*Automated Plant Care System*

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**Introduction**

Le Farmers has collaborated with Professor Jennifer Winikus to create the latest small scale gardening device on the market.

Two of the highest causes of failed gardens/ greenhouses are droughts, and over watering.

This can be devastating to many people who desire to grow their own vegetation. The fact is that many people either don’t have time to tend to their plants, or don’t tend to them properly.

This system would allow for people to grow their plants, see progress, and still have free time.

**Specifications**

*Inputs*:

* Humidity Sensor(DHT11)[1]: Detects humidity and temperature of soil
  + 3.3 ~ 5.5V
  + Input serial data, single-bus
  + 16 bit accuracy
* Radio Dial (Rotary encoder)[2]: Detect the inputted amount of water poured into the plant, and desired watering time
  + 5V
  + Pulses/360° Rotation: 20
  + Output: 2-bit gray code

*Outputs*:

* Motor (Servo)[3]: Controls valve of water bottle/dripper
* The LED’s[4]: Notify user of system state and humidity (Low, Good, and High)

*Breadboard, LEDs, Resistors, and Jumper Wires*

*STM 32 Nucleo- 144:* Specifications and features found at [5]

*Mbed-OS:* Environment used to program STM32 Information found at [6]

**Features**

*Interrupts*

* Interrupts managed with an Event Queue.

*Runs Eternally*

* System will run eternally until user decides to restart

Watchdog

* If system gets stuck for more than 20 minutes, will restart requiring user to customize

Internal Scheduling

* An Event Queue was utilized to schedule user inputs
* Servo rotating periodically with respect to user input, and waiting for an inputted time to turn back

*Synchronization*

* When system is running, feedback is provided every 1 second to show current humidity level
* A green LED Blinks every second, when system is watering

