Lawn Sprinkler System

Submitted By: Group 35

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Problem Statement

Release of water to these sprinklers is done via a valve. Every sprinkler lane has its own valve through which water is released into the lane. There is an overall valve to control water flow into the pipes. A series of 12 soil moisture sensors are placed at different parts of the garden. There is also a water meter that is a water level sensor that displays the level of water. Water can be released only if water level is beyond a threshold. A back flow device is available to prevent back flow of data back into the main lines. The sprinkler system works twice in a day. Once at 11: 00 am and then at 6:00 pm. The sprinkler is turned on and off based on the time of the day and the soil moisture. The time for which the sprinkler remains on depends upon the difference between required soil moisture and actual soil moisture level.

System Description

A typical garden has six lanes of sprinklers. Each lane has two moisture sensors. The sprinklers in each lane can be switched on and off using valves controlled by electromagnetic relays. Each lane's water flow can be controlled using individual lane valves, and there is also the main valve. The water supply comes from an overhead tank and the water pressure is maintained by gravity. An ultrasonic water level sensor is employed to ensure that watering is done only if the water level in the tank is beyond a certain threshold level. The system turns on only at 11:00 am and 6:00 pm. Watering is done only if the actual soil moisture is below required soil moisture. The soil moisture sensors and water level sensor return analog values which are taken via an ADC. The values are compared with the threshold values and output is sent to amplify the voltage. An output of logic high from the microprocessor is passed through a relay and driver circuitry to turn on the solenoid valve. The line valves and the main valve are both turned on using OR logic. Water flows through the valves due to pressure as the appropriate valves are turned on, and the requisite sprinklers turn on. Only at 11:00 a.m. and 6:00 p.m. does this happen. The device is fully automated, and the user just needs to turn on the battery. The lawn irrigation system is then taken care of by the microprocessor.

Assumptions

1. ALP is already stored in the ROM in executable format.
2. IVT is already present in the ROM.
3. The lawn is very big, so that the moisture of one part of the lawn has no impact over the moisture of other parts.
4. The optimal moisture level of the soil corresponds to 3.91V output of soil moisture sensor which translate to 200 by the ADC. (Calibrated to 78.125% moisture)
5. The optimal water level of the tank is corresponding to 1.94V output of water level sensor which translates to 100 by the ADC. (calibrated to 0.7644m)
6. The water flows through the pipes using gravity alone, and no pump is needed.
7. The soil moisture sensor has to be calibrated with completely dry soil and water, before its installation.
8. The soil moisture and water level thresholds are present in the system.
9. Backflow device is a mechanical device and prevents the backflow automatically. It need not be interfaced with the microprocessor.
10. Soil moisture sensors give a negligible error in reading for different weather conditions and temperatures.
11. The system powers ON at 00:00 hours.
12. Time taken in code execution is negligible; it won’t cause any delay.

System Hardware

Sr. No.	Item Name	Description	Quantity
1.	250-124 Soil Moisture Sensor	The Model 250-124 Soil Moisture Sensor monitors soil moisture and outputs a linear DC voltage of 0-5V	12
2.	Electronic Solenoid Valve	The electric solenoid valve opens when an input voltage of 12V DC is applied across it.	7
3.	F500 Ultrasonic Water Level Sensor	F500 is a high accuracy analog 0-5V ultrasonic water level sensor with a measurement range of 30- 2000mm	1
4.	POP2FC Sprinklers	Full circle impact sprinkler with a 3.5mm nozzle size and an operational radius of 11.5m.	6

Design Hardware

Sr. No.	Component Number	Description and Specification	Quantity
1.	8086	16-bit microprocessor chip	1
2.	8264	Clock oscillator chip for supplying a clock signal to 8086	1
3.	8253A	Programmable Interval Timer which performs timing and counting functions using 3 16-bit counters.	1
4.	8255A	Programmable input-output device consisting of 3 8bit directional input-output ports (24 i/o ports)	2
5.	8259	Programmable Interrupt Controller for 8086 microprocessors	1
6.	2716	2KB programmable memory EPROM chip	4
7.	6116	2KB programmable memory SRAM chip	2
8.	7432	OR Gate	8
9.	7404	NOT Gate	2
10.	74LS138	8x3 Decoder Chip	2
11.	74LS373	Octal Latch with 3-state outputs	3
12.	74LS245	Octal Bus Transmitter/Receiver designed for 8-line asynchronous 2-way data communication between data buses	2
13.	ADC0808	Converts Analog Signal from moisture and water level sensors	2
14.	OZ-SH-105D	General purpose relay SPDT 16A 5V DC	7
15.	ULN2803	Analog 5V TTL CMOS Logic, high voltage, high current Darlington transistor array.	1
16.	Resistance	100 ohms	7

