Agnirva Project Report

Project Report Topic: **Operation of Space Robots in Microgravity Environments**

Internship Organisation : **The Agnirva Space Internship program**

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Introduction

- Definition of Microgravity
  Define microgravity and explain its significance in space exploration.
- Importance of Space Robots in Microgravity
  Discuss how space robots contribute to missions in microgravity, including tasks that would be difficult for humans.
- Objectives of the Report
  Outline the aims of the report, focusing on the technologies that enable space robots to operate effectively in microgravity.

Challenges of Microgravity Environments

- Effects of Microgravity on Movement
  Explain how microgravity affects movement and the mechanics of robotic operations.
- Interaction with Objects in Microgravity
  Discuss the challenges of manipulating objects and maintaining stability in a near-weightless environment.
- Need for Specialized Technologies
  Highlight the necessity for advanced technologies to overcome these challenges.

Key Technologies for Navigation and Control

- Reaction Control Systems (RCS)
  Describe how RCS enables space robots to navigate using thrusters.
- Gyroscopes and Reaction Wheels
  Explain the role of gyroscopes and reaction wheels in maintaining orientation.
- Advanced Sensors and Vision Systems
  Discuss the sensors used for navigation, including cameras, lidar, and radar.

Guidance, Navigation, and Control (GNC) Algorithms

- Role of GNC in Space Robotics
  Explain the significance of GNC algorithms for autonomous navigation.
- Path Planning and Execution
  Discuss how GNC algorithms determine optimal paths for space robots.
- Autonomy in Navigation
  Describe the autonomous capabilities enabled by GNC systems.
- 5. Manipulation and Handling in Microgravity
- Specialized End-Effectors
  Explain the types of end-effectors used by space robots for manipulation.
- Gripping Mechanisms and Force Sensors
  Discuss the technology behind robotic grippers and their ability to handle objects.
- Examples of Manipulation Tasks
  Provide examples of tasks that require precise manipulation, such as maintenance and equipment handling.

Stability and Anchoring Mechanisms

- Importance of Stability in Microgravity
  Explain why stability is crucial for performing tasks in microgravity.
- Types of Anchoring Mechanisms
  Describe the various mechanisms used to secure robots during operations.
- Case Study: Canadarm2
  Detail how Canadarm2 utilizes anchoring mechanisms to perform tasks on the ISS.

Collaboration with Human Astronauts

- Design and Function of Robonaut
  Discuss the capabilities of Robonaut and its role in assisting astronauts.
- Benefits of Human-Robot Collaboration
  Highlight the advantages of using robots to support human efforts in space.

- Examples of Tasks Performed by Robots
  Provide examples of tasks that demonstrate effective human-robot collaboration.

Case Studies of Space Robots in Microgravity

- Canadarm2 and Dextre
  Discuss the operational capabilities and contributions of these robots.
- Astrobee Autonomous Robots
  Explain how Astrobee robots navigate and perform tasks on the ISS.
- Applications in the International Space Station (ISS)
  Summarise the various applications of space robots aboard the ISS.

Future Directions in Space Robotics

- Emerging Technologies
  Discuss upcoming technologies that could enhance space robotic operations.
- Potential for Increased Autonomy
  Explore the potential for further automation in space missions.
- Challenges and Opportunities
  Identify the challenges faced by space robotics and the opportunities for advancement.

Conclusion

- Summary of Key Findings
  Recap the significant technologies and solutions discussed in the report.
- Implications for Future Space Missions
  Discuss how these technologies will shape future missions in space.
- The Role of Robotics in Space Exploration
  Emphasise the critical role of robotics in advancing space exploration efforts.