Biosensor Integration Development
ExMC/Canadian Space Agency Collaboration

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ExMC/CSA Biosensor Collaboration

• Background
  – Exploration Medical Capability (ExMC) Medical Data Architecture (MDA) Project objectives
  – Canadian Space Agency (CSA) collaboration objectives

• MDA System – CSA Astroskin Integration
  – Astroskin overview
  – Astroskin configuration
  – Integration approach

• Summary & FY17 Next Steps
Exploration Medical Capability (ExMC) Risk & Gaps

**ExMC Element Risk:**
Risk of Adverse Health Outcomes & Decrements in Performance due to Inflight Medical Conditions

**MDA Needs**
ExMC Gap Med07: We do not have the capability to comprehensively process medical-relevant information to support medical operations during exploration missions.

ExMC Gap Med13: We do not have the capability to implement medical resources that enhance operational innovation for medical needs.

**MDA Goal**
The MDA will develop capabilities that support autonomous data collection, and necessary functionality and challenges in executing a self-contained medical system that approaches crew health care delivery without assistance from ground support.
MDA Project Objectives

• The primary objectives of the MDA project are to establish a robust data architecture that:
  – Provides a unified ability to capture, collect, store, access, integrate, and analyze a spectrum of health-related data to create actionable insight and medical process support leading to an Exploration Medical System (EMS)
  – Provides the capability to manage and process medically relevant data from a variety of sources both medical and non-medical
  
  Establishes interfaces for the integration of hardware and software components
  
  – Enables data retrieval as meaningful information that can inform diagnosis, treatment and health management
  
  Automates data transfers
  
  – Expands the medical system to enable sophisticated data analytics and clinical decision support capability
Test Bed 1 Overview

Test Bed 1 Objectives

• Demonstrate data flow autonomy
• Establish data architecture foundation
• Develop a scalable data management system
• Utilize modular design and standardized interfaces
ExMC/CSA Collaboration Objectives

• Establish a mutually beneficial working relationship
• Clinical decision support
  → Establish interfaces for the integration of CSA analytical tools as identified by the MDA system
• Advance MDA development
  → Integration of the CSA biosensor tool – Astroskin
    • Provides data source for MDA development and helps define integration interfaces for the integration of hardware and software components
• Advance biosensor development
  → Automates data transfers to facilitate streamed data acquisition
  → Expand Astroskin capabilities and evaluate performance
    • Validate functionality in an operational environment
    • Validate operational feasibility for crew health monitoring & crew fitness evaluations
Description

• Wearable garment-based continuous physiological monitoring system, reusable (washable)
• Secure wireless communication
• Physiological events detection & alerts (planned for future version)
• Decision support capabilities (planned for future version)

Sensors (embedded)

• 3-axis accelerometer (activity levels)
• Electrocardiogram (ECG) (3-lead)
  • QRS detection, heart rate, heart rate variability
• Respiration (respiration rate, respiration volume, minute ventilation)
• Oxygen saturation (SpO₂)
• Systolic Blood pressure (calculated)
• Skin temperature
Astroskin Configuration

• Current Configuration
  – Data storage contained in a module connected to the worn garment.
  – Data is later transferred from the module to a laptop for offline processing, analyses, and viewing.
    • This approach used in the FY16 Human Exploration Research Analog (HERA) study.
    • Limits the ability to monitor biosensor data quickly and provide near real-time feedback to the subjects.

• Proposed Configuration
  Collaborate with the Canadian Space Agency (CSA) to develop the appropriate interfaces to capture data in the MDA system.
    • CSA will provide a software application to serialize data and forward to MDA system.
    • NASA Ames Research Center will develop a ‘receiver’ to decode the data.
  Approach facilitates automated data collection from the Astroskin.
MDA Test Bed 1 Functional Block Diagram

- Modular design
  - Layers allow for organization of code and components
- Subsystems separated by interfaces
  - Drop-in replacements of systems in later versions (upgrades, etc)
- Biosensor device adapters are modular
  - Allows device modules to come and go as directed by the Element
MDA system integration tests with the Astroskin scheduled for FY17

- Purpose of the ExMC/CSA study is to:
  - evaluate Astroskin performance and data receiver system with human participants during physical activities relevant to exploration missions (e.g. exercise)
  - validate functionality in an operational environment
  - validate operational feasibility for crew health monitoring and fitness evaluations
Astroskin Process Diagram
Laboratory Testing Photos
Summary & FY17 Next Steps

• Astroskin Integration
  – CSA developed software app to stream data
  – ExMC developed server to accept and read data from iPad software app
  – Demonstrated feasibility of streaming data

• FY17 Objectives
  – Perform data streaming protocol tests with Astroskin
  – Submit a Step 2 Omnibus proposal for next generation CSA biosensor integration
  – Identify common areas of interest for clinical decision support, and development future collaborative investigations