Title of Proposal

Spherical Panoramic Video Creation for Micro-Gravity Applications

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Micro-gravity, video, camera, stabilization

Executive Summary

This is a proposal requesting funding and resources in support of a study that will design, construct and test an inexpensive tethered video camera cluster that will be used to created and transmit real-time spherical panoramic video. The intent of the device is to create a cost-effective means of providing comprehensive, integrated and continuous spherical panoramic views of operational setting in micro-gravity.

1 Introduction

Techniques for synthesizing panoramic images are widespread. A panoramic image can be automatically created from multiple images by aligning and overlapping them using an image registration technique [1]. Various commercial packages, like Apple Computer's QuickTimeVR, support the "stitching" of images to form a 360-degree view. The ability to generate panoramic views has many applications including the generation of virtual reality (VR) backgrounds [2], model-based video compression [3], and object recognition [4].

Until recently, there has been little motivation to develop techniques to present complete spherical views--views that present the entire potential area of view including complete elevation and declination. One assumes that the sky or ceiling is above and the ground below and both are essential invariant. With humanities increased presence in space, and our associated need to move around in all 3 dimensions in a weightless environment, the need for information about ones complete surroundings becomes essential.

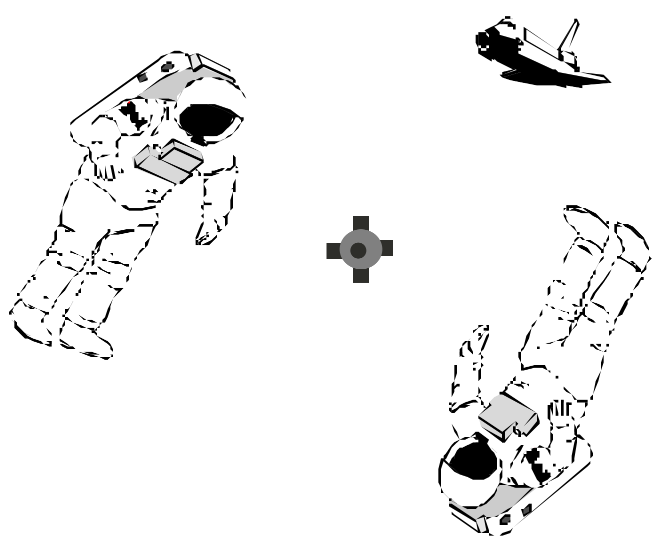

Figure 1 The Need for Spherical Panoramas

2 Proposal

We propose the development of an inexpensive cluster of CCD cameras attached to a central spherical hub (The "Space Ball"). These cameras will be synchronized and will produce images through time with software that will stitch the images together to form panoramic views in all 3 dimensions. The views will be made available for monitoring on a display and the views will be manipulated by software to allow an operator to focus attention on the part of the spherical panorama that is of interest.

It is intended that the Space Ball will not be stabilized in any way and that image and video processing techniques will be investigated and applied to create automatic stabilization, focus and attention to a scene. Rather than relying on cumbersome mechanical means for stabilizing the physical Space Ball, software techniques will be applied to achieve a stable and usable image. It is envisioned that eventually it should be possible to remove the tether and equip the Space Ball with a low-power transmitter to transfer the image streams to the processor.

