SPACE SYSTEMS SYMPOSIUM (D1)
System Engineering - Methods, Processes and Tools (1) (3)

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LOW ENERGY IMAGE PROCESSING ALGORITHM TO STUDY THE AGGREGATION OF TARDIGRADES ON A 3U NANOSATELLITE

Abstract

The University of Manitoba Space Applications and Technology Society (UMSATS) is currently developing a scientific payload to study the characteristics and survivability of an extremophile called the tardigrade in low Earth orbit (LEO). In order to observe the characteristics and survivability of tardigrades, consecutive images of their movements and behavioral patterns must be captured. If the tardigrades are alive they tend to move towards a food source and aggregate around the food source area. Conversely, if the tardigrades are dead they will be spread around due to osmosis effect. Therefore the level of aggregation can tell us whether the tardigrades are alive or not. However, due to the physical constraints of surface area on a 3U nanosatellite and location in LEO, the amount of energy available for constant image capturing at a rate of 1 image per second and image processing on images captured is not adequate to support the entire system as a whole. Our algorithm determines the level of aggregation of the tardigrades and the principle of this algorithm revolves around dividing the screen into 8x8 pixel block and counts the number of tardigrades in each block and the variance is determined. The variance will indicate the level of aggregation based on the fact that if tardigrades are clustered around the food source higher variance will appear opposed to an even distribution of tardigrades that results in a lower variance. The output JPEG image from the lensed camera contains three color channels for red, green and blue. Using Huffman decoding, the image is translated into its discrete cosine transform (DCT) matrix of blocks of 8x8 pixels. Image analysis is then done directly from this matrix which is stored in microprocessor memory. Since the tardigrades are genetically modified to contain a green fluorescent protein (GFP) they emit in the green wavelength spectrum in the presence of ultraviolet light. The resulting DCT matrix of the green channel will be used. The (0, 0) value of the DCT represents the DC value of the 8x8 pixel block. The DC value is proportional to the number of tardigrades in a block since it will increase the intensity of the

green light emitted by the GFP. Therefore, running the variance analysis on the DC values from each 8x8 pixel blocks can provide us with the aggregation level of the tardigrades. This value is sent to the ground station along other telemetry information.