ICSD/12

SMART ELECTRONIC NOSE SYSTEM FOR MONITORING ORGANIC ABUNDANCE IN SOIL

Pranjal Sakhala,
BEIT, Dept. of Information Technology, KKWIEER, Nashik
pranjals548@gmail.com
Pooja R.Adke,
BEIT, Dept. of Information Technology, KKWIEER, Nashik
poojaadke01@gmail.com
Neha S.Darade,
BEIT, Dept. of Information Technology, KKWIEER, Nashik
daradeneha14@gmail.com
Sanjana V.Patil,
BEIT, Dept. of Information Technology, KKWIEER, Nashik
patilsanjana2015@gmail.com
Prof.Smita N. Chaudhari
Assistant Professor, Dept. of Information Technology, KKWIEER, Nashik
s.n.chaudhari@kkwagh.edu.in

Abstract

A rapid increase in the world's population, give rise to significant challenging problems ex. food demand, quality food, industrial environmental pollution, etc. The traditional farming techniques decrease the chances to meet global food demand. So providing access to safe and nutritious food is at probable risk. The quality of food seems to be decreased and the growth of food seems to be slower than the population growth. To increase the food productivity and also its quality, monitoring soil abundance plays a key role in organic farming. To solve this problem, an Electronic Nose (E-Nose) is designed to monitor soil organic nutrients. An E-nose consists of an array of various chemical gas sensors that detect different gases. In this system, Volatile Organic Compounds (VOCs) from the soil are inhaled with the help of the suction pump and they are measured using gas sensors like Mĭngăn Qĭ lai (MQ). The software application is integrated to analyze soil data and display information to a user about deficiency or excess of particular soil minerals, so that it becomes easy for farmer to take decision regarding which crop should be planted.

Keywords: Organic Farming, E-Nose, Food Security, Soil VOCs, Organic Abundance, MQ Sensor.

1. Introduction

A real-time smart electronic system is designed to monitor soil organic richness online in the farm to support farmers in making an informed decision about which crop to plant in their respective farm. The system is capable of archiving real-time soil data based on soil organic volatile. The software application is integrated to analyze soil data and display soil information online including weather parameters in line with the soil status. Base station installed in the farm transmits soil data to the control station for analysis and uploading data into a database for end user's information. Data is analyzed by principal component analysis to grade organic abundance in soil and linear discriminate analysis to segregate soil volatile variation and demands required by regulatory agencies and the consumer for ultimate scalability in commercial markets.

2. Implementation

2.1. Workflow of system

- Real-time smart electronic nose system is customized to transmit data to the control center. Different metal oxide gas sensors are arrayed in the system for sensing soil VOCs to archive real-time data using a microcontroller. The flow unit in the smart electronic nose system controls the switching time between sample gas (soil VOCs) and reference gas (filtered air). The system is programmed to document soil data continuously and to display soil organic abundance on websites for the farmers to make an informed decision for future cultivation[1].

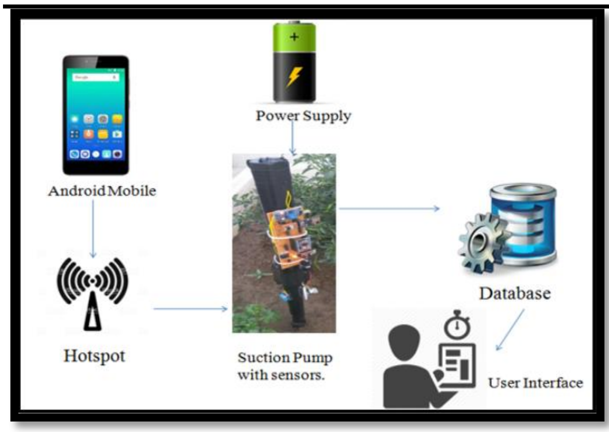

Fig.1. Smart Electronic Nose Architecture

1. Mobiles Hot-spot connected to Arduino UNO transmits data received wirelessly
2. Electric support is provided by Power Bank or if possible then by Laptop
3. Mini air suction pump draws soil odours
4. Sensor chamber consists of an array of three MQ gas sensors that imitates Data Acquisition Module olfactory system
5. Data transmitter uses Arduino UNO to read the sensing response
6. Arduino reads soil data from sensor array every sixth second
7. This data is mapped with the main data in database which is static
8. This data is then displayed to farmers on website to make an informed decision for future cultivation

2.2. Data Acquisition Module

Smart E-Nose system consists of an elongated tube mounted on the soil surface to draw soil odours using an air suction pump. The pump delivers the soil odours through a tube to the sensing chamber that consists of MQ gas sensor array (Table I)[1].

