CSE 3442

PROJECT REPORT

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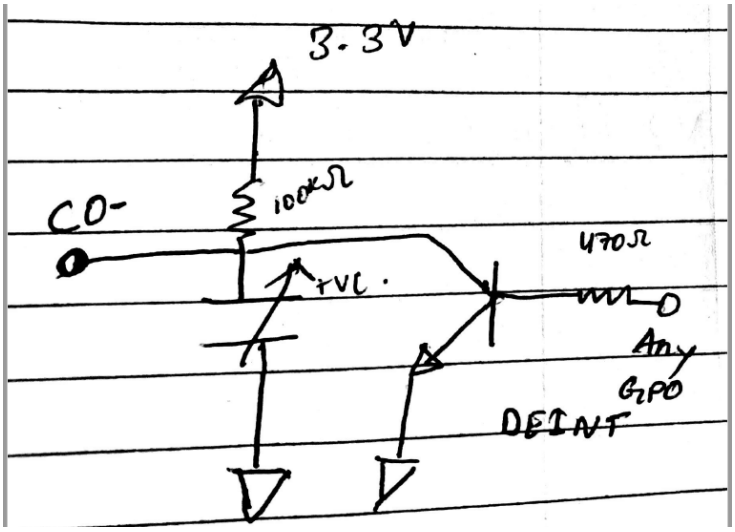
Theory

The smart self-watering flowerpot consists of a few independent circuits built for specific purposes. Each of them is described below:

i) **Water Level Measurement**

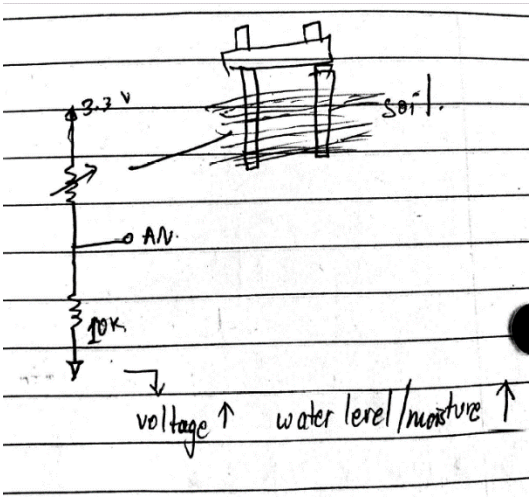
The water level measuring unit consists of a 470Ω resistor connected between a GPIO output pin (DEINT) and the base of a 2N3904 NPN transistor. The DEINT pin acts as a switch to the rest of the circuit. The emitter of the transistor is grounded to collect the current flowing through the Collector when DEINT pin is high. One of the electrodes of the water bottle- which acts as a variable capacitor in this circuit- is connected to the collector of the transistor. The other electrode is connected to the ground. A 3.3V constant voltage supply is provided at the collector with a 100kΩ pull up resistor connected to it. Finally, a comparator input pin is connected at the same junction.

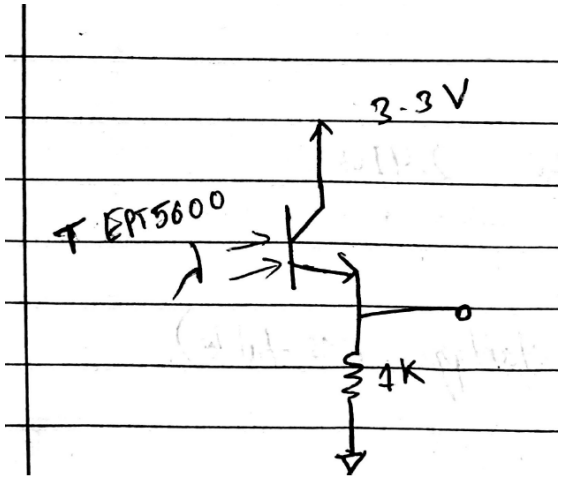


Whenever the DEINT pin is pulled high, the capacitor- in this case the water container- starts discharging. When the discharging completes, the DEINT pin is pulled low, and a timer to measure time in the units of 25ns is started right after. When the capacitor charges fully, the voltage at the junction is greater than 2.469V. When that happens, the comparator output value goes from 0 to 1. So, when the charging completes, the timer value is recorded, and the time taken by the capacitor to charge is directly proportional to the capacitance of the liquid. The capacitance is directly proportional to the volume of the liquid.

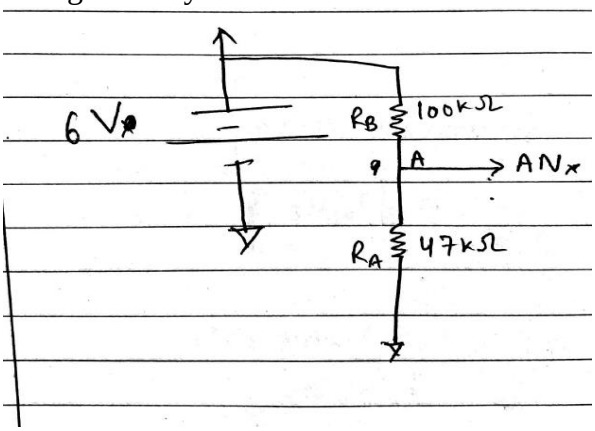
ii) **Light level, Moisture level and Battery Voltage measurement**

A simple voltage divider circuit is used to measure the moisture level and battery voltage. For the moisture measurement, we have one of the electrodes connected directly to the 3.3V power supply. The other electrode is connected to a 10kΩ resistor in series to create a simple voltage divider. Higher the voltage drop in the 10k Ω resistor, higher would be the moisture level which means the resistance offered between the two electrodes is less, resulting in less voltage drop across the electrodes. When the moisture level would be low, it would mean the resistance between the electrodes is high and therefore, the voltage drop in the flowerpot is high, resulting in lesser voltage drop in the 10kΩ resistor. In order to determine the voltage, an Analog to Digital Converter (ADC) is used.





