



Design and Development of an IoT-Based Smart Monitoring System for Real-Time Assessment of Mangrove Ecosystem Health in Sri Lanka

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Mangrove ecosystems play a vital role in coastal protection, biodiversity conservation, and climate change mitigation. However, these ecosystems are increasingly threatened by environmental stressors such as salinity fluctuations, rising temperatures, pollution, and anthropogenic disturbances. Traditional monitoring methods rely heavily on manual field observations, which are time-consuming, costly, and incapable of providing real-time ecosystem data. This study proposes the design and development of an Internet of Things (IoT)-based smart monitoring system for real-time assessment of mangrove ecosystem health in Sri Lanka. The proposed system integrates environmental sensors to measure key parameters, including water temperature, salinity, pH level, dissolved oxygen, and water level. These sensors are connected to a microcontroller unit (e.g., ESP32), which transmits data via wireless communication to a cloud-based platform. A web-based dashboard is developed to visualize real-time data and generate automated alerts when environmental parameters exceed ecologically safe thresholds. The system aims to provide an early warning mechanism for ecosystem stress and support evidence-based decision-making for conservation authorities. The study highlights the potential of low-cost IoT technologies in improving ecological monitoring efficiency and enhancing climate resilience in mangrove ecosystems. The proposed framework can be scaled and adapted for other coastal regions facing similar environmental challenges. Furthermore, the proposed system encourages integration with community-based conservation initiatives by enabling data sharing with local stakeholders and environmental authorities. By combining technological innovation with participatory governance, the system enhances transparency, supports timely intervention, and promotes sustainable mangrove management practices. This approach contributes not only to ecosystem protection but also to long-term coastal resilience and sustainable development goals.

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