International Space Apps Challenge 2014

Project name: ECASA

Tampere, Finland.

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Abstract:

The aim of our project is to develop a tool that can help the astronaut to achieve his tasks during space walks in a easier way. For this purpose we created a concept of both hardware and software of an intelligent astronaut helmet, which will provide the astronauts a tool to facilitate their tasks. This concept is called “ECASA” which stands for “Enhance Contextual And Situational Awareness”.

International Space Apps Challenge 2014:

SPACE WEARABLES: FASHION DESIGNER TO ASTRONAUTS

link -> 2014.spaceappschallenge.org/challenge/space-wearables-fashion-designer-astronauts/

Scenarios:

The scenario that we chose is spacewalks conditions; because during spacewalks the need of information and tools are essential to complete the tasks and these could be improved with already existing technology.

We chose this scenario because we think that space suits can be improved to provide the astronaut a better working tool. We decided to focus specially on the helmet because it is the key part for audio and visual communication with mission control on earth.

Software specifications:

Since NASA has been using previously the Android operating system to create satellite telephones as the PhoneSat project, we think that using a custom Android operating system will fit the necessities of our conceptual system. Android OS provides the necessary tools to support the processing of the information required by the system.

An eye-tracking system will be used to provide user interaction with the helmet. The technology developed by Tobii, a Swedish company, is one of the most advanced in this field and could be suitable for our purpose. The SDK provided by the company requiring Windows, some modifications of the SDK may be necessary.

Augmented reality.

Android OS is suitable for augmented reality applications as it can be seen in mobile phones and Google Glass. Therefore we added this to the ECASA system. Augmented reality will be useful for:

- Navigation tool: which will provide the astronaut a virtual map for destination and important data as distances and measurements.
- Mission information: this will enable the astronaut to have data when needed and important facts about the mission.

User interaction

The user interaction for this system will be by voice control and eye tracking system; which are already developed technologies. This will enable the astronaut free movement of both hands while getting important information about his environment.

- Voice control: this technology will be used because it will facilitate the astronaut the way he can query for information.
- Eye tracking: with eye movement it will be possible to control the system and navigate through the different options it can display, as mission information, camera views, or health status.

Eye-tracking system

Usability: To interact with the helmet, the astronaut will just look some specific icons or things to trigger different events. For example, looking at the information icon for more than 1 second will expand the icon to display more informations about the current spacewalk.

Technology: Several eye-tracking technologies can already be found online. After comparing some of them, it seems obvious that eye-tracking systems require a combination of software and specific hardware to be accurate.

One of the most accurate technology nowadays is developed by Tobii, a Sweden company. This technology uses specifically design EyeX Controller and can be integrated easily in different devices. A development kit can be purchased for 99€.

Bubble camera in space helmet:

The idea behind the bubble camera in space helmet is integrating the concept of bubl camera 360 degree view. So it also helps augmented reality of eye tracking for navigation purposes. The existing technology of bubl camera provides high quality and live streaming videos directly to your computer, mobile devices or via web with a wireless network connection. It provides a video resolution of 1080p/15fps. Thanks to the design, the *durability* of the bubl camera is high for shock resistance because of 4 solid aluminum die-cast structural rings. The existing bubl camera weighs around *300 grams* which can be decreased with further modifications in the materials. And also they provide tri-axial accelerometer, which will be able to assist in stabilizing images when movement affects your orientation.