Memory Mapping

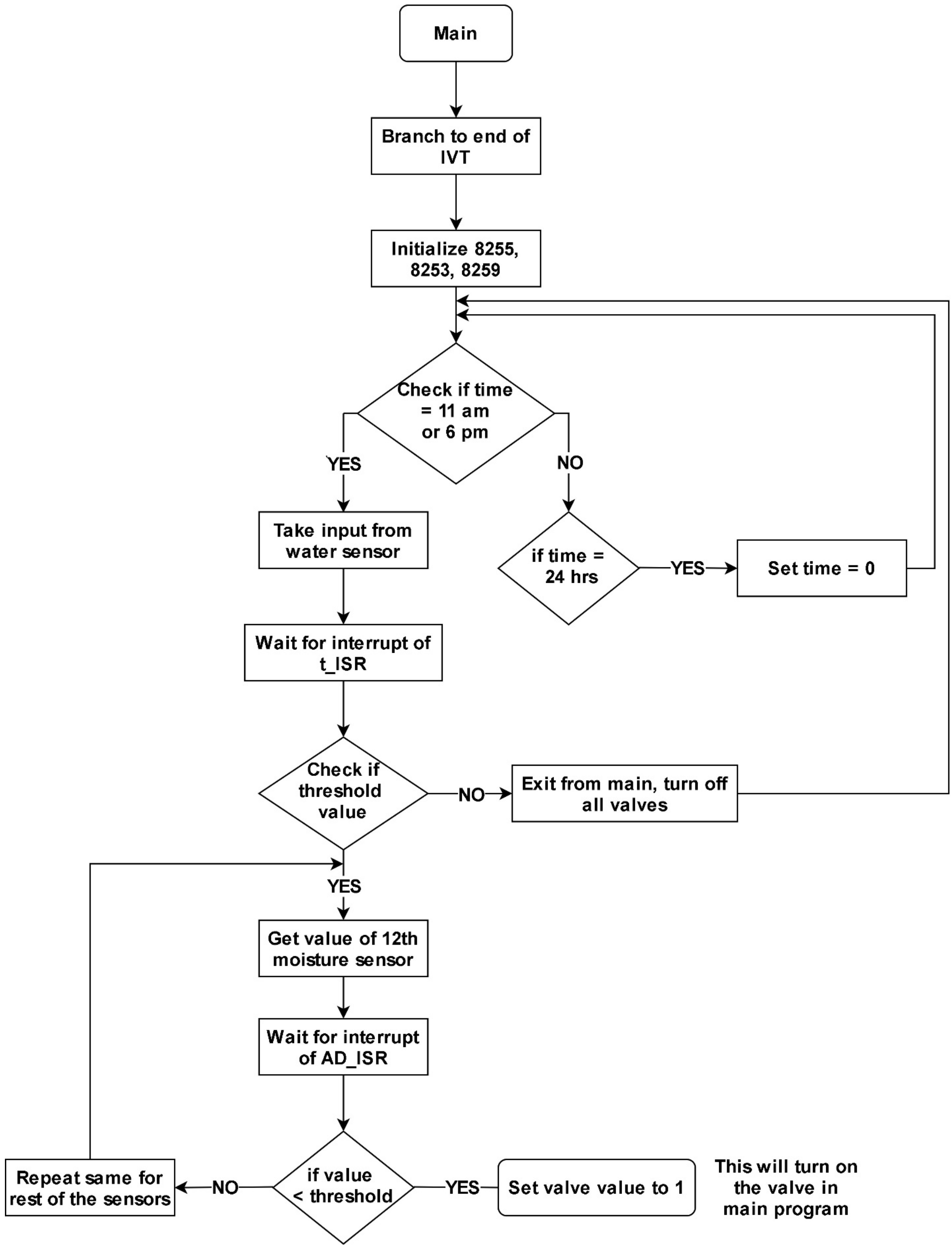
ROM$_{1E}$(2K chip)	00000$_H$ - 00FFE$_H$
ROM$_{1O}$(2K chip)	00001$_H$ - 00FFF$_H$
RAM$_{1E}$(2K chip)	01000$_H$ - 01FFE$_H$
RAM$_{1O}$(2K chip)	01001$_H$ - 01FFF$_H$
ROM$_{2E}$(2K chip)	FF000$_H$ - FFFFE$_H$
ROM$_{2O}$(2K chip)	FF001$_H$ - FFFFF$_H$

