Lunar Smart Adaptive Habitat Design With AI Psychological Monitoring for Crew Adaptive Positive Mental Health

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Mental health affects all aspects of life, it's a significant factor that if overlooked could cost lives and mission success particularly in space exploration. Mental health is a critical factor in mission success, particularly for long-duration space exploration where astronauts face isolation, confinement, stress, and delayed communication with Earth. This project proposes an adaptive modular lunar habitat designed to monitor and support astronaut psychological well-being through integrated environmental design and AI-assisted monitoring systems. The habitat uses a scalable geometric structure that allows seamless expansion while reducing environmental monotony and promoting mental stimulation. Functional modules include living, research, communal, and operational spaces. Supporting technologies such as motion sensors, circadian lighting that mimics Earth's day–night cycle, and a wearable HRV wristband track sleep, behavior, and stress levels through a centralized monitoring dashboard. These systems enable proactive detection of behavioral and emotional changes, improving upon current reactive mental health support methods. Additionally to further prove the efficiency of this design a digital dashboard simulating how the data from the systems would be collected and analyzed from sample scenarios was created. Along with a digital simulation demonstrating how the AI monitoring systems and physical design work cohesively to proactively respond to mental health issues as they arise. Integrating psychological monitoring with habitat engineering may increase mission success and support astronaut well-being during future lunar and deep-space missions.

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