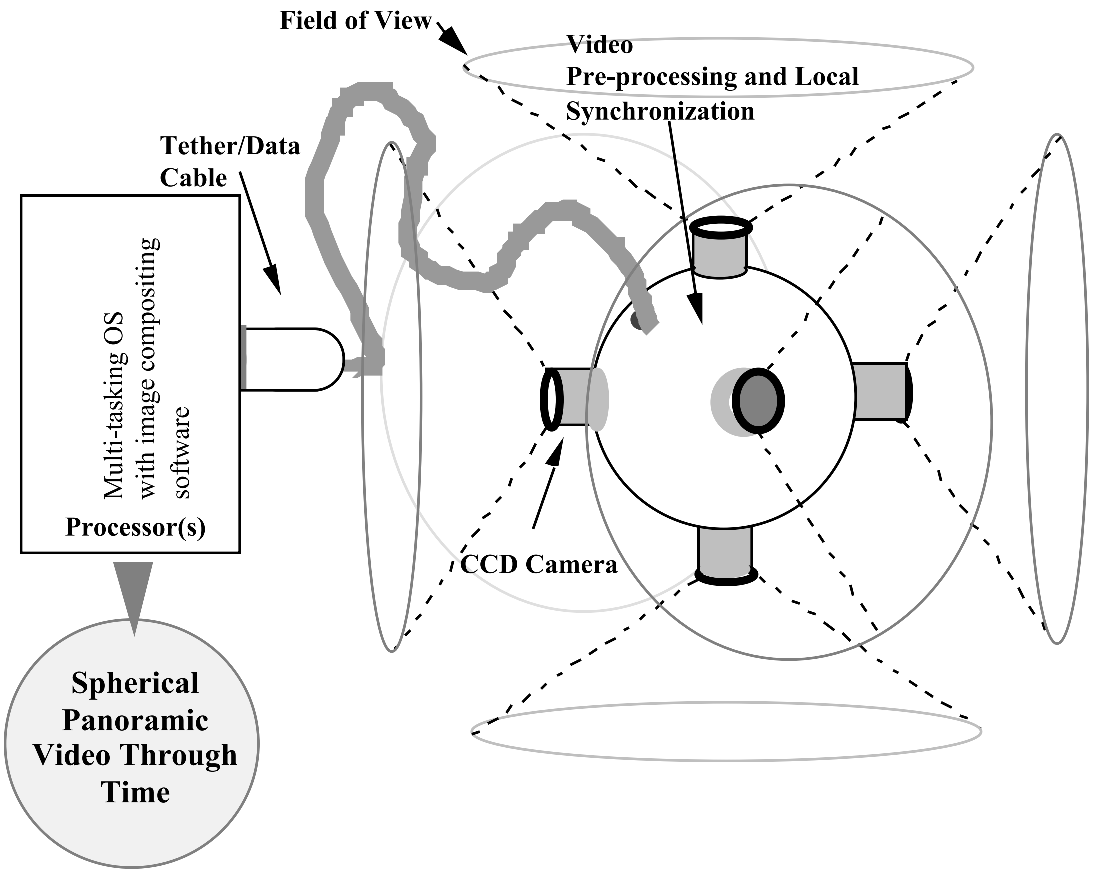

Figure 2 Space Ball Concept

3 Previous Experience

We propose to extend technology developed at Ryerson Polytechnic University on the prototype tele-operated robot MAX [5] (http://max.scs.ryerson.ca). MAX is research robot that can be controlled from any Java-enable browser connected to the Internet. Provided with an on-board B/W CCD camera, MAX feeds a digital image stream to the browser of a remote user who is able to monitor events in our lab while controlling MAX through a custom Java applet. Our video feed technology is very fast, reliable and is effective in stop action mode even on low-bandwidth networks. We have additional experience in image and video processing techniques including scene extraction and understanding.

Figure 3 MAX the Teleoperated Dog

We have created a mock-up of the device (non-functional) with the dimensions we believe will be suitable to house the hardware necessary. The mock-up is shown in the figure below. We are proceeding with preliminary system architecture.

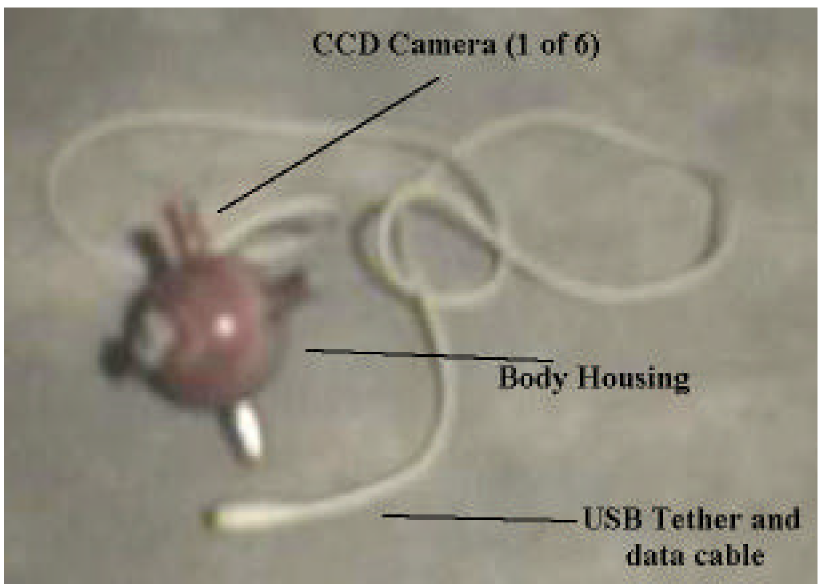

Figure 4 Space Ball Mockup

Specifically the Space ball and associated processor will,

- House 6 low-cost cameras
- Synchronize image capture at source for transfer to main processor
- Tethered by a data cable
- Stream JPEG images
- Initially create spherical panoramic views based on still images captured from the synchronized data stream
- Eventually create a spherical panorama through time, allowing digital spherical "movies" to be compiled
- Use commercially available image processing software to create panoramic views (not in real time).

In addition we have the following goals/questions,

- Can the techniques developed in this project be extended to real-time processing of the data streams thus allowing real-time viewing?
- Can the Space Ball be untethered and still be useful without on-board stabilization?
- Can software compensate for the lack of on-board hardware support?
- Can commercially available software be applied to this problem or will customization be required?

4 Requested Support

Sufficient financial support for,

- One graduate student for a period of six months to perform basic research, supervise construction and software integration.
- Two undergraduate research assistants to develop hardware.
- Construction of hardware and purchase of required software and processor(s).
- Travel expenses for two members of the experimental team to conduct micro-gravity video-capture experiment.

Financial support for a six-month project will not exceed $30,000 (CDN).

In Kind Support for,

- Simulation of micro-gravity conditions in appropriate aircraft in order to release the Space Ball and attempt to create Spherical Panorama over time by capturing images from the data stream.

5 References

[1] Brown, L.G., A Survey of Image Registration Techniques. ACM Computing Surveys,Vol. 24 (1992), No. 4, pp. 325-376.
[2] Teodosio, L. and Mills, M., Panoramic Overviews for Navigating Real-World Scenes, Proc. ACM Multimedia ’93, pp.359-364, 1993.
[3] Anandan, P., Irani, M., Kumar, R. and Bergen, J.,Video as an Image Data Source: Efficient Representation and Applications, Proc. IEEE International Conference on Image Processing 95, IEEE Computer Society Press, pp. 318-321.
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[5] Ferworn, A., Plataniotis, K., "Effective Teleoperation Over the World Wide Web", Proc. of the IASTED International Conference for Robotics and Applications (RA'99), Santa Barbara, USA, October 28-30, 1999.