I/O Mapping

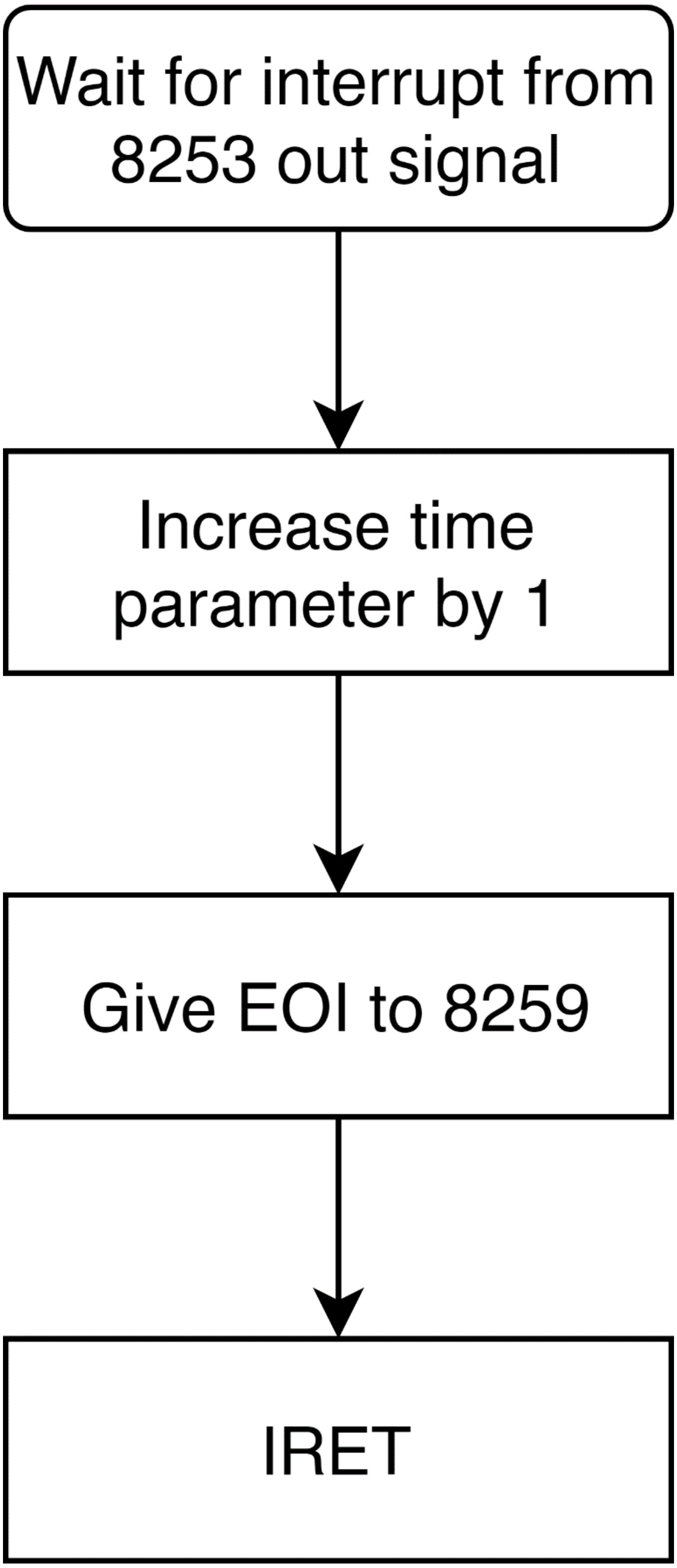
8255$_{(1)}$	40$_H$-46$_H$
8255$_{(2)}$	48$_H$-4E$_H$
8253	50$_H$-56$_H$
8259	58$_H$-5A$_H$

	A19	A18	A17	A16	A15	A14	**A13**	**A12**	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
ROM1E	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	**0**	**0**	1	1	1	1	1	1	1	1	1	1	1	0
ROM10	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	**0**	**0**	1	1	1	1	1	1	1	1	1	1	1	1
RAM 1E	0	0	0	0	0	0	**0**	**1**	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	**0**	**1**	1	1	1	1	1	1	1	1	1	1	1	0
RAM 1O	0	0	0	0	0	0	**0**	**1**	0	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	**0**	**1**	1	1	1	1	1	1	1	1	1	1	1	1
ROM 2E	1	1	1	1	1	1	**1**	**1**	0	0	0	0	0	0	0	0	0	0	0	0
	1	1	1	1	1	1	**1**	**1**	1	1	1	1	1	1	1	1	1	1	1	0
ROM 20	1	1	1	1	1	1	**1**	**1**	0	0	0	0	0	0	0	0	0	0	0	1
	1	1	1	1	1	1	**1**	**1**	1	1	1	1	1	1	1	1	1	1	1	1

