



GreenThumb

Automated Gardening Solution

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Agenda

- **Product Introduction**
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 - GreenThumb Design
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 - Outputs
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The background features three horizontal, overlapping brushstrokes in a vibrant green color. A white rectangular border is superimposed over the center of these strokes, framing the text.

Product Introduction

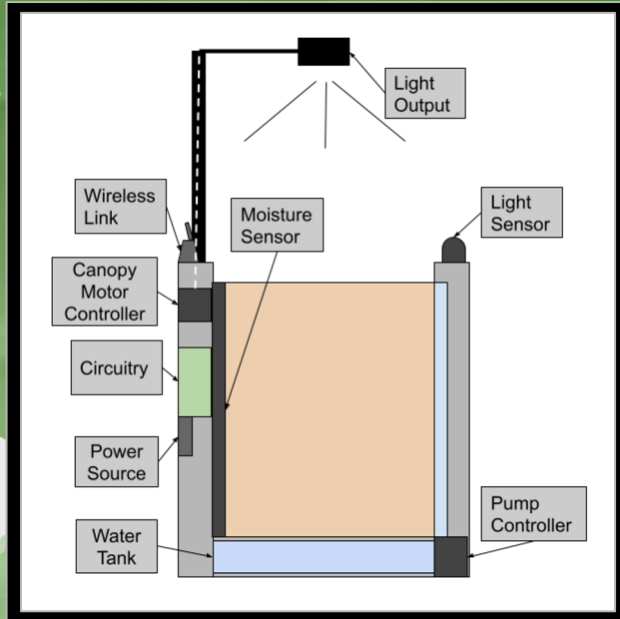


Problem Statement

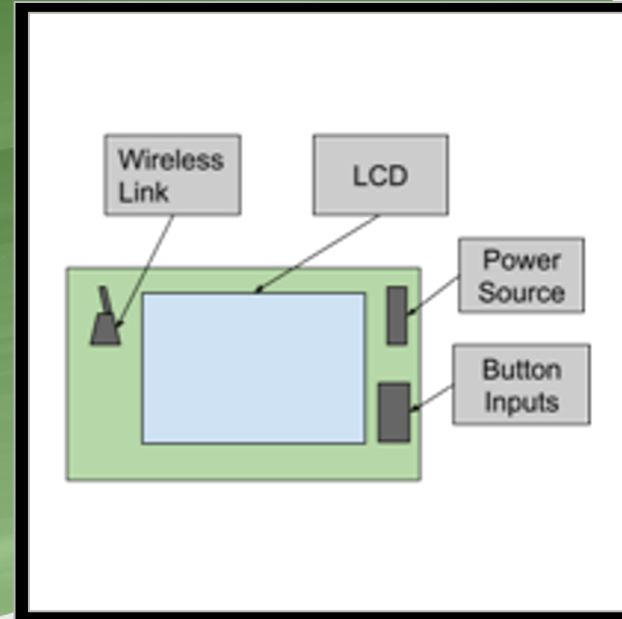
- **Problem:** Gardening has barriers to entry
 - Experience/knowledge of plant needs
 - Consistency of care
- **Solution:** An automated system that handles the daily minutia of garden maintenance
 - Sensors to monitor plant status
 - Outputs to affect plant status

