances. The sensors (light, soil, water level and temperature) and solenoid valve are connected to it. The microcontroller used here is ATmega32.
- ❖ **Solenoid:** Solenoid valves are electromechanical valves that are controlled by stopping or running an electrical current through a solenoid. The solenoid valve makes use of this solenoid in order to activate a valve, thus controlling the water flow, air flow and other things with electricity. The solenoid valve can get damaged after some period, therefore, a replacement may be needed.
- ❖ **Arduino:** Arduino is an open-source electronics platform based on easy-to-use hardware and software. It is a board that can be controlled by sending a set of instructions to a microcontroller on it.

Software Components

- ❖ **GUI (Graphic User Interface):** the GUI will display texts and objects that will convey information to the land owner.
- ❖ **Database Management System:** A database program helps in easy manipulation of data.
- ❖ **C Programming Language**: C is a general purpose programming language that is used to develop software.

DESIGN

There are three microcontrollers in MCU. Two microcontrollers are used to control the solenoid valve by monitoring the sensors, and give information to the third microcontroller. The third microcontroller takes the decision if the pump will be ON or OFF. There are two pumps connected to the MCU, pump A and pump B. Pump A is used to supply water to the land from the reservoir. Pump B is used to remove excess water from the land into another reservoir where it will be recycled and reused. The solenoid valves and sensors (light, temperature, soil moisture, rain and water level) are connected with the MCU.

The MCU controls the solenoid valve. The rain sensor sends signal to the MCU when it is about to rain. The wireless systems consist of encoder and decoder IC's radio frequency transmitter and receiver circuits.

For the security of the pumps and circuit board, a password controlled room is used. Only authorized persons that will enter into the room by entering the right password. If the password entered is wrong, the microcontroller will send a message to the owner of the land through the wireless message system. The microcontroller will also send a message about the pumps (ON/OFF), and also if it is raining or about to rain.