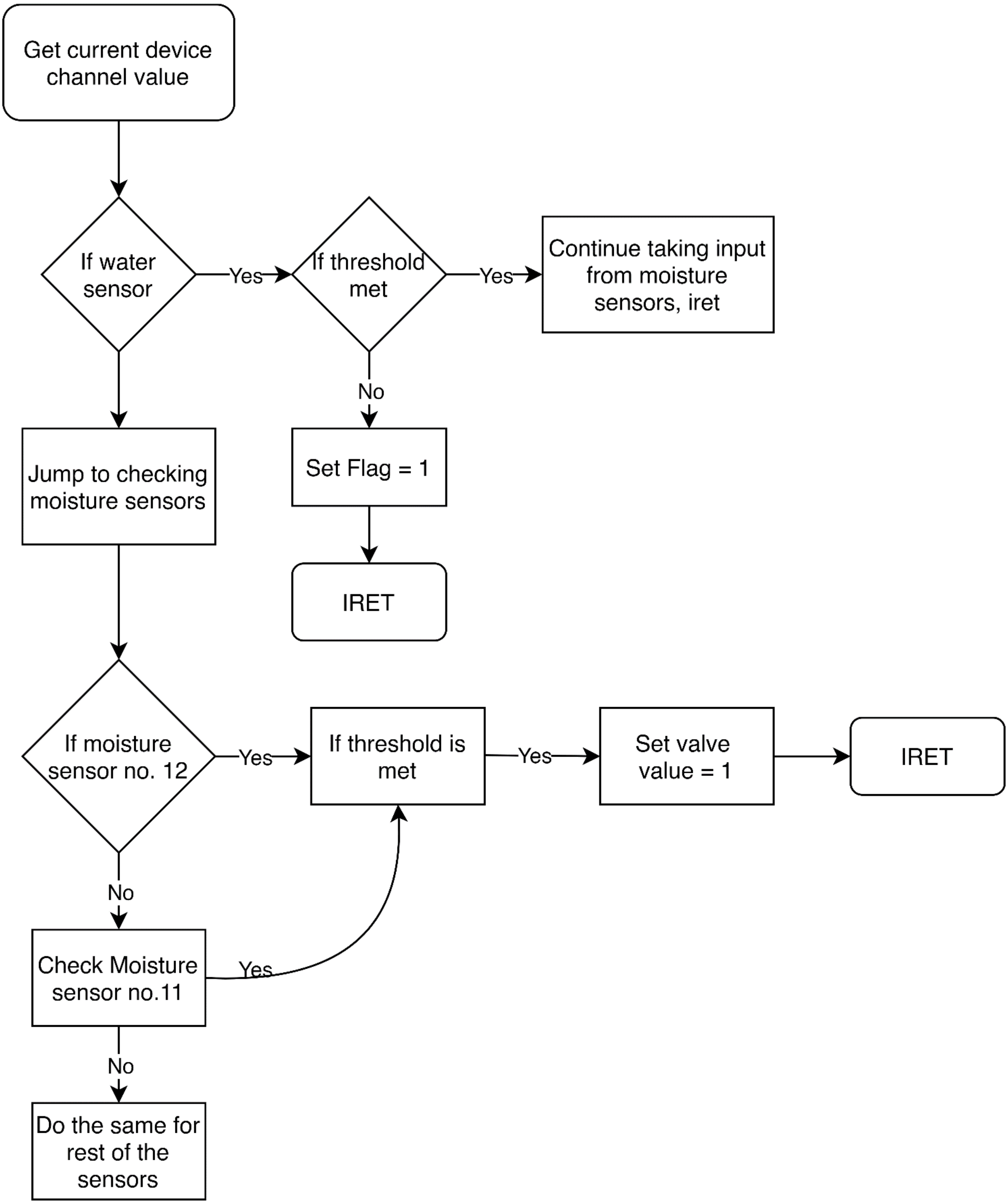
Algorithm (flowchart)



T_ISR


Wait for interrupt from 8253 out signal
Increase time parameter by 1
Give EOI to 8259
IRET

AD_ISR


Get current device channel value
If water sensor
Yes
If threshold met
Yes
Continue taking input from moisture sensors, iret
No
Set Flag = 1
IRET
Jump to checking moisture sensors
If moisture sensor no. 12
Yes
If threshold is met
Yes
Set valve value = 1
IRET
No
Check Moisture sensor no.11
Yes
No
Do the same for rest of the sensors

Variations in Proteus Implementation, with justification

1. ADC Clock set at 500KHz is acceptable, as 1MHz is the maximum clock speed that can be provided.
2. 2732 is used as 2716 is not available in Proteus.
3. Moisture and Water Level Sensors, are replaced by switches giving voltage between 0-5V; as all sensors are not available in Proteus.
4. Relays used in simulation in place of electric solenoid valves.

List of Attachments

1. Complete Interfacing – Interfacing.pdf
2. Manuals
    a. ADC 0808
    b. Electric solenoid valve
    c. Water level sensor
    d. Moisture level sensor
    e. Relay
    f. Darlington array U2803 IC
3. Proteus File – projG35.dsn
4. EMU8086 ASM File - G35code.asm
5. Binary File after assembly - proj.bin