RADemics

Integration of Geographic Information Systems and IoT Technologies for Precision Agriculture and Rural Enterprise Decision Making

Raju Ch, Sweta Priya
UNIVERSITY COLLEGE OF SCIENCE, SAIFABAD, OSMANIA UNIVERSITY, AMITY UNIVERSITY

Integration of Geographic Information Systems and IoT Technologies for Precision Agriculture and Rural Enterprise Decision Making

[1]Raju Ch, assistant professor, Department of computer science, University college of science, saifabad, Osmania university, Hyderabad, Telangana, Tamilnadu. raju.chityala@gmail.com

[2]Sweta Priya, Associate Professor, Amity School of Communication, Amity University Patna, Patna, Bihar, India. sweta.priya35@gmail.com

Abstract

The convergence of Geographic Information Systems (GIS) and Internet of Things (IoT) technologies is revolutionizing precision agriculture and rural enterprise decision-making by enabling data-driven insights and enhanced operational efficiency. This chapter examines critical aspects of managing the vast and complex datasets generated from these integrated systems. It explores data governance models that ensure quality, accessibility, and interoperability, while addressing the unique challenges of rural environments. Privacy and security concerns are analyzed with an emphasis on tailored protocols that protect sensitive agricultural and spatial data from cyber threats and unauthorized access. The chapter further discusses policy challenges surrounding ownership and sharing of agricultural data, highlighting mechanisms to promote equitable access and collaboration among diverse stakeholders. Ethical considerations related to informed consent, transparency, inclusivity, and algorithmic accountability are presented as foundational to responsible technology adoption. Additionally, blockchain technology is examined as a transformative tool to enhance data security and transparency through decentralized ledgers and smart contracts. The synthesis of these dimensions offers a comprehensive framework for advancing secure, ethical, and effective GIS-IoT applications that empower rural communities and foster sustainable agricultural development.

Keywords: Geographic Information Systems (GIS), Internet of Things (IoT), Precision Agriculture, Data Governance, Data Security, Privacy, Agricultural Data Ownership, Ethical Frameworks, Rural Enterprise, Blockchain Technology, Data Sharing, Smart Contracts, Spatial Data, Cybersecurity, Sustainable Agriculture.

Introduction

The rapid advancement and convergence of Geographic Information Systems (GIS) and Internet of Things (IoT) technologies have catalyzed a paradigm shift in the realm of precision agriculture and rural enterprise decision-making [1]. These technologies collectively enable the real-time acquisition, processing, and analysis of spatial and environmental data, which significantly enhances the capacity to optimize agricultural inputs [2], monitor crop health, and improve resource management [3]. Precision agriculture leverages the spatial intelligence of GIS alongside the sensor-driven data streams from IoT devices, facilitating site-specific interventions that increase productivity, reduce waste, and promote sustainable farming practices [4]. Rural enterprises, often constrained by limited access to timely and accurate information, stand to benefit immensely from these integrated technologies through improved operational efficiency and data-informed business strategies [5].

Despite the promising capabilities of GIS-IoT integration, the deployment of these technologies in rural agricultural settings introduces several complex challenges that require rigorous academic and practical attention [6]. Managing the diverse, high-volume, and heterogeneous data generated by spatial sensors, drones, weather stations, and other IoT-enabled devices necessitates robust data governance frameworks [7]. These frameworks must ensure data accuracy, consistency, and interoperability while supporting secure data storage and efficient retrieval [8]. Furthermore, rural areas often face infrastructural limitations such as intermittent connectivity, which complicate real-time data transmission and processing [9], thereby demanding innovative solutions tailored to the unique socio-technical contexts of these environments [10].

Privacy and security concerns emerge as critical considerations in the deployment of GIS-IoT systems for agriculture [11]. The granular data collected can expose sensitive information related to land use, production practices, and rural livelihoods, thereby raising risks of data breaches and unauthorized surveillance [12]. The safeguarding of this data requires the implementation of comprehensive security protocols that address vulnerabilities inherent to distributed IoT networks, including device-level authentication [13], encrypted communication channels, and intrusion detection mechanisms [14]. Additionally, privacy-preserving methods that allow data utilization without compromising individual or community confidentiality are necessary to maintain trust among rural stakeholders and encourage widespread adoption [15].