Flowchart of the System

```
                        ┌─────────┐
                        │  Start  │
                        └────┬────┘
                             │
                        ┌────▼─────┐
                        │Initialize│
                        └────┬─────┘
                             │
                        ╱────▼─────╲
                       ╱   Enter    ╲
                       ╲  password  ╱
                        ╲──────┬───╱
                               │
        NO            ◇────────▼────────◇
    ┌──────────────── │  Is password    │
    │                 │   correct?      │
    │                 ◇────────┬────────◇
┌───▼──────────┐               │ YES
│ Alert land   │               │
│   owner      │               │
└──────────────┘      ◇────────▼────────◇        YES
                      │  Is reservoir   │────────────────────┐
                      │  tank empty?    │                    │
                      ◇────────┬────────◇          ┌─────────▼──────┐   ┌──────────────┐
                               │ NO                │ Trigger alarm  │   │Display on LCD│
                               │                   └────────┬───────┘   └──────────────┘
              ┌────────────────▼───────────────┐            │
   ┌──────────│ Read soil moisture, light,     │   ┌────────▼────────┐
   │          │ temperature and water level    │   │ Switch on pump A │
   │          └────────────────┬───────────────┘   └──────────────────┘
┌──▼──────────┐                │
│Display on LCD│               │
└─────────────┘       ◇────────▼────────◇
                      │ Is soil moisture,│        NO
                      │ light,           │─────────────────────┐
                      │ temperature and  │                     │
                      │ water level      │          ┌──────────▼──────────┐   ┌────────────┐
                      │ normal?          │          │ Switch on sprinklers│   │Turn on pump│
                      ◇────────┬────────◇           └──────────┬──────────┘   │     B      │
                               │ YES                           │              └──────▲─────┘
                          ┌────▼────┐          NO      ◇────────▼────────◇           │
                          │   End   │◄───────────────── │ Is water on land│          │ YES
                          └─────────┘                   │    excess?      │──────────┘
                                                        ◇─────────────────◇
```
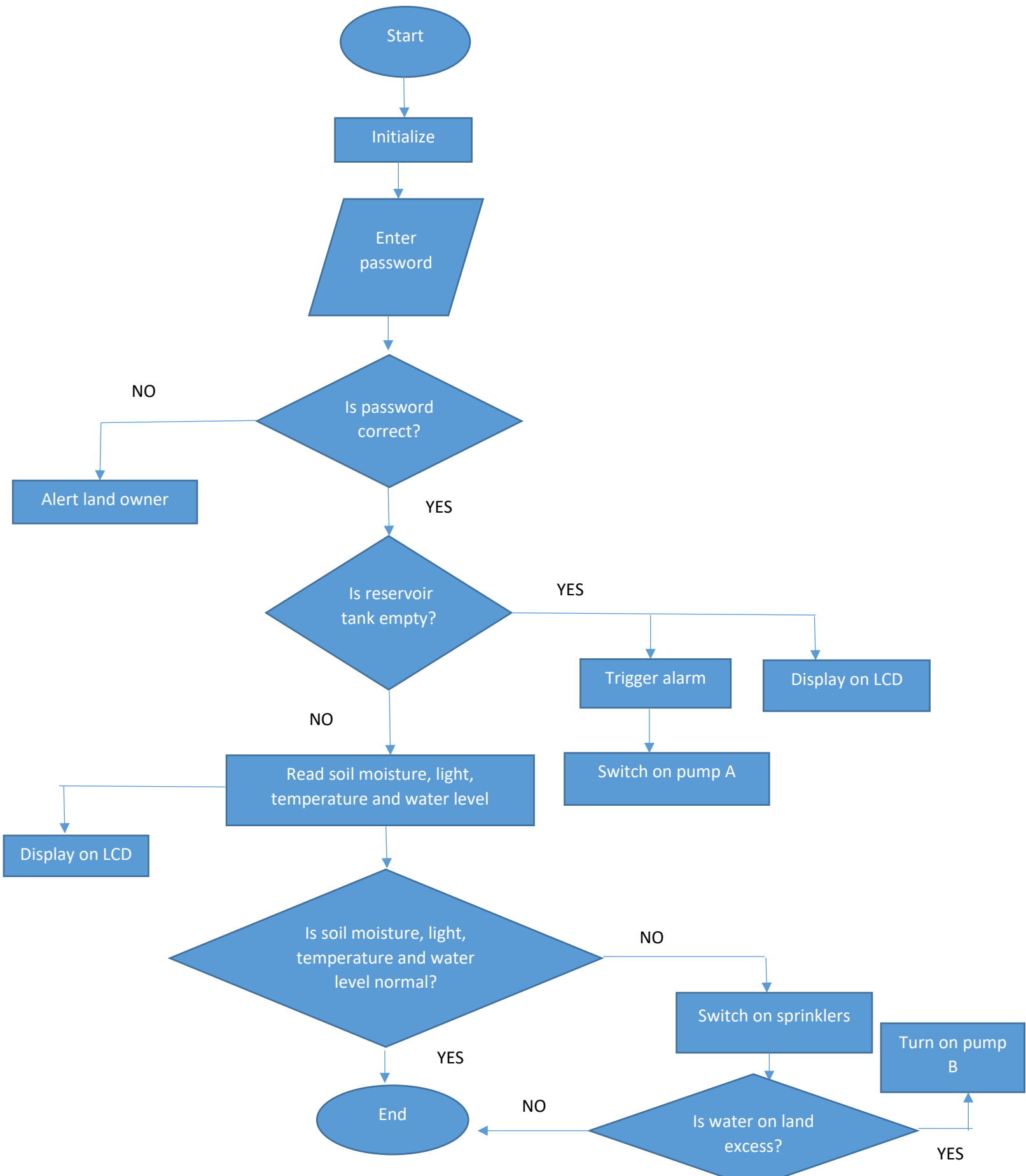
Block Diagram of the System

```
                        ┌─────────────────────────────────────────┐
                        │           Password Protected             │
                        │                                          │
                        │   ┌──────────┐      ┌──────────┐          │
                        │   │ Pump A   │      │ Pump B   │          │
                        │   └────▲─────┘      └────▲─────┘          │
┌──────────────────┐    │        │                │                │    ┌──────────────────────┐
│  Solenoid Valve  │◄───┼───┐    │                │                │    │                      │
└──────────────────┘    │   │ ┌──────────────────────────┐         │    │  ┌────────────────┐  │
                        │   └─┤                          ├─────────┼───►│  │ Solenoid Valve │  │
┌──────────────────┐    │     │   Microcontroller Unit   │         │    │  └────────────────┘  │
│ Sensors (soil    ├────┼────►│                          │◄────────┼────┤                      │
│ moisture,        ├────┼────►│                          │◄────────┼────┤ Sensors (soil moisture,│
│ temperature,light│    │     │                          │         │    │ temperature, light and│
│ and water level) │    │     └──────────────────────────┘         │    │ water level)         │
└──────────────────┘    │                                          │    └──────────────────────┘
                        └─────────────────────────────────────────┘
```