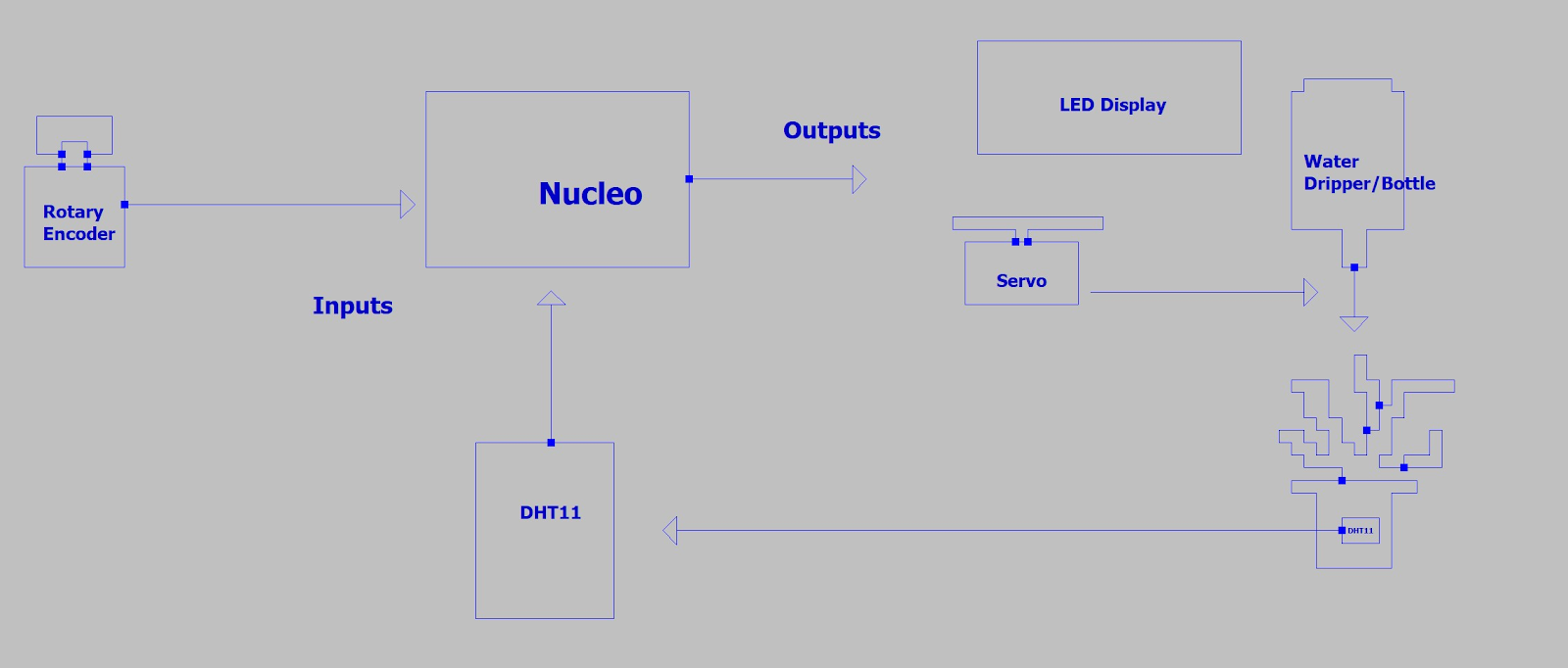
*Driver Configuration*

* LEDs, and Rotary Encoders’ I/O were configured using bitwise

**Constraints**

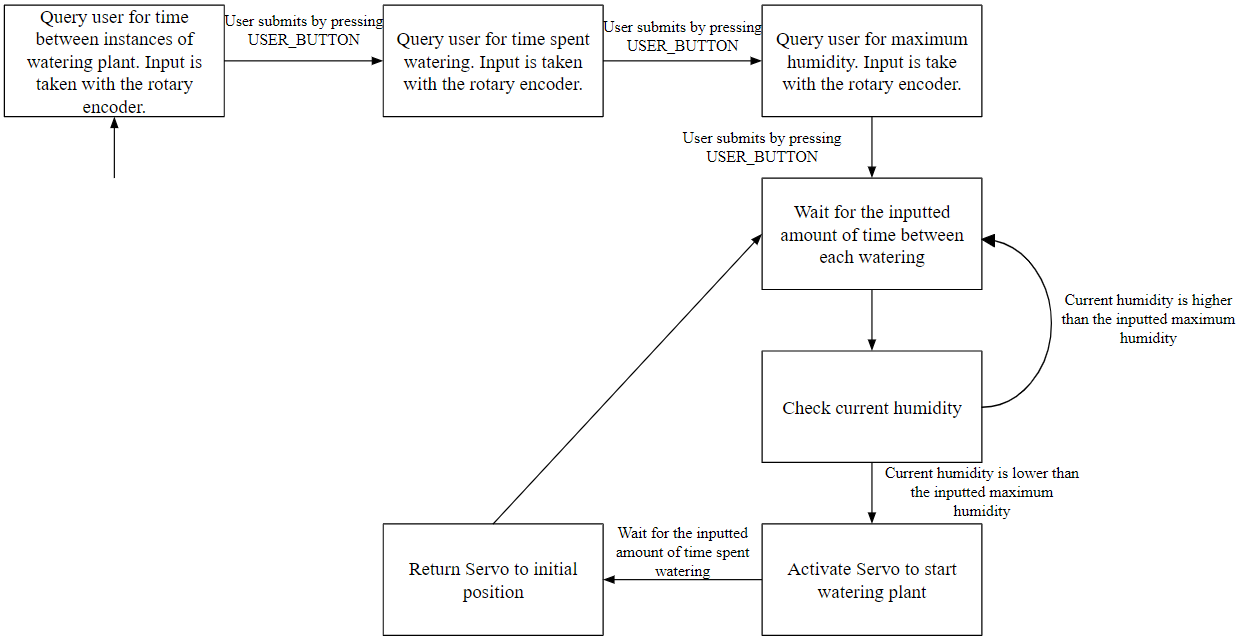
* Humidity sensor must be 1 inch deep in soil
* The frequency of watering and the amount of water need to be inputted before the system can start.
* Sufficient space is needed for the bottle to turn when watering.
* The bottle cannot be swapped out for another bottle, but must be manually refilled and reset when empty.

**Block Diagram**

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*Figure 1: Block diagram/ Basic System Design*

**Functionality Diagram**



*Figure 2: Functionality Diagram*

**Applications**

System is intended for small indoor plants/ gardens. Plant needs proper lighting. Due to the nature of this system, it can also be used to fill dog water trays at a desired time interval, or even be attached to an air freshener to spray at a given interval.

**User Instructions**

*System Use*

1. Upon system start, a yellow light will flash signaling the user to input
2. Follow instructions on the console.
3. Input period to water plants (in seconds), followed by inputting the amount of water (in mL) to water. \*System waters at a rate of 1 mL/second.
4. If the system restarts, enter period and volume again.
5. In case the system is unresponsive for more than 25 seconds, press the restart button.

