Augmented Reality in Space Applications

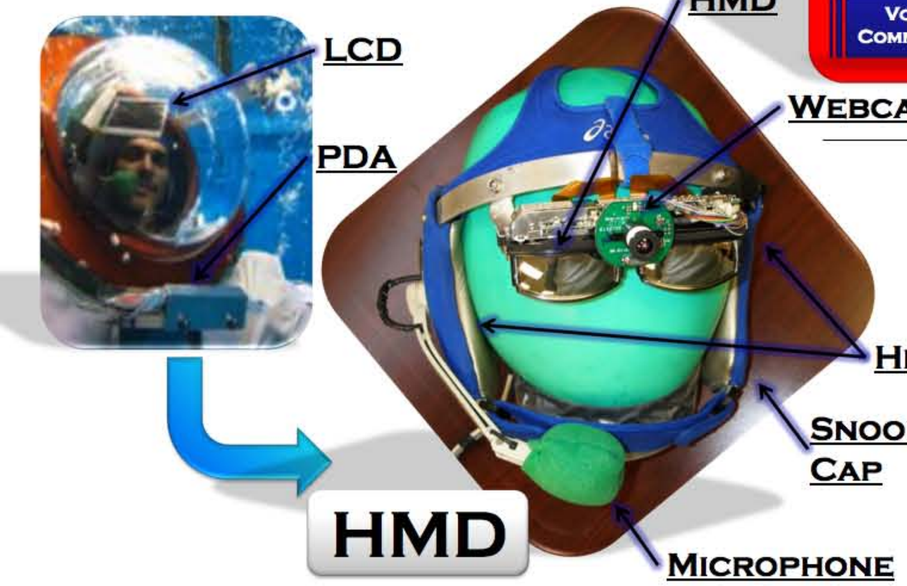
Massimiliano Di Capua, Dr. David L. Akin
Space Systems Laboratory, University of Maryland

Introduction

Information availability and ease of access have always been of prime importance when attempting complex tasks. In-orbit or planetary surface operations definitely fall in this category therefore the development of an enabling system could be highly beneficial for future space operations. Visual stimulation is known to be a very efficient way of feeding information, but it's usually limited to what the environment grants. Today we are able to include synthetic elements in the astronaut's Field-of-view (FOV) such as LCDs or PDAs which are a great aid in almost any task. The price we pay although is the reduced perception of the natural environment.

"Augmented Reality (AR) is an environment that includes both virtual reality and real-world elements"

Current technology allows us to augment the natural environment with the introduction of synthetic elements without occluding it. See-Through Head Mounted Displays (HMDs) are a possible solution to the problem, and the main goal of this study is to define how this can be accomplished and what the Benefits and drawbacks are.



Current Status:

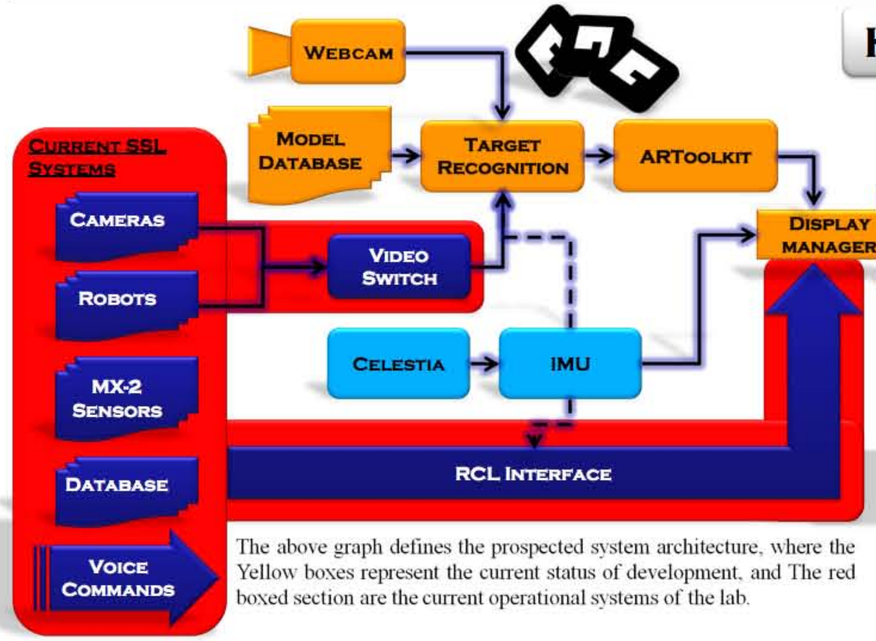
An HMD prototype has been developed and integrated in the MX-2 "Snoopy Cap". Currently its features are:

HMD: (based on a SONY Glasstron PLM-S700)
- •Resolution = 648x486 (NTSC)
- •FOV ≈ 23 sq-deg
- •Composite video Input

Webcam:
- •Resolution: 352x288 (CIF)
- •Refresh Rate: 30 Hz

Software is currently under development and as of today its capable of displaying:
- •2D/3D Static and animated virtual Objects,
  - •Requires target recognition
- •Object centered Text
- •Window centered Text.

