ABSTRACT

In agriculture and plantations, water content greatly influences vegetation growth, survival, and productivity. Measuring soil water content (SWC) directly in large areas requires much time, effort, and money. Indirect measurement using a radar system becomes the right choice for this case. Radar systems have been extensively studied in developing non-contact sensor technology to detect soil water content. The SWC greatly affects the soil relative permittivity which affect the reflected signal, so the radar system can effectively measure SWC.

In plantation areas, vegetation on the ground, which acts as a barrier when detecting using a radar system, can significantly influence the detection result. The estimation of SWC in this study is highly dependent on the reflected signal received by the radar. Without considering the vegetation, the accuracy of the SWC estimation becomes inaccurate. The method for reducing the effect of vegetation is needed to obtain the SWC estimation accurarely.

This paper proposes a method for estimating SWC by considering the presence of vegetation using the Frequency Modulated Continuous Wave (FMCW) radar system by elaborating the model of propagation wave across the layered medium. The numerical simulations were carried out to determine the theoretical correctness of the concepts used in this study. The experiment in static conditions were carried out to define the effect of the vegetation on the detection results using the FMCW radar, to obtain the vegetation electrical properties, and to estimate the SWC in various heights by considering the presence of vegetation. The result obtained using proposed method in static condition has succesfully overcomes the vegetation effects and has the accuracy of 97.38% for estimating the SWC in tea plantation. The experiment in dynamic conditions, the FMCW radar becomes a payload drone. The result obtained using proposed method in dynamic conditions has succesfully overcomes the vegetation effects and non-constant magnitude due to the fluctuation in drone movement and has the accuracy of 97.18% for estimating the SWC in tea plantation.

Keywords: Radar, FMCW, Soil Water Content, Vegetation, Reduction.