*Events*

*Blinking Green Light*: System is currently watering plant

*Yellow Light*: Waiting for User input

*Steady Green Light*: Soil is at a good humidity level

*Steady Red Light*: Soil is at a high humidity level

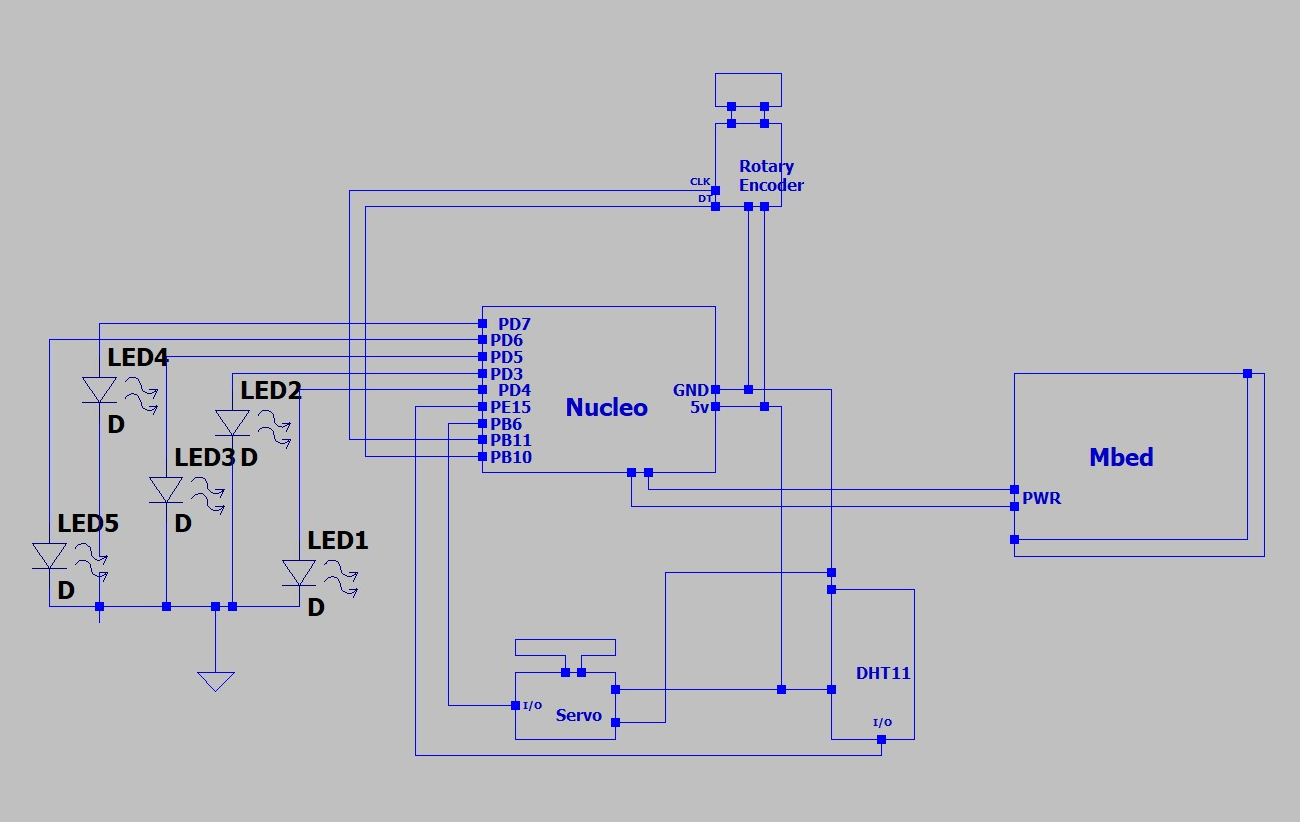
*Steady Yellow Light*: Soil is at a Low humidity level

*System Build*

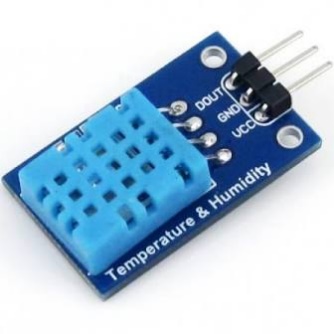
Connect Rotary encoder, Servo, DHT11, and LED’s as seen in schematic.

Stand a water bottle/ dripper upside down above a plant/ cup, and attach a valve to the servo.

