## 21-EPSCoR-R3-0012

## Wearable Sensors for Low-Power On-Demand Health Monitoring (Appendix B: Improvement of Space Suit State of Art, CSCO-2021-02)

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This proposal is in response to the FY2021 NASA EPSCoR Rapid Response Research Opportunity Appendix B: Improvement of Space Suit State of Art (CSCO-2021-02)

This technical proposal is submitted in response to the current call by the NASA Commercial Space Capabilities Office to improve the state of the art of space suits that improve the wearers performance, health and/or safety. The problem currently at hand is the obtrusive nature of on-suit electronics that aide assessing suited crewmembers health. The wired nature of communication between the sensors and the central suit avionics system presents challenges during don/doff, cause irritation during extra vehicular activity (EVA), and restricts the number and type of biomedical measurements. Astronauts work under tremendous stress, especially during EVA, and this can lead to head and neck injuries. Such injuries can be fatal and require serious attention for optimal performance by astronauts. Measuring head and body kinematics unobtrusively during planetary surface EVA is important in gauging ergonomics and guiding crew rehabilitation under weightlessness.

The overarching goal of this proposal is to initiate research within the EPSCoR state of Louisiana on the development of passive RFID biomedical sensors. In comparison to the sensors wired to the central suite avionics, the substantive benefit obtained using passive RFID biosensors include ability to read the sensor signal wirelessly and battery-free operation. This will allow placing the reader in the portable life support system (backpack) and applying the biosensor as a tattoo directly on the human skin. The specific objective of this proposal is to prototype a head kinematics measurement system using UHF RFID strain sensing tattoos. The proposed research builds on existing commercial UHF RFID tags, antenna, and reader, no new complex instrumentation will be developed. The proposed method builds on prior findings showing bending and rotation of a linearly polarized flexible RFID tag affects received signal strength indicator (RSSI) in horizontal and vertical planes. The proposed research will investigate application of such tags to the head-neck region and leverage ANOVA to predict the head pitch, yaw, and roll.

The innovation proposed here includes the following: a) Compared to conventional vision-aided solutions, the lack of prior work on measuring head kinematics using passive RFID shows it is a new concept. b) Unlike gyroscope-based measurements, the soft RFID tags can operate without battery, is skin conformable, and can withstand repeated mechanical bending. c) Compared to conventional method of locating tag resonant frequency for strain sensing in biomedical applications, the combination of ANOVA, RSSI and tag polarization will be relatively faster, portable and accurate. The proposed research will also systematically examine the effect of temperature, humidity, human skin contact, sweat, and antenna positioning on tag readout."