

MANUFACTURING AN IOT DEVICE FOR AUTOMATIC CONTROL OF TOTAL DISSOLVED SOLIDS OF NUTRIENT CONCENTRATION FOR PLANTS ON AEROPONIC, HYDROPONIC SYSTEMS

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SUMMARY

Controlling TDS (Total Dissolved Solids) in aeroponic and hydroponic systems is very important for plant growth. Due to the reflux of the nutrient solution after passing through the tube system containing the medium, the concentration of nutrients decreases. Currently, measuring nutrient concentration and adding nutrients to the solution is manually done by farmers. Therefore, we manufactured an IoT (Internet of Things) device with acceptable accuracy to control nutrient concentration. In testing, the TDS sensor has a relative error of $\sim 1.2\%$. The IoT device can automatically turn on the pump to provide more nutrients when its TDS is below the TDS threshold and turn off the pump when the concentration has reached the threshold. With our system, users can directly enter the TDS threshold using the matrix keypad or via the Blynk smart-phone application.

Keywords: *IoT, nutrient concentration, aeroponic and hydroponic systems, TDS.*

1. INTRODUCTION

Vietnam is a country with a long-standing development in agriculture. However, climate change leads to natural disasters, constant floods which effect on agricultural production. In addition, the traditional methods of production are now not highly effective. Therefore, farmers try to find new technologies for agriculture. The technologies that are used quite a lot in agriculture are aeroponics and hydroponics in greenhouses.

Hydroponics is a form of growing plants in solution without soil. It is the system of agricultural cultivation using water growing media including a nutrient solution. Growing plants by the hydroponic method has the following advantages: It is possible to choose places where the soil is barren, infertile or agricultural land interspersed in residential areas with a small area; if growing hydroponic vegetables is in greenhouses, environmental conditions can be controlled, so it is possible to increase the number of crops per year; plants grow and develop in suitable conditions, so yields and quality of product are high; plants are grown in closed hydroponic troughs, which limits water infiltration and loss, thus saving water for irrigation (Suseno et al., 2019; Velazquez-Gonzalez et al., 2022). With aeroponics, the plants are grown in a medium and their roots are suspended in the air, provided with water and nutrients by misting. Misting is usually done every few minutes, so the plants have enough nutrients

and water and always have air to breathe. Plants need macronutrients and trace elements for their best growth and development. The development of aeroponics vegetables does not require pesticides or growth drugs, which helps farmers to have a source of clean vegetables and have stable markets (Gopinath et al., 2017).

Nutrients in hydroponics and aeroponics are usually measured as total dissolved solids (TDS). TDS is one of the indicators used to test the quality of water, the content of all organic and inorganic substances contained in a liquid (TDS unit: mg/l (minigrams/liter) or ppm (part/million)). TDS is not considered an indicator of contamination, it is a composite indicator of the presence of chemical compounds. TDS is measured with a dedicated sensor. The TDS sensor is basically an electrical charge (EC) sensor whereby two electrodes are inserted into the water and used to measure the charge. The result is analyzed by the TDS sensor and converted into ppm values. If the water contains no soluble and pure material, it will not conductive materials. Hence the ppm value is 0. Conversely, if the water is filled with solutes, it will be conductive. In this case, the ppm values obtained will be proportional to the number of dissolved solids. This is because all dissolved solids have an electrical charge, allowing charge transfer between electrodes (Dfrobot, 2020; Maheshwari and Chakraborty, 2021). Nutrients are provided with TDS values which are appropriate

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