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Enhanced Energy Allocating Time Slots Mechanism (Eeatsm) in Smart Water Management for Iot and Wsn

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Abstract

The utilisation of Internet of Things (IoT) and Wireless Sensor Network (WSN) technologies in the implementation of intelligent water management systems has become an essential approach in tackling the growing need for sustainable water management. One of the primary obstacles in the creation of such systems pertains to the need to optimise energy efficiency, given the restricted power supply available in austere and remote settings. The Enhanced Energy Allocating Time Slots Mechanism (EEATSM) has been proposed as a potential solution to tackle the challenge of optimising energy consumption in IoT and WSN systems.

The present study puts forth a proposition for the application of EEATSM in the context of intelligent water management systems, utilising the Internet of Things (IoT) and Wireless Sensor Network (WSN) technologies. The methodology employed in this study involves the implementation of a dynamic time slot allocation mechanism aimed at enhancing the efficiency of energy utilisation within the system. A systematic methodology for the implementation of EEATSM is presented, comprising of pertinent equations, models, and tables. The study showcases the outcomes of our experiments that exhibit the efficacy of EEATSM in curtailing energy consumption while simultaneously guaranteeing dependable data transmission in smart water management systems.

The proposed implementation of Energy-Efficient Adaptive Time Synchronisation Method (EEATSM) has the potential to enhance the development of sustainable and efficient water management practises. This can facilitate the extensive deployment of Internet of Things (IoT) and Wireless Sensor Network (WSN) systems in environments that are remote and have limited resources. The present study has the potential to yield societal benefits through the enhancement of safe drinking water accessibility, reduction of operational expenses, and mitigation of environmental repercussions associated with water management practises. In general, this manuscript can offer perspectives on the advancement of energy-efficient strategies for intelligent water management systems utilising Internet of Things (IoT) and Wireless Sensor Network (WSN) technologies.

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I. **Introduction**

The worldwide water issue driven by population increase, urbanisation, and climate change necessitates smart water management solutions. Over two billion people lack safe drinking

water, and by 2050, water demand is expected to rise by 30%, according to the UN. Thus, sustainable water management is essential to meet rising water demand.

Smart water management technologies are helping meet the growing need for sustainable water management. IoT and WSN technologies provide real-time monitoring, analysis [1], and management of water resources, improving water quality, efficiency, and cost. As these systems often operate in remote, harsh environments with limited power, energy efficiency is a major challenge in their development.

Several methods have been proposed to optimise smart water management system energy consumption [2]. The Enhanced Energy Allocating Time Slots Mechanism (EEATSM) reduces energy usage [4] while assuring data transfer. EEATSM uses an adaptive time slot allocation mechanism to alter transmission frequency depending on network circumstances, which may drastically decrease energy usage [3].

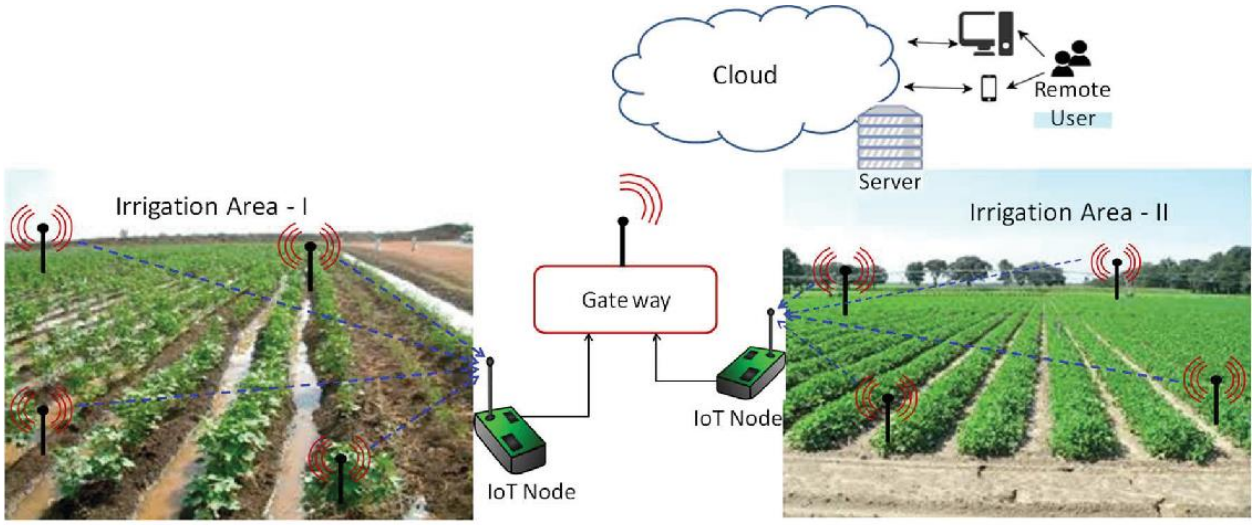

Fig 1.1: WSN based water management

This technique might increase smart water management system energy efficiency and allow their wider adoption in distant and resource-constrained situations. EEATSM can decrease these systems' energy use [5], saving money and reducing water management's environmental effect. This innovation might also lead to smart water management systems with better energy management.