GreenThumb Design

SmartPot



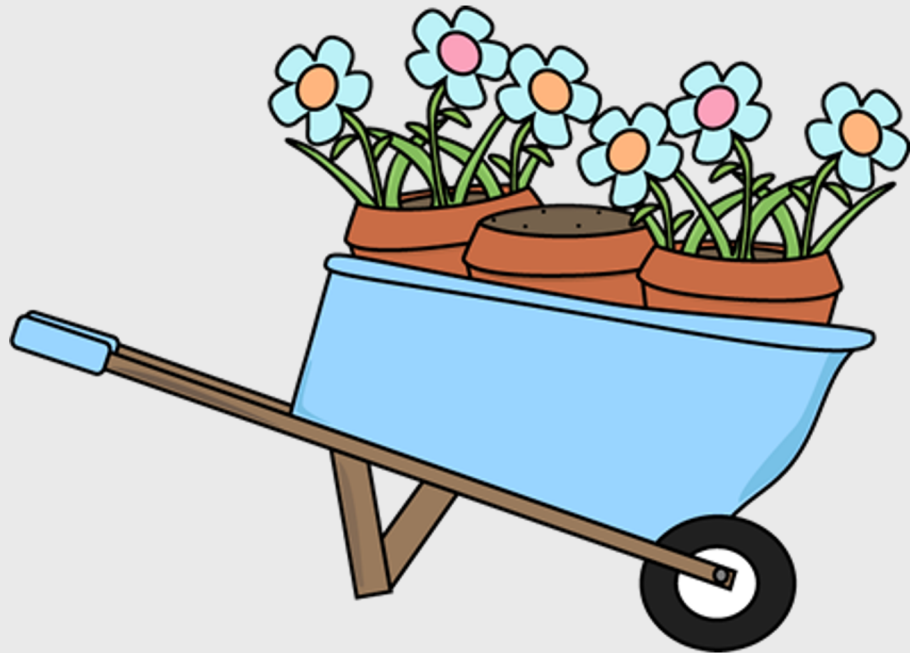
Main Controller



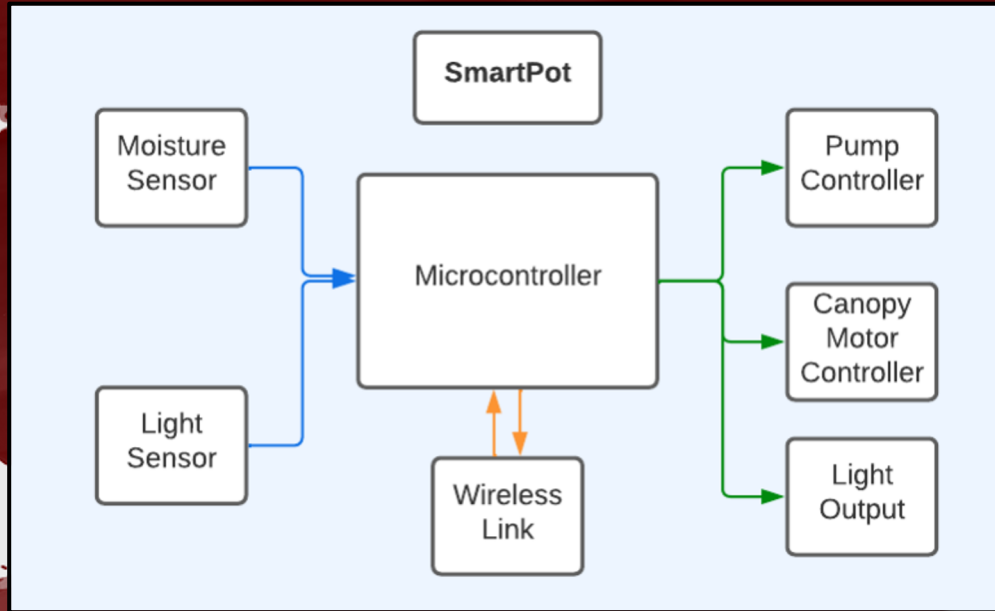


Hardware

Block Diagrams



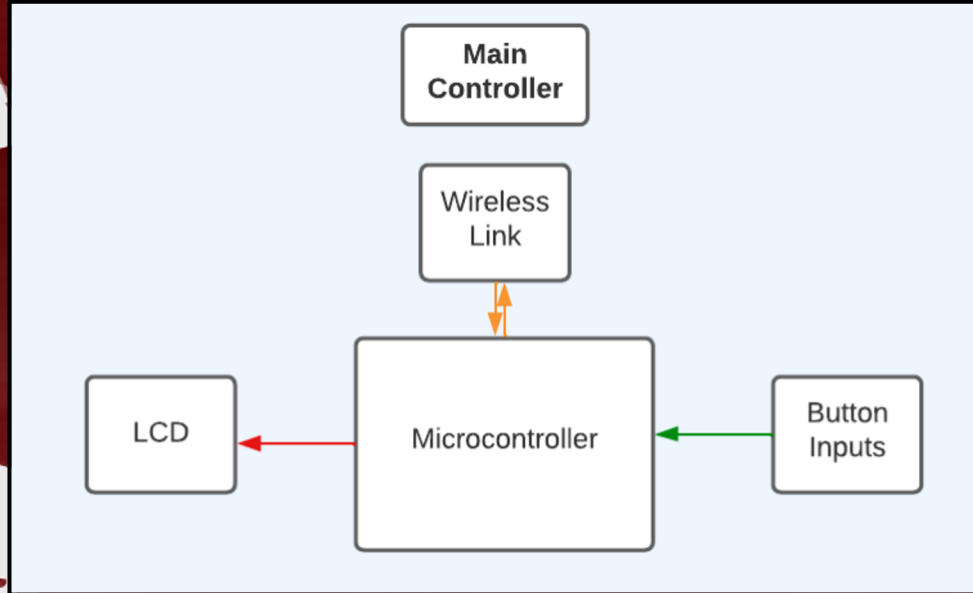
Block Diagram: SmartPot



Connection Legend

- Analog Input
- Digital Output
- SPI

Block Diagram: Main Controller



Connection Legend

- I2C
- Digital Output
- SPI

Inputs and Outputs



PinOut: SmartPot

(PCINT14/RESET) PC6	<input type="checkbox"/>	1	28	<input type="checkbox"/>	PC5 (ADC5/SCL/PCINT13)
(PCINT16/RXD) PD0	<input type="checkbox"/>	2	27	<input type="checkbox"/>	PC4 (ADC4/SDA/PCINT12)
(PCINT17/TXD) PD1	<input type="checkbox"/>	3	26	<input type="checkbox"/>	PC3 (ADC3/PCINT11)
(PCINT18/INT0) PD2	<input checked="" type="checkbox"/>	4	25	<input type="checkbox"/>	PC2 (ADC2/PCINT10)
(PCINT19/OC2B/INT1) PD3	<input type="checkbox"/>	5	24	<input type="checkbox"/>	PC1 (ADC1/PCINT9)
