Universidad Simon Bolivar

Title: Nanosatellite Constellation for Rural Telemedical Applications

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Need

Traditionally, rural areas are attended by Medical Doctors (MD) in training or paramedical personnel with little to no medical expertise. Telemedicine has been proposed as a solution, but thus far has been limited to ambulatory care centers. Accessibility is an additional concern in overpopulated "misery" corridors around urban areas. The idea is to develop a wearable telemedical system or eMD, that allows a practitioner full mobility within a broad range of environments and real time communication with experts located worldwide. In order to achieve these real time communication a constellation of nanosatellites equipped with long range Wi-Fi connectivity is proposed, since satellite phones are too expensive for the intended user.

The eMD is comprised by a Connectivity Device (CD) composed of a Central Processing Unit, Wi-Fi connectivity, solid state hard drive and a battery pack. The eMD will communicate with a constellation of seven nano-satellites (NS-MD), each weighing about five kilograms and similar in design to the eMD.

This CD will be incorporated in a back pack for the proof of concept and will connect with peripheral I/Os via blue tooth connection. Multiple peripherals could be coupled to the CD but only a few will be developed and tested for the first stage. Speech to text and text to speech (S/T/S) software will be employed as the main interface with the CD. The Microphone/speaker system will also allow for real time chat and interconsultation with experts. An additional visor mounted monitor, will be included for the MD to read and retrieve information from patient's Electronic Medical Record (EMR).

All of the information recorded by the eMD will be automatically loaded into the NS-MD Constellation and can be retrieved when needed. A web based-cloud computing EMR such as the Microsoft® .NET Framework will be employed for communication amongst the parts of the network.

Mission Objectives

- Develop and test the eMD (Currently working on this face)
- Test the long range Wi-Fi network and system functionality
- Develop and ground test the NS-MD
- Develop and test the ground control navigation station
- Network with other satellites and test the system functionality

Concept of Operations

The key mission elements are the operation of a low cost portable telemedical network operating over a broad area network utilizing inexpensive Wi-Fi radio communication, as seen in the following figure.

NS-MD is designed to test the performance of the nano-satellites as communications data relay for telemedicine over a wide area network.

Key Performance Parameters

This an unconventional and creative approach to the problem of Medical Asistance, since it takes telemedicine and world wide experience to the bed of any person, greatly improving appropriate diagnosis and effective treatment to the less developed areas. It also serves to test the usability of wearable devices on a practical real world experience. Since it will be proven by integrating already existing information, a successful proof of concept prototype will be developed and tested within a

reasonable time frame.

Space Segment Description

We have no space segment experience. We will base our design on other university developed systems, such as the BRITE Spacecraft & Communications, developed by the Technical University Graz. According to their description [1] navigation should be controlled via three orthogonal reaction wheels and three orthogonal magnetorquer coils for three-axis attitude control and momentum dumping, these should enable attitude determination to 10 arcseconds, attitude control accuracy to better than a degree, and attitude stability down to one arcminute rms. The satellite should contain a main on-board computer (OBC) an attitude determination and control computer and a Wi-Fi communication routers. These computers should use an identical design with 256KB FLASH memory for code storage. Computer and communication should also be identical to the eMD communication backpack.

Orbit/Constellation Description

To be determined

Implementation Plan

Project design and implementation plan:

- Development of an eMD and NS-MD proof of concept prototype:
    - Technology Evaluation and Design (1 month)
    - Procurement (2 weeks)
    - Assembly and Testing of the CD (2 weeks)
    - Software Development, Testing and Implementation (2 months)
    - Development of Peripherals (2 months)
    - Field testing of the device (3 months)
    - Evaluation and Documentation of Results (1 month)
    - Conclusions, Recommendations and Next Stage Planning (1 month)
- What essential data will be generated during Phase I?
    - Compatibility and usability of existing technologies
    - Ease of integration and networking
    - Preliminary field testing of a wearable device and network accessibility

- Peripheral functionality and integration
- Integration of the personal network to the cloud-computing-EMR
- Real Time Epidemic Data Gathering and Monitoring
- Guidelines for the development and use of personal wearable devices

- If experiments in Phase I are successful, what are the next steps?
  - Next step would be to protect the intellectual property, develop a fully integrated and operational eMD, NS-MD system, optimize the tested peripherals and develop and test new peripherals, develop a working Nanosatellite base station and communication platform. We can also test the applicability of the solution to other fields of work.

References

1. BRITE Spacecraft & Communications, Technical University Graz http://www.univie.ac.at/brite-constellation/spacecraft.html
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3. Neri, J.A.C.F.; et al. Key technological solutions towards the saci-1 microsatellite design. Available on line: http://www.smallsat.org/proceedings/10/sess2/keytech.pdf