# Identification of Fenugreek vegetable disease using IoT-based Color Sensor

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## ABSTRACT

The agriculture industry plays a crucial role in ensuring food security and sustaining global economies. However, fenugreek plant diseases pose a significant threat to vegetable income and quality, leading to substantial economic losses. Early detection and timely management of these diseases are critical for effective vegetable protection and improved farming practices. This fenugreek plant disease detection uses a TCS3200 color sensor to control the disease in its early stages for allowing the identification and differentiation of healthy and diseased fenugreek vegetable plants. Using IoT TCS3200 color sensor with Arduino UNO code to detect the color of fenugreek plant and shows the plant is disease or healthy. The TCS3200 color sensor-based fenugreek plant disease detection system offers several advantages over traditional manual inspection methods. It provides a non-invasive, rapid, and accurate means of detecting diseases before visible symptoms are visible. This enables farmers to take proactive measures, such as targeted treatments or timely removal of infected plants, to prevent further spread and minimize vegetable losses.

**Keywords:** Fenugreek, TCS3200 Color Sensor, Arduino UNO, Disease.

## INTRODUCTION

Fenugreek plant disease detection is an essential aspect of modern agricultural practices. Timely detection and accurate identification of plant diseases can help prevent the spread of infections, save vegetables, and increase productivity. In recent years, advancements in technology have made it possible to develop innovative methods for fenugreek plant disease

detection. One such method involves utilizing TCS3200 color sensors to identify disease symptoms in fenugreek plants. TCS3200 Color sensors are capable of measuring and analyzing the different color characteristics of plant tissues, which can provide valuable information about their health conditions. By detecting subtle changes in color patterns, these sensors can help identify the presence of diseases at an early stage, enabling timely intervention and control measures [1]. Figure 1 shows the different colored leaves of Fenugreek vegetable plants.

Figure 1. Different color leaves of Fenugreek vegetable plant.

The principle behind TCS3200 color sensor-based fenugreek plant disease detection is based on the fact that diseased plant tissues exhibit distinct color changes compared to healthy tissues. When plants are infected by pathogens or subjected to environmental stressors, they undergo various physiological changes that affect their pigment production, leading to alterations in color. These color changes can be indicative of specific diseases or stress conditions, providing a reliable means for disease detection.

TCS3200 Color sensors are designed to capture and quantify the intensity and variation in color values of plant tissues. They utilize specific wavelengths of light to illuminate the plant samples and measure the reflected or transmitted light. The reflected light is then analyzed using mathematical algorithms to extract color information, which is compared with pre-defined color thresholds to determine the presence and severity of diseases [2] [3].

## INTERNET OF THINGS (IoT)

The fenugreek vegetable leaves color detection using the TCS3200 color sensor consists of several components. The TCS3200 color sensor collects RGB color from fenugreek vegetables, which is then transmitted to a microcontroller or a central processing unit. The

microcontroller processes the data and sends it to a serial monitor [4]. This enables users to access real-time color information about the fenugreek plant. IoT is a User interactive device that a farmer can integrate into real-time and experimental approach for all the electrical or electronic gadgets to change them into a very ore smartly. This research is beneficial to farmers for continuous inspection, collected information analysis, storing of cloud information, generating an activity dependent on a farmer's concern, real-time alert system, and plant observations.

The Internet of Things research report has an excess of 50 Billion gadgets that will be connected to IoT in the 2022 year and also developed various applications to rise towards automation, effective frameworks, and smart gadgets. Farmers do not easily understand the Internet of Things but they can handle gadgets easily and also they can build their learning methods by using IoT devices or sensors [5].

In the ancient systems, there were no methods or systems available to detect the fenugreek vegetable leaf color. Detecting plant leave color using nicked eye required good eye vision of the farmers. Sometimes they fail failures detect the color of the fenugreek plants. To solve these problematic situations design a well system to detect the fenugreek vegetable plants [6].

## EXPERIMENTAL METHOD

This system contains RGB Color range by using a TCS3200 color sensor that is linked to the Arduino UNO which is to be used for collecting RGB Values on fenugreek vegetable plants, as a result of their different RGB range values. Collecting the present farming features such as RGB range color from fenugreek vegetable plants that were evaluated with the Arduino UNO programming. The TCS3200 Color sensor transfers its RGB range values to the Arduino UNO and then shows whether the fenugreek vegetable is diseased or healthy. Figure 2 shows the System diagram for detecting the color of Fenugreek vegetable plants by using the TCS3200 Color Sensor.

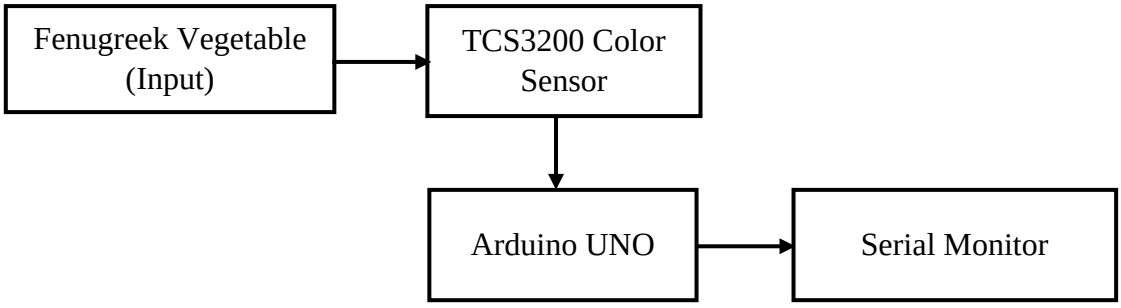

Figure 2. System diagram for detecting color by using TCS3200 Color Sensor.