(PCINT20/XCK/T0) PD4	<input type="checkbox"/>	6	23	<input type="checkbox"/>	PC0 (ADC0/PCINT8)
VCC	<input checked="" type="checkbox"/>	7	22	<input checked="" type="checkbox"/>	GND
GND	<input checked="" type="checkbox"/>	8	21	<input type="checkbox"/>	AREF
(PCINT6/XTAL1/TOSC1) PB6	<input type="checkbox"/>	9	20	<input type="checkbox"/>	AVCC
(PCINT7/XTAL2/TOSC2) PB7	<input type="checkbox"/>	10	19	<input type="checkbox"/>	PB5 (SCK/PCINT5)
(PCINT21/OC0B/T1) PD5	<input type="checkbox"/>	11	18	<input type="checkbox"/>	PB4 (MISO/PCINT4)
(PCINT22/OC0A/AIN0) PD6	<input type="checkbox"/>	12	17	<input type="checkbox"/>	PB3 (MOSI/OC2A/PCINT3)
(PCINT23/AIN1) PD7	<input type="checkbox"/>	13	16	<input type="checkbox"/>	PB2 (SS/OC1B/PCINT2)
(PCINT0/CLKO/ICP1) PB0	<input type="checkbox"/>	14	15	<input type="checkbox"/>	PB1 (OC1A/PCINT1)

ATMega328P-PU

Connection Legend

- Ground
- Power
- Moisture Sensor
- Light Sensor
- Wireless Link
- Pump Controller
- Canopy Motor
- Light Output