Table 1: Arrayed Gas Sensors of the System

SR. No.	Target Gas of Soil	Sensor Type
1	Ammonia & Nitrogen Gas	MQ 135
2	Alcohol & Benzene	MQ 3
3	Methane	MQ 4
4	Hydrogen	MQ 8

Microcontroller initiates the input commands and the output data is floated via Mobile Hotspot Connection- wirelessly that reads data from Arduino and transmits in every twenty seconds.

3. Literature Survey

- After studying several papers we came to know that plant leaves disease can be identified through some techniques:
  - Image Aquisition
  - Segmentation
  - Feature Extraction
  - Classifires

  This was in the "Identification of plant disease through Image Processing" paper. Limitation in this paper was that it is not applicable in all areas.
- Other paper "Soil sensing: A new paradigm for agriculture (Viscarra Rossel and Bouma, 2016)" indicated that soil affects on the plant growth.
- Another paper "Soil sensing survey robots based on electronic nose(T. Pobkrut, T. Kerdcharoen)" was on checking the functionality of soil. Limitation was with sensors which gave duplication of values.

4. Example

The soil is a dynamic natural body composed of mineral and organic material and living forms in which plant grow. Plant growth is a progressive development of organs or whole plant and expressed in term of dry weight, length or diameter [2].

4.1. Percentage of Nutrient in Wheat and Soybean are:

The Nutrients like C, H, O, N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B, Mo, Cl, Ni. and their values in percentage for Wheat and Soybean are given below[5].

Table 2: Nutrients In Wheat And Soybean

Nutrients	Wheat	Soyabean
Calcium Ca	2.9	19.7
Iron Fe	0.139	0.355
Magnesium Mg	12.6	6.5
Phosphorus P	28.8	19.4
Potassium K	36.3	62
Zinc Zn	0.265	1.5
Copper Cu	0.043	0.099
Manganese Mn	0.399	0.013
Nitrogen N	7	7

4.2. Gases and their value required for Wheat and Soybean are:

Here we take records or data of Wheat and Soybean which is our database and that values are mapped with sensing values. The requirement of Hydrogen gas for plant growth is more than 63%. Ammonia is harmful to plant but is used in fertility so it should be less than 0.5 ppm[4].

Table 3: Gas in Wheat and Soybean

Gas	Wheat	Soybean
Hydrogen Gas	More than 19.24100ppm	More than 19.24100ppm
Ammonia	Less than 0.5ppm	Less than 0.5ppm
Carbon Dioxide	More than 2500ppm	More than 2500ppm
Oxygen	209000ppm	209000ppm
Nitrogen	792000ppm	792000ppm

5. Features

- It will be easy for farmers to take decision regarding which crop to plant
- As it is cheap, many of the farmers can afford this system
- System will be available in all the local languages so it will be very beneficial as there will be no compulsion of English
- Farmers can save themselves from big loss
- Farmers will be aware about their farm

6. Challenges

- Duplication of values got from Sensors
- Weather conditions

Conclusion

In this study, greater variation of soil VOCs emission was established among the locations examined. This variation was accounted to the effects of environmental parameters such as light, soil temperature and soil moisture. The twenty-four hours of soil VOCs profile exhibited that the soil VOCs emission rate was high during the day due to the presence of light and higher temperature leading to higher diffusion rate while it was low during the night. It was found that organic nutrients varied within field areas that were positively classified by PCA patterns in different groupings. One of the optimistic results indicated from the soil data analysis was similar PCA patterns were accomplished from the soil with similar fertility level of organic nutrients. The system was successful in predicting surface soil organic matter content which can be used in place of conventional arial mapping to predict surface soil organic matter content. In future, smart electronic nose system could be deployed to predict nitrogen content in soil using specific sensor array and finding soil degradation rate.

References

[1] U.Dorji, T.Pobkrut, S.Siyang, "Development of Real-time Smart Electronic Nose System for Monitoring Organic Abundance in Soil", Bangkok 10400, Thailand, 2017

[2] T. Pobkrut, T. Kerdcharoen, Department of Physics, Faculty of Science, Mahidol University," Soil sensing survey robots based on the electronic nose" Bangkok 10400, Thailand, 2014

[3] U. Dorji, T. Pobkrut, T. Kerdcharoen, International Conference on " Electronic Nose Based Wireless Sensor Network for Soil Monitoring in Precision Farming System " 978-1-4673-9077-4/17/31.002017IEEE

[4] N. E. Tautges, T. S. Sullivan, C. L. Reardon, and I. C. Burke, “Soil microbial diversity and activity linked to crop yield and quality in dryland organic wheat production system,” Applied Soil Ecology, vol.108, pp. 258-268, 2016.

[5] R. A. ViscarraRossel and J. Bouma, “Soil sensing: A new paradigm for agriculture,” Agricultural Systems, vol. 148, pp. 71-74, 2016.