**Arduino UNO**

The Arduino UNO is based on an ATmega328P microcontroller board. It has a total of 14 digital input and output pins from this 6 Analog inputs, a 16 MHz quartz crystal, a USB connection, and a power jack pin are available. It is a popular development board for beginners and experienced makers alike, as it is relatively easy to use and has a large community of users and resources available. It can be programmed using the Arduino programming language. Figure 3 shows Arduino UNO, which can be used for a variety of projects, ranging from simple LED blinking to more complex robotics and automation systems.

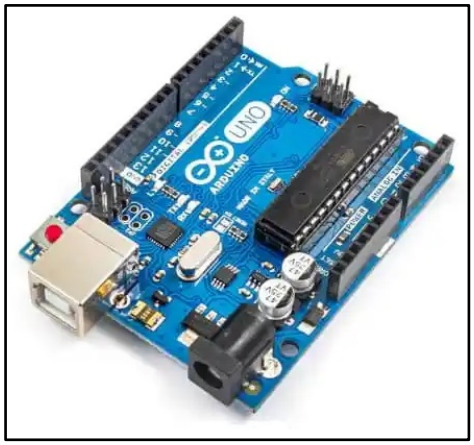

Figure 3. Arduino UNO

**TCS3200 Color Sensors**

The TCS3200 is a color sensor module that can detect and measure the intensity of light in different wavelengths, making it capable of recognizing and distinguishing between different colors [7]. It features an array of photodiodes with red, green, blue, and clear filters, which can be used to detect the RGB components of light. Figure 4 shows the TCS3200 color sensor that will be connected to the Arduino UNO. This Sensor has four pins:

i. VCC: Connect the VCC pin to a 5V power source.
ii. GND: Connect the GND pin to the ground of the microcontroller.
iii. S0 and S1: Connect the S0 and S1 pins to the desired frequency scaling selection. These pins determine the output frequency range, allowing you to control the sensitivity of the sensor.

iv. OUT: Connect the OUT pin to a digital input pin on your microcontroller.

After connecting this sensor's pin to the Arduino UNO then writes code to read the data from the sensor and detect the RGB color range [8]. This can be done using the Arduino UNO library and by implementing the communication protocol to communicate with the sensor directly.

Figure 4. TCS3200 Color Sensor

**Experimental Procedure for identification of Fenugreek Plant Disease using TCS3200 Color Sensor**

The color of the plant tells up heath conditions of the fenugreek plants, that color changes due to plant tissue, and fenugreek plants staining uses green tissue for losses of their color due to chlorophyll. So to identify the color using RGB color range values to determine whether fenugreek plants are healthy or diseased. The following steps are used to determine whether the fenugreek plants are diseased or healthy. If the Minimum range of R=110, G=70, and B=100. In the maximum range of R=140, G=110, and B=120 the fenugreek plant shows a green color which means the plant is healthy otherwise the fenugreek plant is diseased [9] [10].

Step 1: Start

Step 2: Set the TCS3200 Color Sensor near Fenugreek Plants

Step 3: Sense the color of the fenugreek plants using the TCS3200 Color sensor.

Step 4: Take a reading of the fenugreek plant using RGB Values.

If (Min_RGB_Value < Actual_RGB_Value < Max_RGB_Value)
Display “Healthy”

Otherwise,

Display “Disease”

Step 5: Stop

## RESULTS

This system tested 100 fenugreek vegetable plants out of which 50 samples are Disease, 50 samples are healthy. Initialized the standard range of RGB color Minimum range of R=110, G=70, and B=100. Maximum range of R=140, G=110, and B=120 for identifying the healthy color of fenugreek plants. If the reading of a color sensor is greater than or less than this initialized range then the fenugreek plants are diseased, which means it will show the other colors like brown, yellow, and white are the fenugreek plant disease color. This range is reading taken from the TCS3200 color sensor and then identifying this color range by using Arduino UNO code. Table 1 shows that TCS3200 Color Sensor values were taken in a fenugreek plant farm and the accuracy level of this system is 98% in identifying the fenugreek plant healthy or diseased.

Table 1: TCS3200 Color Sensor values

| **Plant No.** | **Color Value** | | | **Healthy Or Disease** |
|---|---|---|---|---|
| | **R** (Min=110, Max=140) | **G** (Min=70, Max=110) | **B** (Min=100, Max=120) | |
| 1. | 112 | 78 | 110 | Healthy |
| 2. | 10 | 60 | 100 | Disease |
| 3. | 150 | 250 | 190 | Disease |
| 4. | 115 | 80 | 112 | Healthy |
| 5. | 220 | 230 | 180 | Disease |
| 6. | 130 | 230 | 140 | Disease |
| 7. | 120 | 82 | 113 | Healthy |
| 8. | 112 | 75 | 103 | Healthy |
| 9. | 162 | 232 | 135 | Disease |
| 10. | 122 | 80 | 115 | Healthy |

## CONCLUSION

The identification of fenugreek plant diseases using TCS3200 color sensors is a valuable and efficient method in the Internet of Things (IoT). Color sensors can accurately detect changes in the color of plant tissue, which often indicates the presence of diseases or other physiological disorders. By analyzing the data collected from these sensors, researchers and farmers can quickly diagnose the specific diseases affecting the plant. This early detection enables timely intervention, such as targeted treatment or removal of infected plants, which can help minimize the spread of disease and prevent crop losses. TCS3200 color sensors and Arduino UNO are cost-effective, non-invasive, and can be easily integrated into automated systems for large-scale monitoring. Overall, the use of color sensors for the identification of fenugreek plant diseases offers great potential in improving plant health, crop management, and ultimately, ensuring food security.

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