IRES and CESS for the purpose of the QSET CubeSat

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# Section 1: Overview

## Section 1.1: Introduction

One of the main issues for a satellite in space is the determining of position, attitude, and altitude. Attitude determination is a key aspect of satellite operation as it is vital when transmitting information, generating power, and gathering data such as photographs. The two key points of attitude determination are “estimation of a vehicle’s orientation from body measurements and known reference observations and filtering of noisy measurements”[1]. Both an infrared earth sensor, IRES, and coarse earth sun sensor, CESS, fulfill the first condition, while the second condition can be fulfilled by programming in the CubeSat’s onboard computer. The IRES or CESS aid in determining the attitude of a satellite by determining the sensor’s angle relative to the earth.

## Section 1.2: Coarse Earth Sun Sensor

A coarse earth sun sensor is a sensor used in determining the attitude of a satellite. The sensor consists of two separate sensor types, one used for detecting solar emissions, and one used for detecting infrared emissions [2]. Using the two sensors, the CESS can determine the satellites attitude in relation to both the sun and the earth. This sensor type is generally lightweight, and can be integrated partially into an existing solar array by “measuring the current produced on each [solar] cell” [3].

## Section 1.3: Infrared Earth Sensor

Similarly to a CESS, an infrared earth sensor can be used to determine the attitude of a satellite. They function by “using thermopile measurements of the Earth’s infrared emission to locate the Earth’s horizon” [4]. They do this with an array of infrared sensors, either by capturing photons to generate an electrical current or by thermal detectors [5]. For the purposes of the QSET CubeSat, the latter is more practical than the former, as photon detectors are expensive, bulky, and require extensive cooling to generate accurate data [5].

# Section 2.0: Discussion

There are advantages to both the CESS and IRES systems, however for the purposes of the QSET CubeSat design the two systems will serve the same purpose, as the CubeSat applications are identical. Both sensor options utilize infrared sensors to determine the attitude of a satellite. For the purpose of the MockSat, purchasing IR sensors and creating a sensor array from scratch will be the best option.

Several options for Arduino-compatible infrared sensors have been found. The best option is the VS1838B IR Receiver, as it will allow for testing up to a range of 18m allowing for a variety of testing arrays. This option is available here [6] and here [7]. A secondary option is the Adafruit IR receiver TSOP38238 [8]. This would be a preferred first choice, as Adafruit is a reputable third-party Arduino hardware supplier; however, this sensor is out of stock.

# Bibliography

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