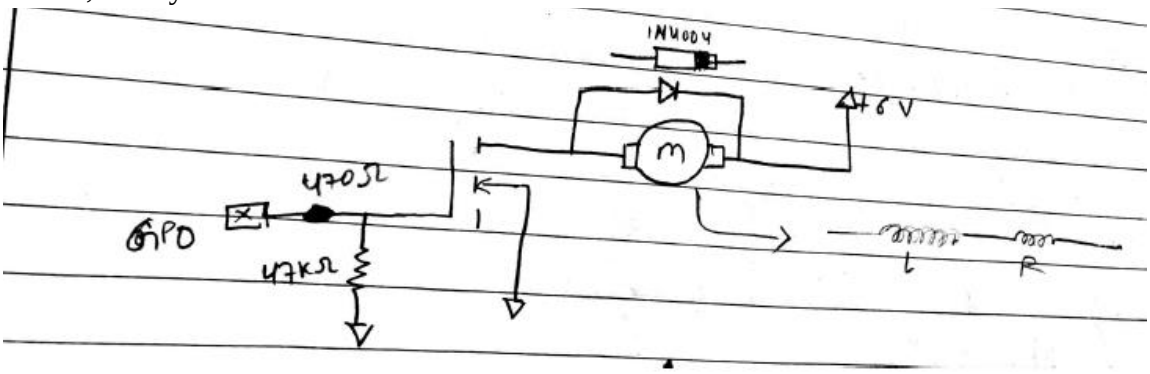
For the light level measurement, a light sensor is used. Higher the light level, higher current would flow through the collector to the emitter, resulting in higher voltage read in the ADC input pin. In this way, the light level would also be directly proportional to the voltage read by the ADC.



For the battery voltage measurement, a similar voltage divider circuit is used to divide the voltage from a 6V source, between a 100kΩ resistor and a 47kΩ resistor. As the 6V source starts to degrade, the voltage read by ADC at the node of two resistors will fall at linear rate.

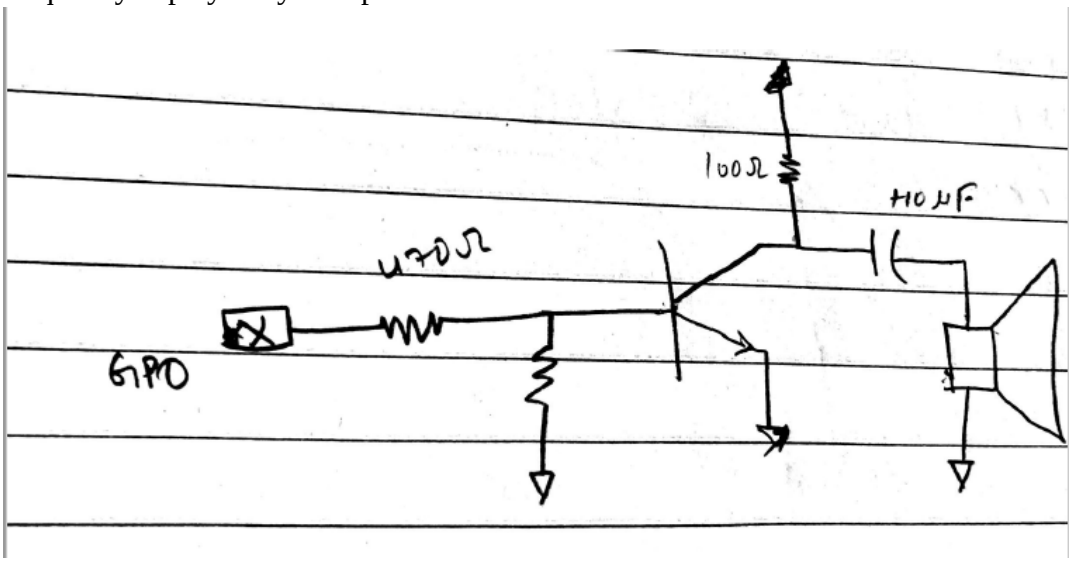
iii) **Motor Control**

A FQP20N06L MOSFET is used as a switch to turn the pump ON and OFF. A GPIO output pin drives the gate of the MOSFET which in turn will complete the circuit that drives the pump. The pump is set to be turned on by a 6V voltage source. A flyback diode is connected across the two terminals of the pump in order to eliminate the spike of high voltage that would otherwise occur if the pump is suddenly turned off. If such case occurs, the flyback diode would save the MOSFET.



iv) **Speaker Control**

A GPIO output pin turns the transistor switch ON and OFF as required, and the circuit consisting of a speaker connected to a high pass filter is completed. A constant 3.3V source is applied to the filter with a 100kΩ pull up resistor. The high pass filter does not let any lower frequencies flow through the speaker. When the GPIO output is toggled using a timer interrupt, set at a frequency required to play the melody, the same frequency is played by the speaker.



UART Commands

The following commands are entered in the UART to perform specific functions for the system.

Commands	
level	Sets the moisture level below which watering occurs
status	Returns the level of the water in the reservoir (mL), the moisture level of the soil (0% equals dry soil, 100% equals saturated soil), and light level (% relative to reference light source), battery level (V)
pump ON|OFF	Manually turns pump on and off
alert LIGHT_LEVEL	Sets the light level above which the beeper will sound if water is low
time H M	Sets the time of the lock
water H1 M1 H2 M2	Sets the time window (>H1:M1 and < H2:M2) in which the watering can occur

After the successful compilation of the code, the system operates as in the following state diagram: