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USING CUBESATS FOR MEASURING SOIL MOISTURE LEVELS IN HOT AND DRY AREAS

Abstract

In Saudi Arabia, nearly 80 percent of the total cultivated area is irrigated with groundwater, which accounts for 98 percent of its total water sources. However, statistics show that approximately two third of groundwater in Saudi Arabia has not been discovered yet. The Northern Border University and Shaqra University are collaboratively working on a project that seeks to develop a CubeSat to pinpoint crop areas around the Kingdom of Saudi Arabia with the highest soil moisture rates. The aim is to have the CubeSat use remote sensing in order to determine the amount of water from rain stored under the soil. Thus, the CubeSat must have the capability to collect data that supports the calculation of vegetation and evaporation variables. The collected data from this CubeSat could be valuable to farmers, forecasters, and scientists in Saudi Arabia and in the Gulf region. The primary purpose of this paper is to present the mission concept and associate analysis and technical development activities for this CubeSat mission. As part of this work, the group is also designing a new power subsystem for the CubeSat by using graphene batteries instead of the commonly used lithium-ion variety. Because laser systems consume significant energy from the batteries and increase the amount of heat inside the subsystem, the risk of battery explosion is increased. Graphene batteries on the other hand have a lower risk of explosion, charge faster and are lighter in mass. The laser system will consume about 1/5 of graphene battery's energy. The design of this proposed subsystem as well as initial testing, in support of the proposed mission concept are also presented. The paper will present the designs for a 3U CubeSat, including a CAD model of the entire CubeSat and the components and compartments designed for system components, command and telemetry, OBC, ADCS, and hardware and software testing. The 3U CubeSat includes magneto-torquer, solar panels, batteries, reaction wheels, and onboard camera detector. This CubeSat will use radio signals with lower frequency that are sensitive to soil moisture and remote sensing techniques to determine the amount of water stored under the soil. In addition to presenting the spacecraft's design, its value to Saudi Arabia and beyond are also assessed from economic and scientific perspectives. The paper concludes with a discussion of prospective future work.