International Journal of New Technology and Research (IJNTR)
ISSN:2454-4116, Volume-4, Issue-1, January 2018 Pages 45-51

Validation of Wireless Volumetric Soil Water Content Sensor Based on Soil Temperature and Impedance Measurements

José Antonio Gutiérrez-Gnecchi, Enrique Reyes Archundia, Adriana del Carmen Téllez Anguiano, Arturo Méndez Patiño, Luis Enrique Fregoso Tirado.

***Abstract*— The rational use of water resources requires accurate assessment of soil moisture content. During the last three decades, electromagnetic measurement techniques have evolved into versatile, cost- effective solutions for conducting in situ soil moisture measurements. However, it is still necessary to further continue developing technological solutions that can yield soil moisture measurements close to the real content, stressing ease of use and can be adjusted to operate under different site conditions. Here the authors describe a volumetric soil moisture measurement instrument based on soil impedance measurements. The soil temperature is used as an additional parameter to implement a measurement compensation method. The measurement compensation process uses a feedforward artificial neural network. 10 measurements were obtained in situ in three test fields (maize, wheat, pastureland), over a period of 10 weeks (october-december 2017). The results were compared to measurements obtained using a commercial soil moisture instrument (6050X1 Trase System) and the gravimetic method. The results indicate that the prototype developed for this application can yield information close to gravimetric data for the three test sites (Maize SSE [sum of squared error]: 5.97, Wheat SSE: 19.81, Pastureland SSE: 12.71) in agreement with TDR data.**

***Index Terms*—Soil moisture measurement, soil electrical impedance, artificial neural network, wireless sensor.**

I. Introduction

The importance of sustainable development in the global context, is widely recognized [1] as a key factor to mitigate climate change, favour economic growth and social development while preserving the environment. In particular Mexico has shown great commitment to take environmental policy seriously by introducing regulatory environmental laws with clear actionable goals; Mexico is a signatory of the Kyoto protocol and was the first developing country to submit a climate action plan ahead of the 2015 Paris Agreement. In addition Mexico's, National Strategy on Climate Change: Vision 10-20-40 (*Spanish: Estrategia Nacional de Cambio Climático: Vision 10-20-40* [2]) recognizes the vulnerability of Mexico to climate change and establishes actionable guidelines towards sustainable development. Despite the Mexican efforts to introduce domestic legislation and planning, as well as efforts to comply with international environmental policies, a recent report [3] highlights the challenges Mexico faces to attain sustained development.

One particular aspect of strategic interest for Mexico is adequate management of water resources since it plays an essential role towards achieving sustainable development. The United Nations (UN) Sustainable Development Goal (SDG) 6, identifies water-use efficiency and water resources management as a key component of the sustainable development agenda. In accordance with the Bellagio Principles on valuing water" the Mexican Strategy on Climate Change (*Spanish: Estrategia Nacional de Cambio Climático* [4]) highlights the significance of research, development for improving water resources management; therefore, it is necessary to conduct development, adoption and adaptation of ad hoc technology according to regional needs and conditions, to generate knowledge that can be translated into feasible solutions to increase the efficiency of water usage.

In turn, soil moisture measurements plays an important role in elucidating important information about the synergistic relationship between multiple natural and anthropogenic processes in agricultural management systems. In addition, soil moisture is a critical component of the continental land system that influences geomorphologic [5], atmospheric [6]-[7] hydrologic [8] and biological processes [9]-[11]. On the other hand, it is also important that research and development efforts are conducted considering the end user.

There is a wide variety of soil moisture sensing technologies commercially available [12]. However, in developing countries, it is necessary to raise awareness and educate farmers about the benefits of adopting advanced technologies to increase crop yield [13]. Therefore, it necessary to conduct research and development, cantered on the end user in order to facilitate promotion and adoption of new technological developments. In addition commercially available equipment may not be suitable for measuring water content in some types of soils, and could be difficult to

José Antonio Gutiérrez-Gnecchi. División de Estudios de Posgrado e Investigación, Tecnológico Nacional de México/Instituto Tecnológico de Morelia, Morelia, Michoacán, México.
Enrique Reyes-Archundia. División de Estudios de Posgrado e Investigación, Tecnológico Nacional de México/Instituto Tecnológico de Morelia, Morelia, Michoacán, México.
Adriana del Carmen Tellez-Anguiano, División de Estudios de Posgrado e Investigación, Tecnológico Nacional de México/Instituto Tecnológico de Morelia, Morelia, Michoacán, México.
Arturo Méndez-Patiño. División de Estudios de Posgrado e Investigación, Tecnológico Nacional de México/Instituto Tecnológico de Morelia, Morelia, Michoacán, México.
Luis Enrique Fregoso Tirado. INIFAP, México. Santiago Ixcuintla experimental field. fregoso.luis@inifap.gob.mx