First Results of the Cyborg Astrobiologist*

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***Abstract*— In March and June 2004, we tested the 'Cyborg Astrobiologist' at a white-and-tan-colored gypsum-bearing outcrop near Rivas Vaciamadrid. The Cyborg Astrobiologist is a wearable computer and robotic video camcorder system that we are using to test and train a computer-vision system towards having some of the autonomous decision-making capabilities of a field-geologist. The Cyborg Astrobiologist platform has thus far been used for testing and development of these algorithms and systems: robotic acquisition of quasi-mosaics of images, real-time image segmentation, and real-time determination of interesting points in the image mosaics. The hardware and software systems function reliably, and the computer-vision algorithms are adequate for the first field tests. In addition to the proof-of-concept aspect of these field tests, the main result of these field tests is the enumeration of those issues that we can improve in the future, including: dealing with structural shadow and microtexture, and also, controlling the camera's zoom lens in an intelligent manner. Nonetheless, despite these and other technical inadequacies, this Cyborg Astrobiologist system, consisting of a camera-equipped wearable-computer and its computer-vision algorithms, has demonstrated its ability of finding genuinely interesting points in real-time in the geological scenery, and then gathering more information about these interest points in an automated manner. Particularly, the system was able to autonomously identify as unusual, and then proceed to study further, two mid-sized dark regions on the outcrop. These two dark regions were caused by water leaking out of the outcrop.**

Keywords: computer vision, image segmentation, interest map, field geology on Mars, wearable computers.

Fig. 1. Human Astrobiologist & Geologist Ormö is wearing the computer part of the Cyborg Astrobiologist system, as Human Astrobiologist & Roboticist McGuire looks on. During this pictures, the robotic part of the Cyborg Astrobiologist was slaving away, acquiring & processing the images of a 9×4 vertically oriented mosaic. These pictures were taken during the March 3rd expedition to Rivas Vaciamadrid. Note the absence of the black spots near the bottom of the cliff face; these black spots appeared sometime after this 1st mission and before the 2nd mission. Photo Copyright: Díaz Martinez, Ormö & McGuire

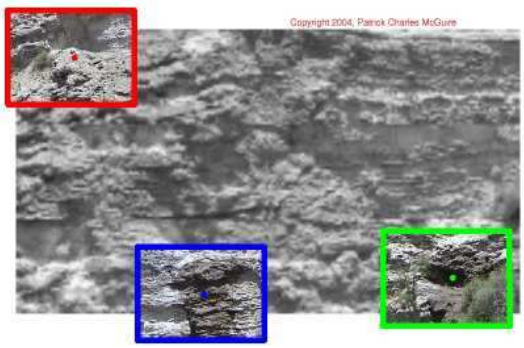

Fig. 2. Mosaic image of a three-by-four set of grayscale sub-images acquired by the Cyborg Astrobiologist at the beginning of its second expedition. The three most interesting points were subsequently revisited by the camera in order to acquire full-color higher-resolution images of these points-of-interest. The colored points and rectangles represent the points that the Cyborg Astrobiologist determined (on location) to be most interesting; *green* is most interesting, *blue* is second most interesting, and *red* is third most interesting. The images were taken and processed in real-time between 1:25PM and 1:35PM local time on 11 June 2004 about 60 meters from some gypsum-bearing southward-facing cliffs near the "El Campillo" lake of the Madrid southeast regional park outside of Rivas Vaciamadrid.

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