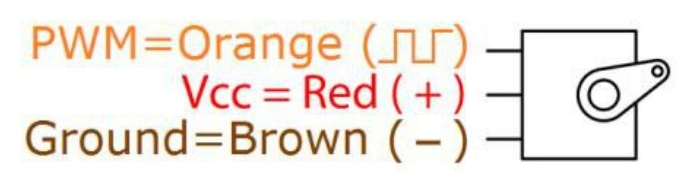
**Schematic**

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*Figure 3: Schematic diagram*

* *

*Figure 5 : Rotary Encoder           Figure 6: DHT11*

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*Figure 7:Servo Motor                                  Figure 8: Servo I/O*

*\*\* LED1= Green*

*\*\* LED2= Yellow*

*\*\* LED3= Green*

*\*\* LED4= Red \*\* LED5= Green*

**Testing Plan**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test name** | Description | Expectations | Outcomes |
| Humidity Sense | This test is to ensure that the DHT11 is functional and being utilized properly | Able to sense humidity levels properly | Functional(12/09) |
| Servo | This test ensures the servo is functional. | Able to rotate servo to desired motion. | Functional(12/10) |
| Timed- Rain | Timed- Rain is a test used to probe the servo and DHT11’s real time response. | “Rains” at a desired interval, and signals humidity levels via a serial monitor. | Functional (12/10) |
| Final | Final ensures final system works as intended. | System works as intended | Functional(12/11) |

**Memory Management Design and Proposed Enhancements**

*Scheduling Enhancements*

* EventQueue to manage user input
* Bounce for Rotary Encoder, timing and differentiating input signals

*Design Considerations for Future Improvement*

* Bounce prevention for the rotary encoder can be improved
* LCD use instead of serial monitor

*One Advanced Nucleo communication feature to leverage*

* Information can be transferred to multiple similar systems to water more plants simultaneously by implementing SPI

*DMA Possibilities*

* Directly mapping the Rotary Encoder inputs would make the knob turning function more accurate.

**References / BOM**

|  |  |  |
| --- | --- | --- |
| *Item* | *Description* | *Link* |
| *Nucleo-L4R5ZI* | - Board that runs on the STM32 microcontroller | <https://ublearns.blackboard.com/bbcswebdav/pid-5809698-dt-content-rid-36009862_1/xid-36009862_1> |
| *DHT11 Temperature Humidity Sensor Module* | -Humidity Measure Range 20%-95%,humidity measurement error: +-5%; Temperature Measure Range 0-50°C,temperature measurement error: +-2 degrees.  - Working voltage: DC 3.3V-5V.Output form: digital output. | <https://smile.amazon.com/Temperature-Humidity-Digital-3-3V-5V-Raspberry/dp/B07WT2HJ4F/ref=sr_1_23?crid=2ZECVUH3BF3V9&dchild=1&keywords=arduino+sensor&qid=1598036337&s=electronics&sprefix=arduino+sen%2Celectronics%2C165&sr=1-23> |
| *Rotary Encoder* | -Working voltage: 5V;  -The rotary encoder can count the number of pulse output during rotation in the positive direction and reverse direction through the rotation  -The Material of Knob Cap: aluminium alloy | <https://smile.amazon.com/Cylewet-Encoder-15%C3%9716-5-Arduino-CYT1062/dp/B06XQTHDRR/ref=sr_1_37_sspa?dchild=1&keywords=arduino+output&qid=1598037996&sr=8-37-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEyNVdPWVFSQUFXODA0JmVuY3J5cHRlZElkPUEwMzA3Mzg5MzIyUUlFQkhNRjBQSyZlbmNyeXB0ZWRBZElkPUEwMDgzOTU5MVBaRklNODVVRlNBRCZ3aWRnZXROYW1lPXNwX2J0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=> |
| *Servo* | -No Load Running Speed: 0.12 second/60 at 4.8V. Rotary Angle: 180°. Stall Torque (4.8V): 17.5oz /in (1kg/cm). Dead bandwidth: 7usec. Operating voltage: 4.8V~6V. | <https://smile.amazon.com/MakerDoIt-Micro-Arduino-Walking-Control/dp/B07C5PGD3Q/ref=sr_1_13?dchild=1&keywords=arduino+motor&qid=1598038649&s=electronics&sr=1-13> |
| *Jumper Cables, Resistors, LEDs* | -Standard | https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=aa67714567 |