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Newly Calibrated Analytical Models for Soil Moisture Content and pH Value by Low-Cost YL-69 Hygrometer Sensor

Weng Yeow Tan[a], Yi Lung Then[b*], Yao Long Lew[c], Fei Siang Tay[d]

[a,b,d]*School of Engineering, Faculty of Engineering, Computing, & Science, Swinburne University of Technology Sarawak Campus, 93350 Kuching, Sarawak, Malaysia.*
[c]*School of Chemical Engineering & Science, Faculty of Engineering, Computing, & Science, Swinburne University of Technology Sarawak Campus, 93350 Kuching, Sarawak, Malaysia*

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ABSTRACT

Soil moisture content and soil pH values, especially in the surface layers of the soil play a significant role in agriculture production in hydrological processes, meteorology observation and horticulture study. This paper proposes an analytical model of estimating the moisture content, acidity and alkalinity in soil through measurement of soil resistivity by an on-site, real-time method. In this study, a low-cost soil resistivity sensor YL-69 was used to characterize the dynamics of soil moisture content and its pH value. Laboratory calibrated regression models were developed for three types of soils, i.e., clay, thionic, and fine sandy loamy to evaluate the effect of soil temperature and the depths of sensor on the apparent soil moisture content and pH value with a single resistive sensor. The prediction models were found to be accurate with the accuracy of 98%. The findings obtained from this study could provide inexpensive and accurate simultaneous soil moisture content and pH value measurement.

1. Introduction

Soil moisture content is an influential source of water in the hydrological cycle and the fundamental importance to many biological, hydrological and biogeochemical processes. The availability of moisture in soil is essential for nutrient-cycling and a pre-requisite for primary production (Dobriyal, Qureshi et al. 2012). On the other hand, the chemical properties of a soil such as alkalinity and acidity determine the quality and productivity of the soil. pH value within the range of 5.5 to 6.5 is considered optimum while it is well known that soils of extreme acidity or alkalinity can make crops more prone to diseases and are non-productive for most crops.

Soil moisture content and pH value are a useful index in making management decisions for agriculture and natural vegetation because they influence variety of processes related to agriculture production, plant growth, changes in the hydrological regimes as well as a range of soil processes. Soil moisture content acts as a nutrient (Ansari and Deshmukh 2017) and serves as solvent for other nutrients and it makes significant impact on plant growth, evaporation, microbiological decomposition of soil organic matter and percolation while soil pH value serves as a predictor of various chemical activities within the soils and a rough indicator of the plant availability of nutrients in the soil (Ansari and Deshmukh 2017). In agriculture point of view, soil moisture content and pH value are essential for many applications like irrigation scheduling, plant stress and for improving crop yield. Therefore, the accessibility and information about the soil moisture content and pH value will alter the fate of water and resources allocation for various human needs, including industrial, domestic and agriculture uses.

Examination methods of soil moisture content and soil pH have been investigated. Measurement of soil moisture content can be categorized into direct and indirect methods. Direct methods have high accuracy but also destructive and thus not repetitive. Indirect methods on the other hand are mainly based on measurements with non-destructive sensors. Time Domain Reflectometry (TDR), Frequency Domain Reflectometry (FDR), capacitive and resistivity sensor are most popular among indirect soil moisture content measurement. TDR and FDR have high temporal resolution, but they are costly to implement and lack of sustainability.

* *Corresponding author*
E-mail address: ythen@swinburne.edu.my