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Review on the SENSE Organization and Future Applications

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Abstract: This article reviews the establishment and contributions of NASA's Space Environment and Spacecraft Effects (SENSE) organization, created to extend human presence beyond Low Earth Orbit and explore Near Earth Asteroids. SENSE aims to educate the public, develop space research models, and collaborate with global space organizations. The article outlines SENSE's hierarchical structure and technical working groups, which focus on charged particles, space environment, and interplanetary extra-terrestrial effects. It highlights the organization's use of robotics and artificial intelligence and presents two innovative applications derived from SENSE's research: electromagnetic wings for Low Earth Orbit and biometric nose cones for re-entry vehicles.

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1. Introduction

To extend human presence beyond Low Earth Orbit and explore Near Earth Asteroids through various missions, NASA established the Space Environment and Spacecraft Effects (SENSE) organization. SENSE aims to educate the public about space, develop models based on space research, and collaborate with global space organizations to provide comprehensive research reports. SENSE has a well-defined hierarchical structure, including a Chief, a Deputy Chief, and the Technical Working Group (TWG), each led by experts in their respective fields. The TWG comprises three main groups: Charged Particles, Space Environment, and Interplanetary Spacecraft Effects (IEE). Each group follows the same hierarchical structure as the overall organization.

2. Charged Particle Technical Workshop

The Charged Particles Technical Working Group focuses on space radiation, its types, and its effects on the space environment. This group differentiates charged particles based on ionization, convergence, or scattering. Studying ionization is crucial for spacecraft design, as hypersonic travel produces ionization and dissociation effects. Additionally, using electronic equipment in space vehicles requires charging, which can pose risks for astronauts performing Extravehicular Activities (EVA). Micrometeorites can also damage internal equipment of space vehicles.

3. Space Environment Group

The Space Environment Group examines the effects of various space environments on spacecraft, including space debris impact on path optimization and the effects of different layers of space on spacecraft. This group develops reports on these environments, which can aid countries aspiring to build their space stations. However,

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to prevent duplication of efforts, SENSE decided not to make entire research reports available to other space organizations.

4. Interplanetary Extraterrestrial Effects Group

The Interplanetary Extraterrestrial Effects (IEE) Group focuses on environmental effects near Lunar Orbits, Near Earth Asteroids, Geostationary Orbits, and Lagrange points. Studying Lunar Orbits is vital for future Moon missions, while information on Lagrange Points is essential for missions to Near Earth Asteroids. Understanding geostationary orbits is crucial for the communication and broadcasting satellites.

5. Contribution of SENSE

SENSE scientists use robotics technology for space vehicle equipment, particularly for Extravehicular Activities. Artificial intelligence is employed to detect anomalies in the space environment, as predicting space conditions is challenging and ground operators cannot correct failures in subsystems or components while a space vehicle is in transit. SENSE's work led to the development of two models: MARSGram and VENUSGram, which include data from experiments on the effects of the space environment on spacecraft.

6. Application

Two applications derived from SENSE's research are the use of electromagnetic wings in Low Earth Orbit and biometric nose cones for reentry vehicles. Experiments using naturally deceased honeybees focused on their abdomens, which bend in specific directions under load. This inspired a new biometric nose cone structure for reentry vehicles, offering more maneuverability than conventional designs and adjustable configurations based on mission profiles.

7. Conclusion

NASA's SENSE organization plays a crucial role in advancing our understanding of space environments and their effects on spacecraft. By focusing on charged particles, space environments, and interplanetary effects, SENSE contributes valuable research and innovative applications that enhance space exploration and technology. The organization's efforts in robotics and artificial intelligence further support the safe and effective exploration of space.

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9. Conflict of Interest

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