Purpose:

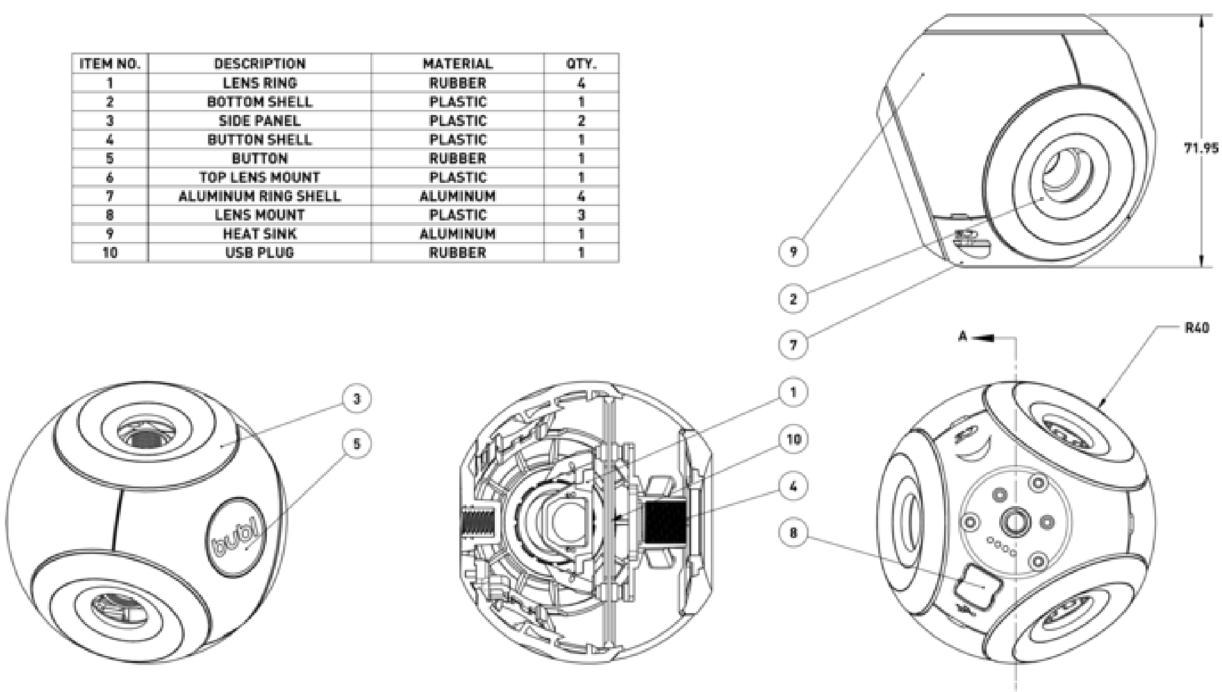
1) Because of wireless video streaming it can provide vision for space station or ground control to help astronauts in completing their tasks during their space walk. It also helps to record the entire space walk. Later these recordings can be used for research purposes.

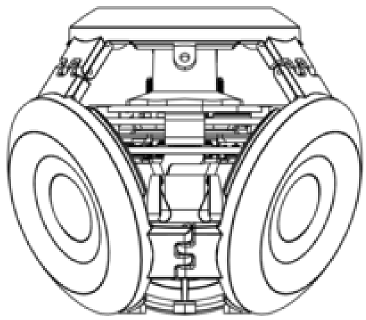
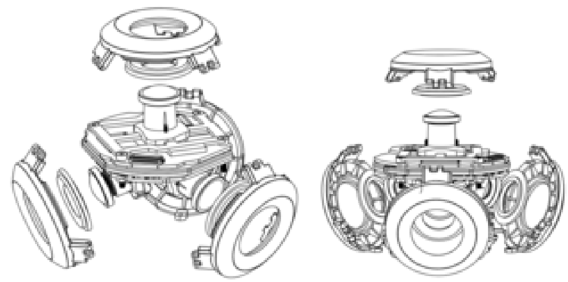
Extreme situation like losing their device or tools during the spacewalk, with the 360 vision it can be easily detected.

2) When astronauts choose navigation option through augmented reality, it provides live stream of 360 vision with the bubl helmet. With the 360 vision the selected navigation destination can be verified by the astronaut.

