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SENSOR BASED SOIL NUTRIENT MONITORING IN AGRICULTURE

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Abstract

The creation and use of sensing technology is one of the main components in achieving sustainability in agricultural production through precision agriculture. This article outlines the primary sensing methodologies used for tracking soil nutrients in view of recent improvements in the sensing devices utilised in literature. To locate the nutrients in the soil, the designed prototype has AS73211 colour sensors that work with a NODE MCU. Two different soil samples were used for the measurement. Testing on various samples showed that Nitrogen and Potassium is more that the threshold values of 445-485nm and 625 – 685nm respectively in both the soil samples. The method developed is more useful and suitable for use in farming.

Keywords: NPK, Soil Sensor, NODE MCU

1. INTRODUCTION

Many sorts of technology have now been developed in the field of advanced technology to make it easier for people to go about their everyday lives. Many instruments have been developed in agricultural technology and elsewhere to aid farmers in carrying out their agricultural operations and producing healthy crops. Land with sufficient fertiliser is one of the essential elements that should be present for a decent yield. In order to meet the demands of a society that is increasingly dependent on food supply, enough fertiliser may help plants generate good yields and volumes. Every nation must have enough nutrients (NPK) quantity of crops. These three nutrients each support different aspects of plant growth: nitrogen supports the development of leaves, phosphorus supports the evolve of roots, and potassium supports the development of flowers and fruits while maintaining nutrient and water balance in plant cells. A variety of techniques, including optical, electrochemical, acoustic, electrical and electromagnetic, and mechanical ones, have been used by previous researchers to construct NPK detection devices [2]. [3] Provides a useful overview of sensors for precision agriculture. Because of its exceptional sensitivity and quick reaction, the optical detection approach has recently been found to offer a better potential for real-time detection [4]. Many studies on the detection of NPK soil using optical methods [1, 5-7] have been published. In these experiments, the soil is lit by a light. To drive the light to the earth, the majority of the produced systems included additional optical components such fibre optics [7, 8].

An optical detection approach based on colour detection is used in this work. The detection method is regarded as a direct detection method since it does not require any extra components. Using a photodiode that can convert light into electricity. The AS73211 chip is employed for both colour conversion and this function. The output current is transformed and presented as a result of NODE MCU's manipulation of the chip's output.

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2. METHODOLOGY

Fig. 1 depicts a combined optical transducer with NODE MCU for detecting NPK in the soil. The light source was controlled by the microcontroller (NODE MCU) in a transmission system. In addition, it served as a data collecting system for light detecting systems and offered control features for the display. In our current system, an AS73211 chip with low power and low integration is employed as the optical transducer. Three channels create a continuous or triggered measurement by converting light signals from photodiodes to a digital output. The photodiodes transform the incoming light into a photo current, which is then converted to digital data by a later current-to-digital converter. Using an external resistor, an internal reference generator supplies all essential references for the A/D conversion and the photodiodes.

Three 16-bit registers hold the A/D conversion's output and may be accessed through the I2C interface. The input pin SYN can be utilised for the measurement's externally driven start or start and stop. The state of the conversion is shown in the output, READY. The AS73211 is ideal as an optical converter for three distinct wave lengths due to its great versatility.

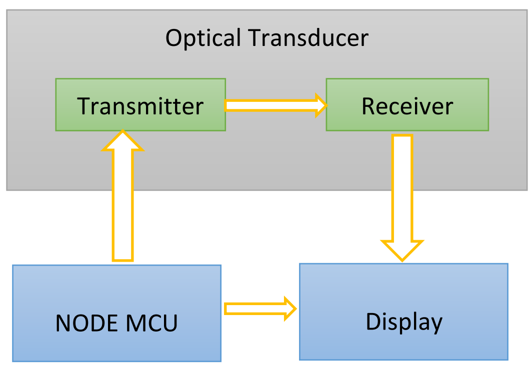

Fig 1: Block diagram of combined optical transducer and NODE MCU

3. EXPERIMENTAL SETUP

Fig.-2a depicts the schematic layout of the experimental setup used to measure soil nutrients. The soil measuring setup is shown in Fig.-2b. The AS73211 chip and LED were placed parallel to one another for the measurement. The chip sensor detects light after it has been reflected by the reflector. To estimate the optical path length, the influence of the incident light that the detector emits was examined. According to the specification of the LED datasheet, the LED considerably collimated the incoming light in the region of 1 to 5 cm. The measurements were made by moving the LED and sensor chip from the closest to the furthest positions.

