Bean Sprout Cultivating Assistant

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1. Introduction & Reason

In many cuisines, especially Asian, bean sprouts are a popular ingredient used in a wide range of dishes, such as stir-fries, soups, salads, and noodles. Their crips, crunchy texture and a mild, slightly nutty flavor help elevate the overall food experience. They are also a good source of vitamins, minerals, and fiber while being relatively low in calories, making them a valuable addition to a healthy diet. Bean sprouts are served as side dishes in a lot of eateries or family meals, and anyone can buy them at a cheap price.

Since bean sprouts can be easily purchased in traditional markets and are daily consumed in large quantities, the source of them becomes a matter of concern, as fertilizers can be over-applied to improve productivity, leading to potential health issues when consumed regularly. Therefore, an alternative to get fresh and safe bean sprouts is to grow them at home. However, growing them successfully requires consistent environmental control, especially temperature and humidity. Traditional manual methods can be labor-intensive and unreliable, particularly for beginners or those with busy schedules. Therefore, a Bean Sprouts Cultivating Assistant is introduced, automating and monitoring the cultivation process using an IoT (Internet of Things)-based system to help people grow bean sprouts themselves.

2. Background and context

Mung bean is a fast-germinating legume widely grown in Asia, especially for its sprouts known as *giá đỗ* in Vietnam. One of the key characteristics of mung beans is their ability to germinate rapidly under suitable conditions, often within 2–3 days. During this process, the bean's outer shell softens, and a white sprout emerges.

Ideal growing conditions for bean sprouts require a temperature range of 20 to 25°C. High humidity levels are necessary, particularly, they should be between 95% and 100%. Bean sprouts thrive in darkness and should be kept away from direct sunlight to prevent bitterness and promote proper sprouting. Maintaining these conditions consistently is crucial for healthy growth, optimal texture, and a clean, fresh taste.

3. Features

Bean Sprout Cultivating Assistant is designed to handle two main tasks:
- Collecting data and delivering messages: It has a temperature and humidity sensor placed in the growing container, collecting real-time data, which is processed by a microcontroller, and then displays the data on the device. When the temperature is higher or lower than allowed, it delivers a warning message to the owners.

- Automatically watering: It waters the bean sprouts either every 3 hours or when humidity drops below optimal levels.

4. Problem Statement

Manual cultivation of bean sprouts requires constant monitoring and precision, often leading to inconsistent growth and wasted resources. For instance, temperatures below 20°C can cause slow growth, while those above 25°C can stress the sprouts, or a moist environment should be properly maintained to ensure the germination process. An IoT-based system can enhance reliability, reduce manual labor, and optimize resource use.

5. Proposed Solution

The system will:
- Monitor conditions using temperature, humidity, and optional soil moisture and light sensors
- Automate watering via a relay-controlled pump based on humidity levels or preset intervals
- Display real-time data on a mobile/web dashboard
- Send alerts through notification services (e.g., email or Telegram)
- Record environmental and watering data for analysis and improvements

6. Technologies

- Programming Language (C/C++ (Arduino)) : Core language used to program Arduino Uno
- Development Platform (Arduino IDE)
- Sensor Libraries (DHT.h) : Used for interfacing with DHT11 temperature/humidity sensor
- Actuator Control (Manual digital output (for relay)) : Relay is controlled via digital HIGH/LOW signals from Arduino
- Data Visualization (Serial Monitor) : Used to view sensor output values in real time during simulation

7. Hardware

- Arduino Uno R3 : Main microcontroller
- Soil Moisture Sensor : Monitors soil moisture to trigger watering
- DHT11 Sensor : Measures air temperature and humidity
- Relay Module (1 Channel) : Controls the water pump (simulated)
- DC Motor (as Pump Simulation) : Acts as a simulated water pump
- 10kΩ Resistor
- Breadboard
- Jumper Wires Multiple
- External 5V Power Source

8. Circuit and code:
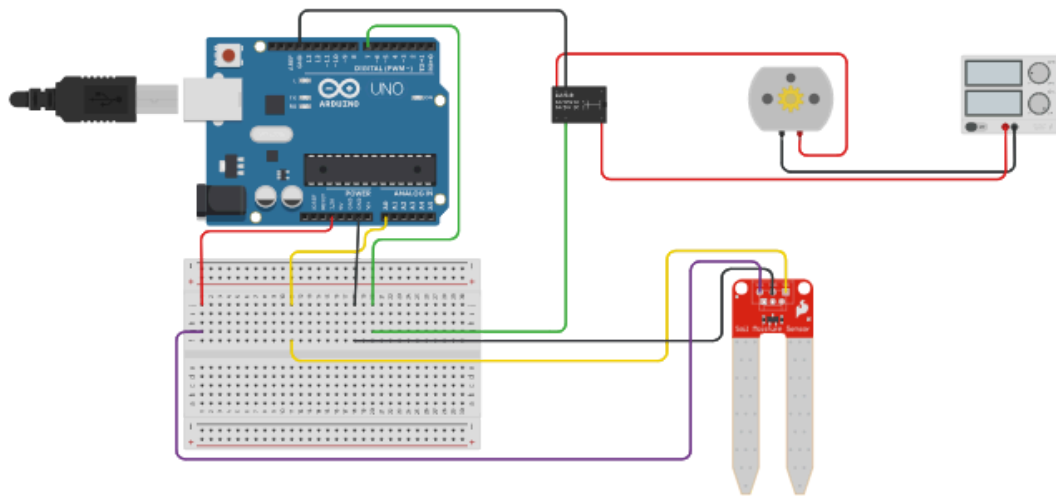
Code:

```arduino
1   #define moisturepin A0
2   #define pump 7
3
4   int moisturevalue = 0;
5   int lastmoisturevalue = -1;
6
7   void setup()
8   {
9     Serial.begin(9600);
10    pinMode(pump, OUTPUT);
11    pinMode(moisturepin, INPUT);
12  }
13
14  void loop()
15  {
16    moisturevalue = analogRead(moisturepin);
17    if (moisturevalue != lastmoisturevalue) {
18      lastmoisturevalue = moisturevalue;
19      if (moisturevalue <= 300) {
20        digitalWrite(pump, HIGH);
21        Serial.println("Soil Humidity = " + String(moisturevalue) + "% - Pump ON");
22      } else {
23        digitalWrite(pump, LOW);
24        Serial.println("Soil Humidity = " + String(moisturevalue) + "% - Pump OFF");
25      }
26    }
27    delay(100);
28  }
```

9. Expected outcomes

The expected outcomes of this project include the development of a working prototype that automates and improves the bean sprout cultivation process. By utilizing controlled environmental conditions, the system aims to enhance both the consistency and yield of the sprouts. Additionally, the inclusion of a remote monitoring and alert system ensures ease of use, allowing users to manage and oversee the cultivation process conveniently and efficiently.

10. Conclusion

The Bean Sprout Cultivating Assistant demonstrates how IoT can simplify urban farming. It provides a scalable solution for precision agriculture and lays the foundation for expanding automation to other crops in future versions.