PinOut: Main Controller

(PCINT14/RESET) PC6	<input type="checkbox"/>	1	28	<input checked="" type="checkbox"/>	PC5 (ADC5/SCL/PCINT13)
(PCINT16/RXD) PD0	<input type="checkbox"/>	2	27	<input checked="" type="checkbox"/>	PC4 (ADC4/SDA/PCINT12)
(PCINT17/TXD) PD1	<input type="checkbox"/>	3	26	<input type="checkbox"/>	PC3 (ADC3/PCINT11)
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VCC	<input checked="" type="checkbox"/>	7	22	<input checked="" type="checkbox"/>	GND
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(PCINT6/XTAL1/TOSC1) PB6	<input type="checkbox"/>	9	20	<input type="checkbox"/>	AVCC
(PCINT7/XTAL2/TOSC2) PB7	<input type="checkbox"/>	10	19	<input checked="" type="checkbox"/>	PB5 (SCK/PCINT5)
(PCINT21/OC0B/T1) PD5	<input checked="" type="checkbox"/>	11	18	<input checked="" type="checkbox"/>	PB4 (MISO/PCINT4)
(PCINT22/OC0A/AIN0) PD6	<input checked="" type="checkbox"/>	12	17	<input checked="" type="checkbox"/>	PB3 (MOSI/OC2A/PCINT3)
(PCINT23/AIN1) PD7	<input checked="" type="checkbox"/>	13	16	<input checked="" type="checkbox"/>	PB2 (SS/OC1B/PCINT2)
(PCINT0/CLKO/ICP1) PB0	<input type="checkbox"/>	14	15	<input type="checkbox"/>	PB1 (OC1A/PCINT1)

ATMega328P-PU

Connection Legend

- Ground
- Power
- LCD
- Buttons
- Wireless Link



Sensors



Moisture Sensor

Seeed Studio Capacitive Moisture Sensor

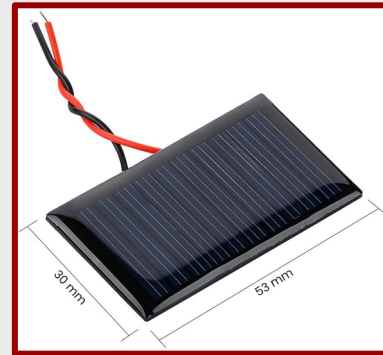
- Corrosion resistant
- Analog output will be read and used for determining when to water plant



Light Energy Sensor

5V Solar Cell

- Read output voltage generated by cell
 - Treat as an analog input
 - Calculate energy being produced
- Use energy value to determine when to open canopy/provide additional light via LEDs



Outputs



Water Pump

3V DC Submersible Pump

- Activates when moisture reading falls below threshold
- Pumps fixed volume of water from in-pot reservoir
- 100 mA draw
 - Needs transistor-diode switching



Canopy Motor

6-12V DC Motor

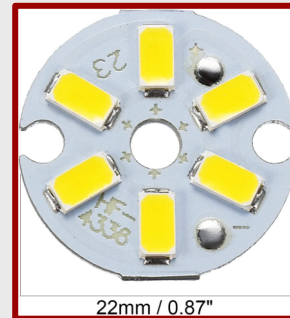
- Activates when measurement of total received light energy exceeds threshold
- Motor will pull on a pulley to expand and retract canopy
- 1 A draw
 - Transistor-diode switching



LED Grow Lights

3W White LED Chips

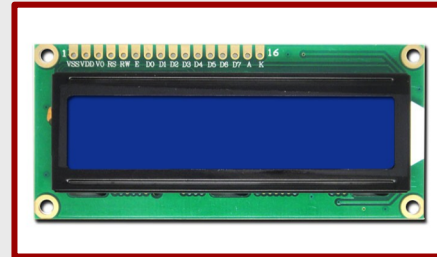
- Activates when light energy requirement has not been met after a specified time
- Artificially supplements plant light requirements
- 300 mA draw for each light
 - Buck converter in conjunction with transistor-diode switching



LCD Screen

16x2 LCD Screen

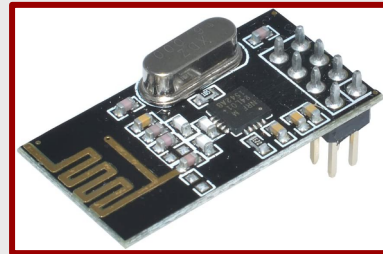
- Used in initializing pots and displaying status updates to user on the main controller
- Connected to main controller using I2C protocol
- 5V power, can draw from microcontroller directly



Wireless Transceiver

NRF24L01 RF Transceiver

- 100+ meter range, duplex communication, 125 selectable frequencies
- Used in SmartPots and main controller to exchange information via SPI
- Interrupt can wake device from sleep when communication is received



Powering the Devices

18650 Li-Ion Batteries

- Rechargeable, 3.7 V, 2600 mAh cells
- 3 or 4 will be used in both the SmartPots and the main controller



The image features a dark teal, textured brushstroke background that resembles a thick layer of paint. A white rectangular frame is superimposed over the center of the brushstroke. The word "Software" is written in a bold, white, sans-serif font, centered within the white frame.

