ABSTRACT:

The search for signs of extraterrestrial life is one of the ultimate challenges in astronomy and planetary science. Areas of the solar system most likely to have harboured life in the past, such as Mars, Europa, and Enceladus, have been identified, but are unlikely to see manned missions for many years or decades. At present and for the foreseeable future the search for extraterrestrial life will have to be undertaken with robotics.

Planetary rover missions have a high cost and are constrained by a loss of productivity due to long times waiting for the intervention of Earth-based scientists and engineers. This limitation could be improved by providing rovers with greater autonomy, to take images and samples and perform primary analysis of objects of scientific interest.

In an environment like the Martian surface the most likely place to find biosignatures pointing to extraterrestrial microbial life is within aqueously deposited sedimentary rocks. The object of this thesis was therefore to develop algorithms capable of classifying rocks using visual information.

This thesis presents a novel type of neural network with logit-normal weights designed to simulate a Bayesian network which was developed to allow autonomous visual identification of rock types by extracting texture data from rock images, along with a iv

comparison with other commonly used approaches. Examined approaches differ by methods of extracting texture information, methods of transforming texture data to achieve rotational invariance in the texture feature vector and methods of classification.

The various methods were trained and tested on a set of images of rocks of different types. It was determined from the results of these testing that the accuracy of the algorithms, as well as the length of the feature vectors needed to achieve high accuracy correlates with the degree of information lost in converting the extracted texture information to a rotationally invariant form. The accuracy in positive rock type identification achieved by the presented method was 88.2% among 14 classes and 93.7% among 4 classes which exceeded that of the other methods examined.

BIO:

Alex Tettenborn is currently a PhD student at Carleton university researching robotic vision and image analysis. He previously completed a Masters at the University of Waterloo on robotic assisted walking devices. His Bachelors from the University of Western Ontario was in astrophysics.