Rain detector

Encoder → RF transmitter

RF receiver → Decoder → Microcontroller → LCD display and alarm
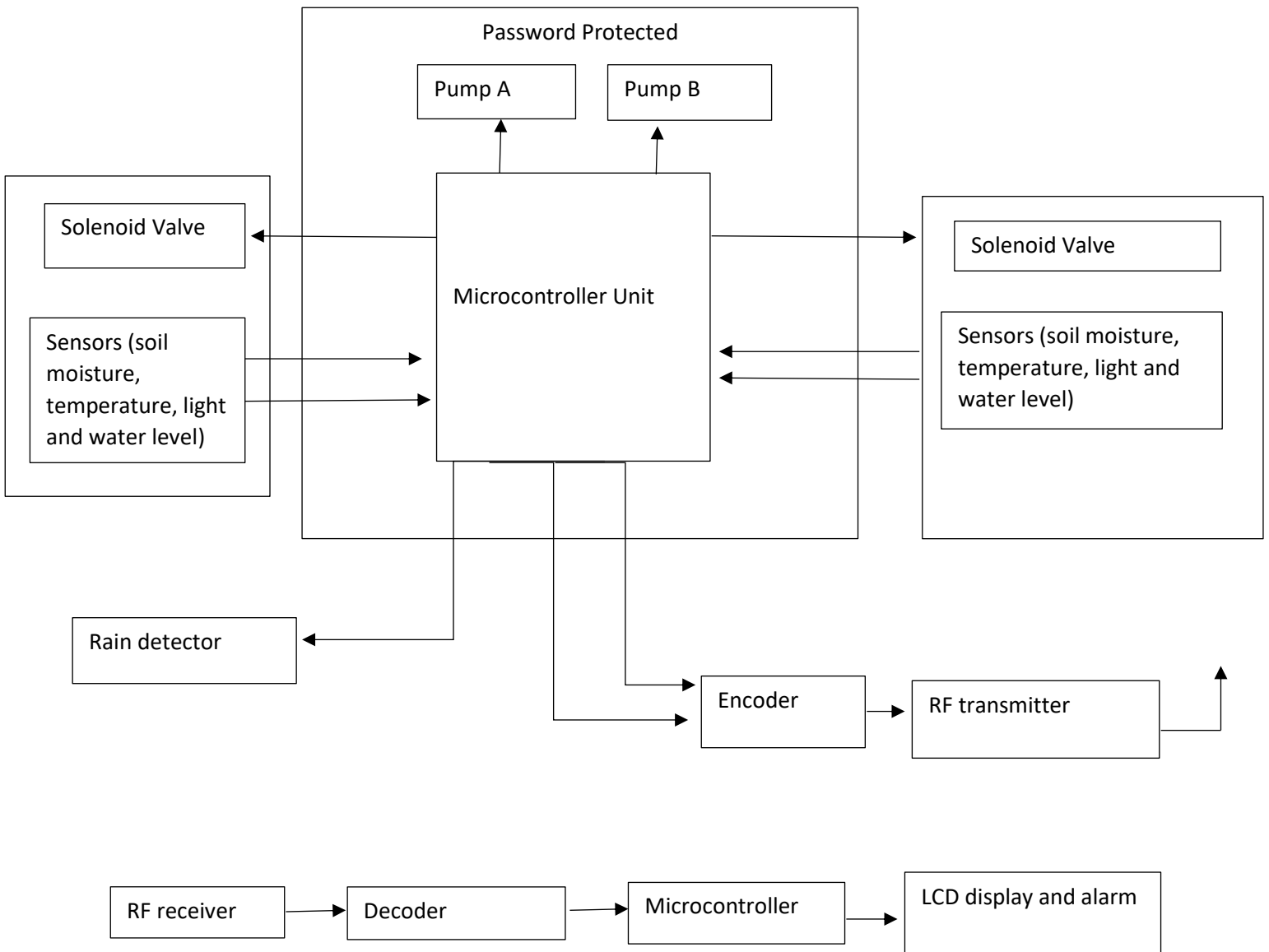
Algorithm of the System

Step 1: Start

Step 2: Enter password

Step 3: If password is correct,

      Read reservoir level

      Else,

      Alert owner

Step 4: If reservoir is empty or almost empty

      Trigger alarms then turn on pump A

      Else,

      Read soil moisture, light, temperature and water level

Step 5: If soil moisture, light, temperature and water level is normal

      End

      Else,

      Turn on sprinklers

Step 6: If water on farm land is excess

      Turn on pump B

      Else,

      End

Step 7: Stop

Top-Down Design of the System

SIMI'S AUTOMATED IRRIGATION SYSTEM

Wireless Messaging	Security	Sensors

Message owner about security	Message owner if rain is falling or about to fall	Password for the system	Soil moisture	Light and temperature	Water level

IMPLEMENTATION

C programming language was used for the coding of the system.

TESTING

The codes were correct and ran.

MAINTENANCE

There would be a monthly check up on the irrigation system for any issues or bugs.