System Architecture



The above graph defines the prospected system architecture, where the Yellow boxes represent the current status of development, and The red boxed section are the current operational systems of the lab.

Applications

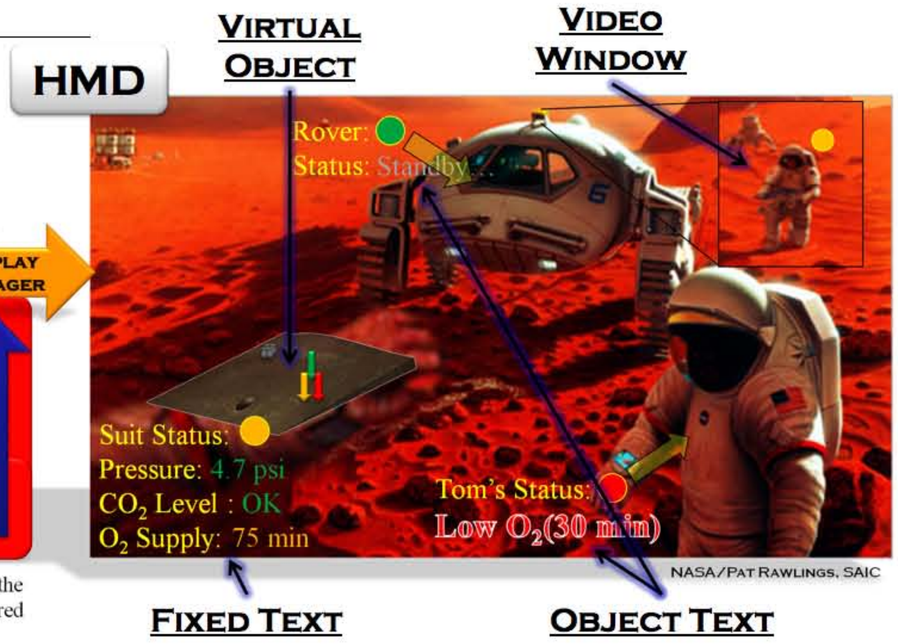
The HMD system will find its role in several space related applications, where the multiple features that characterize it will be triggered in granting new or improved capabilities to the astronaut. A few examples would be:

General Features Display:
- •Suit Status
- •Checklists
- •Task Information
  - Graphs/schemes
  - Instructions
- •Videos

Simulation/Training Display:
- •Background Subtraction
- •Virtual objects
  - Celestial Bodies (environment)
  - Structures
  - Robots
- •Robot Interaction
  - first-person views
  - Status and capabilities

In-Orbit/Planetary surface ops. Display:
- •Virtual objects
  - 3D Interactive maps
- •Near-by elements
  - status
  - Interaction Possibilities

In all the above, a mandatory feature will be the ability of managing the displayed information enabling the user to decide how and what to display at all times. All the features above, will also find application in IVA scenarios, making this system extremely versatile if equipped with wireless communication capability.



Artist Concept Example of what an astronaut would see through a HMD during a routine EVA on Mars. This example emphasizes on the ability to easily and rapidly monitor all critical parameters of surrounding crew and systems.

Research

Testing will proceed in two ways:
1.Test bench based human performance studies, will be conducted in a safe environment and will be aimed in Comparing the proposed in-FOV system with analogue non-in-FOV systems. Reaction times, Accuracy and Overall Situation awareness will be measured and Compared.
2.Integration in the SSL's MX-2 Space Suit Analogue, and testing in the Neutral Buoyancy Research Facility (NBRF).
Will this system help astronauts or will it distract Them and how much? What are the factors that cause distraction and how to avoid them.
Finally since very little research is done on HMDs for such particular applications, this study will also try to determine and define the future HMD features. Those will serve as baseline for manufacturers willing to deliver these devices for space applications.

Contacts:

Massimiliano Di Capua
Masters Student,
Space Systems Laboratory
University of Maryland
maxdicapua@yahoo.com

Dr. David L. Akin
Director,
Space Systems Laboratory
dakin@ssl.umd.edu

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