Software

SmartPot:

How the
program will
work

- Implement a Watchdog Timer for 15 minutes to have chip on sleep mode until Watchdog interrupt occurs
- Then perform reading of sensors, call respective functions to perform actions depending on the values obtained
- Will use a BAUD rate of 9600 for sending and receiving serial data
- Will also use built in battery level detector to determine how much power left in device

A large, dark teal brushstroke graphic that starts from the left edge and extends towards the right, partially overlapping a white-bordered box. The brushstroke has a textured, painterly appearance with varying shades of teal and some white highlights.

SmartPot:

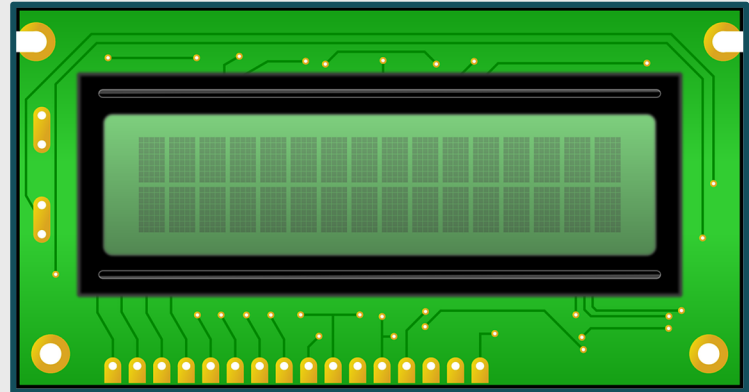
Component Communication

- Read analog measurements from moisture and light sensors using ADC pins (PC1 & PC2)
- Perform analog to digital conversions
- If moisture value readings fall below a certain threshold, will send digital output signal to water pump
- Depending on light energy sensor readings, will send digital signal to canopy motor to deploy or LED lights to turn on additional light

Main Controller:

How the program will work

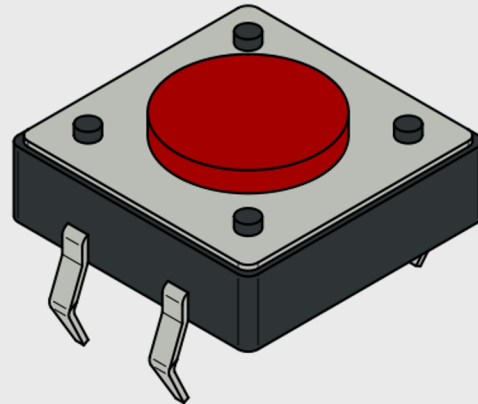
- The program will have an infinite loop to read inputs from button presses and output to the LCD screen
- Interrupts will be enabled in the case of receiving information from the SmartPot



Main Controller:

Component
Communication

- Will read in data from button inputs (up, down, select etc) and update LCD screen
- By reading the values of the respective pins at the button inputs, will output to LCD through the I2C protocol





Interrupts

- SmartPot Interrupt
 - Generate ISR to instantiate SmartPot from main controller → wake Pot from sleep mode to implement changes
- Main Controller Interrupts
 - If SmartPot detects a really low moisture (determined by threshold) for 3 cycles → notify MC of empty water tank
 - If SmartPot detects low light for more than 3 cycles → notify MC of possible bulb fuse
 - If SmartPot detects too much light for more than 3 cycles → notify MC of possible canopy deployment failure

MC = main controller



Cost Estimate

Main Controller

- ~\$32 in components (LCD, microcontroller, transceiver, batteries)

SmartPot

- ~\$55 in components (sensors, output devices, microcontroller, transceiver, batteries)



Q&A

THANKS!

