Astronaut performance and health risks

One of the major NASA’s operation is space exploration which is the constant investigation and discovery of celestial patterns in the space by means of developing and increasing space technology. Although the space is studied by astronomers using telescopes, it can be physically explored both by unmanned robotic assistances and human astronauts. As the period of the space mission and the distance of the exploration increases, the importance of systems monitoring astronaut health increases as well. For example, as a result of factors such as gravity fields, space radiation, change in pressure, change in oxygen level, distance and long-term weightlessness, human body may suffer significant hazardous effects including muscle atrophy, spaceflight osteopenia, cardiovascular system malfunctioning, balance disorders, eyesight disorders and immune system weakening. NASA’s new policies for space exploration by astronauts mandates significant changes and improvements in astronaut health monitoring systems. Therefore, health monitoring throughout all phases of space exploration including in-flight and extra-vehicular activity is essential. The real-time monitoring of astronauts’ physiological situations should be performed, either onboard or from Earth, and the obtained information must be evaluated.

To examine the astronauts’ performance and health risks involved with space missions and develop essential technology and breakthroughs to minimize the risks and provide safer and more effective exploration, the Human Research Program (HRP) has been found at NASA [1]. The research scope of this program falls on four sections of Exploration Medical Capability, Human Factors and Behavioral Performance, Human Health Countermeasure, and Space Radiation. The overall emphasis of Exploration

Medical Capability research section is to develop novel technologies to deal with the challenges of extending human space exploration and habitation. It is particularly intended to provide evidence-based techniques to observe and preserve astronaut health. To fulfil this objective, it is necessary to develop methods to detect and avoid any health risks that might happen during space missions [2]. To do so, an integrated research plan is employed by HRP to recognize the methods and research activities intended to deal with health threats, which are allocated to certain sections within the program and is placing requests for more detailed and accurate data to be recorded relative to astronaut health monitoring. Such efforts are raising awareness for the need to deploy effective and comprehensive physiological monitoring in order to develop accurate documentation of astronaut health during Extra-vehicular activity and event performance.

Conventionally, the only physiological factor observed through NASA extra-vehicular activities was the heart rate. Modern spacesuits integrate comprehensive life-support systems and modular components. These spacesuits highly assist space missions mostly throughout maintenance jobs and exploration operations. A variety of spacesuits has been made in the course of time and they have developed into today’s modern, modular and self-contained forms [3]. Monitoring the crew members through their spacesuits during the space operations such as extra-vehicular activities provides the information about the performance and health of the members as well as the environmental awareness which is necessary to fulfil mission requirements. However, most of these methods require direct contacts of sensors, either in the form of electrode or garment, to the body which, under certain conditions such as anxiety and perspiration, make the results not to be error-free [4].

Therefore, the need for contact-less sensors able to monitor physiological and health status of the astronauts especially during extra-vehicular activity is essential. Furthermore, these sensors must be non-invasive or minimally invasive and very sensitive and provide real time information. On top of that, the sensors should be durable, gravity-independent, low in power consumption, compact in size while simply repairable or replaceable. To fill the gap for effective monitoring we propose…..

The objectives of this proposal are highly aligned with NASA’s requirements as follows [1]:

EVA 10: Can knowledge and use of real-time physiological and system parameters during EVA operations improve crew health and performance?

EVA 8: What are the physiological inputs and outputs associated with EVA operations in exploration environments?

Osteo 5: We need an inflight capability to monitor bone turnover and bone mass changes during spaceflight.

Sleep Gap 1: We need to identify a set of validated and minimally obtrusive tools to monitor and measure sleep-wake activity and associated performance changes for spaceflight.

SM7. 1: Determine if there are decrements in performance on functional tasks after long-duration spaceflight. Determine how changes in physiological function, exercise activity, and/or clinical data account for these decrements.

Team Gap 2: We need to identify a set of validated measures, based on the key indicators of team function, to effectively monitor and measure team health and performance fluctuations during autonomous, long duration and/or distance exploration missions.

References:

[1]https://humanresearchroadmap. nasa. gov/

[2]https://humanresearchroadmap. nasa. gov/Explore/

[3]https://www. nasa. gov/feature/the-next-generation-of-suit-technologies

[4] https://www. nasa. gov/centers/ames/research/technology-onepagers/life-guard. html