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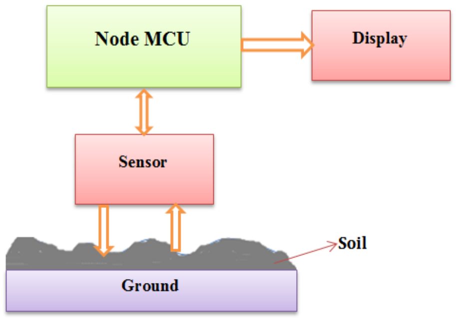

Fig 2a: Illustration of soil nutrient measurement system

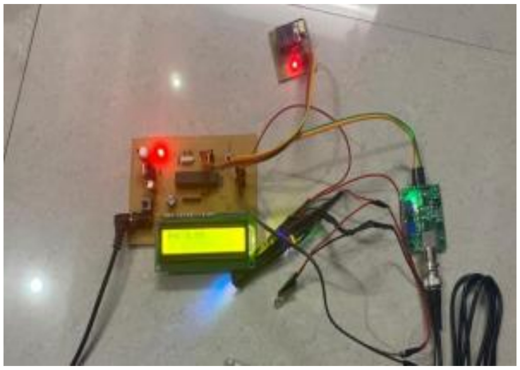

Fig 2b: NPK soil measurement setup

The AS73211 chip was used to assess the soil test absorption using two soil samples, as shown in Fig. 3. The table contains a list of the example specifications. Under the irradiation of LED light, each soil sample that had the ideal density was exposed to the reflector.

Table 1: Soil Characteristics of different samples

Sample	Soil Characteristics
1	Dry and sandy
2	Grassy and damp

$$\begin{pmatrix} X_{sensor} \\ Y_{sensor} \\ Z_{sensor} \end{pmatrix} = K.\begin{pmatrix} adcX \\ adcY \\ adcZ \end{pmatrix} \qquad (1)$$

X_{sensor}, Y_{sensor} and Z_{sensor} in (1) are corrected sensor values in ADS73211 chips that determines the colour. adcX, adcY and adcZ are different absorbed values of the photodiodes of the sensor. The NODE MCU established a set of threshold values that were used to compare the measured wavelengths for each nutrient to. These voltage levels—High, Mid, and Low—were used to categorise the degrees of nutrient shortage in the soil.

4. RESULTS AND DISCUSSIONS

Fig.-3 depicts the sensor module's reactions to LED illumination for various lengths of the path. To find the ideal route length between 1.0 and 9.0 cm, all of these replies will be compared. Because of the ADS73211 chip's sensitivity, as can be seen in Figure 3, the received light was greatly dispersed at both shorter and longer distances. Thus, a 5 cm optimal route length between the sensor chip and soil sample was selected based on the analytical results.

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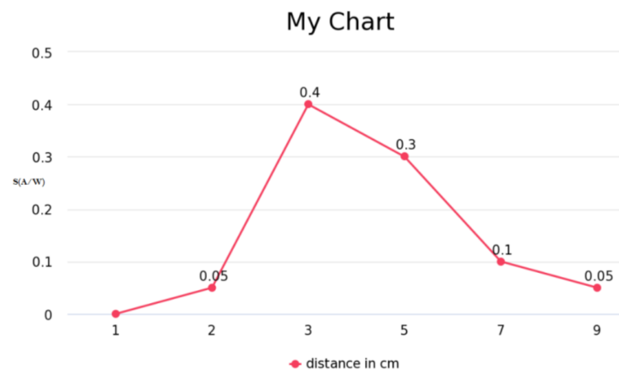

Fig 3: Determination of optimum path length

Table 2: Range of wavelengths for NPK soil

Nutrient	Wavelengths in nm
Nitrogen	445-485
Phosphorous	505-565
Potassium	625-685

The threshold wavelengths of NPK in the soil are shown in Table 2. The obtained wavelengths of NPK in soil samples 1 and 2 are displayed as bar graphs in Fig.-4. According to the value above the 485 nm threshold wavelength, soil sample 2 has the maximum quantity of nitrogen.

Nitrogen is present in sufficient amounts in Sample 1. Phosphorous is present in sufficient amounts in both samples 1 and 2. Whereas sample 2 has an acceptable quantity of potassium, sample 1 has a low potassium content. As a result, it is simple to calculate the NPK soil concentration in each sample when just a specific nutrient is applied to the sample.

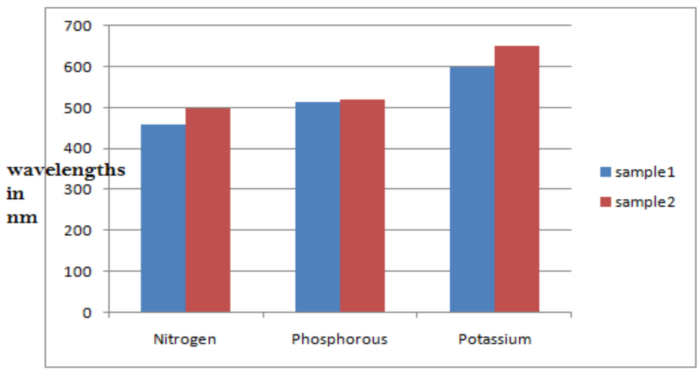

Fig 4: Absorbed Wavelengths of NPK in Soil Sample 1 and Sample 2

5. CONCLUSION

The results of this study show that the AS73211 sensor with Node MCU may be used to precisely measure the concentrations of N, P, and K in soil. This study can assist farmers who are having problems estimating the quantity of nutrients in their soil, at a lesser cost than current technologies. It can also lessen the accidental injection of soil fertiliser. This may be calculated, and the NPK levels of the soil can be shown, using nutrient light absorption from colour sensor LEDs.

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