Blue print of Bubl camera:

ITEM NO.	DESCRIPTION	MATERIAL	QTY.
1	LENS RING	RUBBER	4
2	BOTTOM SHELL	PLASTIC	1
3	SIDE PANEL	PLASTIC	2
4	BUTTON SHELL	PLASTIC	1
5	BUTTON	RUBBER	1
6	TOP LENS MOUNT	PLASTIC	1
7	ALUMINUM RING SHELL	ALUMINUM	4
8	LENS MOUNT	PLASTIC	3
9	HEAT SINK	ALUMINUM	1
10	USB PLUG	RUBBER	1



Hardware & Software specifications:

When projected on a head mounted, helmet mounted or visor (see-through) display, such image appears like an image in a movie theater or on a computer monitor, but is created using magnifying optics from a very small display near to the eye. Such an image displayed with very high resolution, can appear solid and real, or made see-through depending on the type optics used.

Size and Weight	40mm radius	280g
Video Resolution	720p / 30 fps	1080p / 15 fps
Video Format	MP4	H.264
Photo Format	JPG	3840p x 3840p
Sensor	5 Mpixel	2592p x 1944p
Screen Resolution	1440p x 1440p	
Lens	4 x 190º FOV	1.2mm
Storage	MicroSD	4GB - 32GB
Output	USB 2.0	Wi-fi 802.11n
Chip	432 Mhz	
Memory	512 Mb DDR2	64 Mb flash
Battery	1000mAh	3.7V LiPo
Audio	Omni PUI mic	-45dB ±3
Accelerometer	Tri-axial +/- 1.5G	120 Hz
Software - Playback	Mac OSX - Windows 7, 8 - iOS - Android	

Amoled for space visor

Amoled (Active Matrix Light Emitting diode) display system will provide integration and interface of imaging sensors, and position tracking devices, permitting the astronaut a clear view of the external and internal environment during operations.

The basic principle behind the working of AMOLED is Electro luminescence. Electro luminescence(EL) is an optical phenomenon and electrical phenomenon in which a material emits light in response to the passage of an electric current or to a strong electric field. The visor with Amoled technology will be thin and light and thanks to the its flexibility it can be embedded in fabrics easily.

An important feature about Amoled technology is its fast response time. An Amoled can theoretically have less than 0.01 ms response time, enabling up to 100,000 Hz refresh rate.

Technical requirements

For all these scenarios to work, the following technologies must be integrated into a fully functional system that is E.C.A.S.A.

- Augmented reality platform
- Astronaut space suit
- Semi-autonomous Cubesat network for outdoor navigation and data management.
- wireless communication

Minimum viable product

To test the concept a minimum viable product must be built. This product is going to showcase the main functionalities of E.C.A.S.A. system and help with further development of user need based design.

Hardware modules:

1. Sensors: Eye tracking controller, Microphone, camera(s), buttons
2. Projection system: AMOLED
3. Microcontroller: RasPi, Arduino, PIC or something else
4. Wireless network of access points protocols to choose from: Wi-fi, bluetooth, zigbee or something else
5. (Cloud)server

After the minimum viable product is achieved it should be redesigned into 3D printable Thin Film electronic modules.

Demo

Its available on github: https://github.com/dveerendra/ECASA.git

And follow updates on www.ecasasystem.com

Future Vision

- Future Applications
  - Educational systems.
  - Medical field, for example assisting doctors for surgery
  - Military purposes, for example Threat detection.
  - Training for work environments
  - Flight and maritime navigations

- Future Evolutions and features
  - Neural interpreter using Epoch system
  - Assistance for maintenance tasks.
  - On windshield assistance for driving vehicles

References

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https://www.kickstarter.com/projects/bublcam/bublcam-360o-camera-technology-for-everyone

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Eye Tracking:

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TFT LCD: http://en.wikipedia.org/wiki/Thin-film-transistor_liquid-crystal_display

RasPi: http://en.wikipedia.org/wiki/RasPi

Arduino:http://en.wikipedia.org/wiki/Arduino

PIC: http://en.wikipedia.org/wiki/PIC_microcontroller

Augmented Reality(AR): http://en.wikipedia.org/wiki/Augmented_reality
http://vimeo.com/71502987