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EVOLUTION OF SPACE EXPLORATION USING WIRELESS SENSOR NETWORKS

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ABSTRACT

Wireless sensor networks (WSNs) have found their way into a numerous applications due to their diverse and flexible nature. Space exploration is a field that can benefit from the advancements in WSN technology. this paper presents the idea of using WSN to monitor various parameters like temperature, pressure, gaseous concentration etc in a space shuttle internally and externally.

Keywords: *Wireless sensor networks, space exploration, life support sensors, thermal sensors, wireless monitoring*

I. INTRODUCTION

Wireless sensor networks have changed and evolved a large number of technologies in the past few years. One particular field that can be benefited by WSNs but has not yet employed wireless sensor networks on a large scale is of space exploration. The major reason for this was the lack of complexity and limited range of operation of wireless sensor networks and their restricted ability to acquire and process data with the available Limited resources. But the WSNs have now evolved to great extent and can perform complex tasks that were not possible before. One major part of space exploration is the space shuttle engineering. Wireless sensor networks can impact all the major parts of a space shuttle from its construction, environmental sensing, and internal communication to telemetry. Space shuttle has large number of internal and external sensing and diagnostic devices and long wiring running throughout its length to accommodate these sensors and their power supplies. This makes shuttle the overall shuttle bulky. Wireless sensor networks can replace various internal and external sensors. These sensors due to their wireless nature do not require physical wiring between them. This frees space and reduces the shuttle weight. Various sensors that can be implemented using WSN are internal and external thermal sensors, internal and external pressure sensors, impact sensors, gas sensors, intermodular communication and radiation detector..

II. DIFFERENT TYPES OF WIRELESS SENSORS [1][2][3][4]

1. Thermal sensors

The internal and external pressure sensors provide continuous monitoring for the change in external pressure and the change in internal shuttle pressure at every stage of the mission and provides information regarding even the slightest change in the internal or external pressure. External thermal sensors keep continuous track of external atmospheric temperature at lower altitudes. As the altitude increases during launch, the shuttles surface temperature rises due to friction with atmosphere and these sensors can then monitor the shuttle's external surface temperature. Once clearing the earth's atmosphere, the same sensors can keep track of extreme thermal conditions of space. These readings from the sensors provide valuable input for the shuttle crew and the ground based control station. Distributed thermal sensor network can provide complete thermal profile of the shuttle's exterior at all stages of the mission. Internal thermal sensors provide continuous monitoring off the temperature inside the shuttle's interior and the temperature gradient between the different modules of the shuttle. The internal thermal sensors can also provide valuable information regarding the thermal profile of the electronic equipment on board.

2. Pressure sensors

The external pressure sensors help in forming complete stress profile of the shuttle during transition from Earth's atmosphere to the free space. The internal pressure sensors can keeps track of various pressure gradients required in different modules of the shuttle and can alert the crew regarding any variations.

3. Impact sensors

These sensors can be distributed over entire shuttle surface. These are basically mems based accelerometers and gyroscopes which can interact with shuttle's communication system and alert the crew in case of any abrupt changes in shuttle's spatial coordinates due to an impact even at very minute levels. These impacts can be result of collision with microscopic space debris.

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4. Gas sensors
These sensors can keep track of exact concentration of gases inside the shuttle. Oxygen and carbon dioxide precise monitoring can be achieved. Also other gases can be detected according to requirements in different modules of the shuttle. Gas sensors when employed externally can provide accurate gaseous profile while transitioning from different layers if atmosphere. Gas sensors can also be used in the combustion chamber to detect the exact composition of gases coming out of exhaust of the engines. This provides feedback to onboard crew as well as ground control station regarding proper adjustment of fuel and oxidizer ratio.

5. Radiation sensors
These sensors are basically group of various high energy particle detectors distributed over shuttle's external surface. These can detect the harmful space radiations and their intensity. This can help in monitoring different radiations emitted by different planetary bodies and their intensity levels at different positions in space.

6. Intermodular communication and monitoring
Internal Telemetry-WSN can provide viable replacement to conventional inter modular communication within a shuttle or spaceship. Heavy wiring can be removed and space as well as weight can be freed. Each module can have its own WSN based communication system which van communicate on intermodule basis also.

7. Life support system
WSN can keep track of heart rate, step count, body temperature and other vitals of astronauts wirelessly and keep uploading the data to shuttle's onboard computers for logging and reference

8. Technology challenges [2][4]
There are several challenges and limitations that are to be overcome before using WSNs in adverse conditions of space. The sensors have to withstand a high acceleration force during the initial stages of lift off. The external sensors have to withstand the extreme friction and heat generated due to this friction that can damage the sensor itself beyond repair. The operating frequency range also creates challenge in WSN operation in space. Sensors also have to withstand the harmful high energy particles present in space that can destroy the sensor electronics.

III. CONCLUSION
WSNs can provide a viable solution for replacing conventional wired network inside a spacecraft. Different sensors can be replaced by their smaller wireless counterparts. This technology has its own present limitations but certainly has the capability to revolutionize the field of space explorations.

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