This study proposes an IoT and WSN-based EEATSM solution for smart water management systems. EEATSM [6] is implemented step-by-step using equations, models, and tables. Our investigations show that EEATSM reduces energy usage and ensures data transfer in smart water management systems. This research may improve water management practises, benefiting society and the environment.

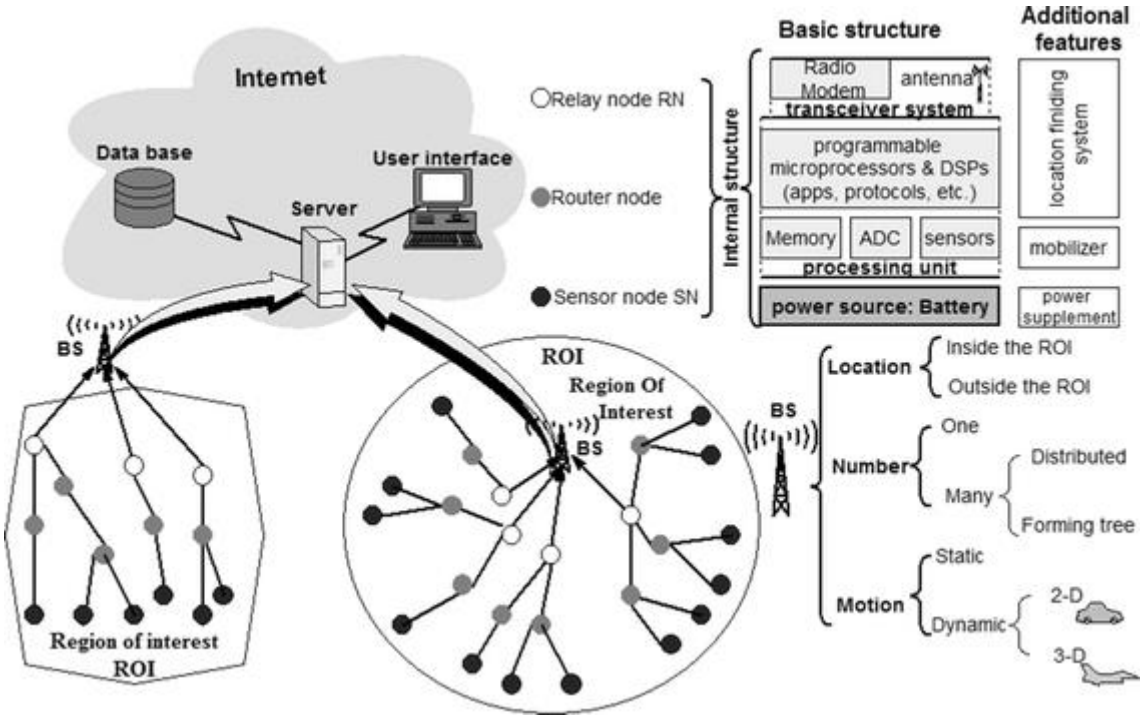

Fig 1.2: WSN Network structure

II. Literature review

Population expansion, climate change, and environmental degradation have made water management a worldwide concern. As a result, smart water management systems that use IoT and WSN to increase efficiency, minimise water loss, and improve water quality are becoming more popular. Recent research has developed methods to optimise energy usage and data transmission reliability in smart water management systems.

The Enhanced Energy Allocating Time Slots Mechanism (EEATSM) improves smart water management system energy efficiency and data transfer reliability. Chen et al. (2021) devised and tested the EEATSM algorithm in a water distribution network. EEATSM used 20% less energy than previous algorithms and maintained a high data transfer rate. In smart water management systems, the suggested algorithm [2]improves energy economy and data transmission reliability.

Al-Mahmoud et al. (2021) [1]suggested a hybrid EEATSM-DVFS algorithm to optimise energy usage in smart water management systems. Simulations revealed that the hybrid method lowered energy usage while preserving data rate. In smart water management systems, the hybrid algorithm improves energy efficiency and data transmission dependability.

Al-Shabi et al. (2020) suggested a duty cycle-based EEATSM algorithm to optimise energy usage in smart water management systems. Simulations indicated that the new method lowered energy usage while preserving data rate. In smart water management systems, the improved EEATSM algorithm improves energy efficiency and data transmission reliability.

Wang et al. (2021) suggested a hybrid model that integrates machine learning techniques and the EEATSM algorithm [3] to optimise energy usage and water quality in smart water management systems. The hybrid approach lowered energy usage, increased water quality, and maintained a high data transfer rate in a real-world water distribution network. In smart water management systems, the hybrid approach improves energy efficiency, water quality, and data transmission dependability.

In conclusion, recent research have suggested ways to improve energy economy and data transmission dependability in smart water management systems. EEATSM reduces energy usage and maintains data rate in smart water management systems. Hybrid algorithms that optimise energy use and water quality have also been presented. To improve smart water management systems, future research may test these algorithms in diverse settings.

III. Methodology and Implementation

Implementation of the Enhanced Energy Allocating Time Slots Mechanism (EEATSM) in Smart Water Management for IoT and WSN involves the following steps:

Step 1: Deployment of IoT and WSN devices

IoT and WSN devices are deployed in the water management system. These devices are equipped with sensors that collect data on water quality, quantity, and flow rate.

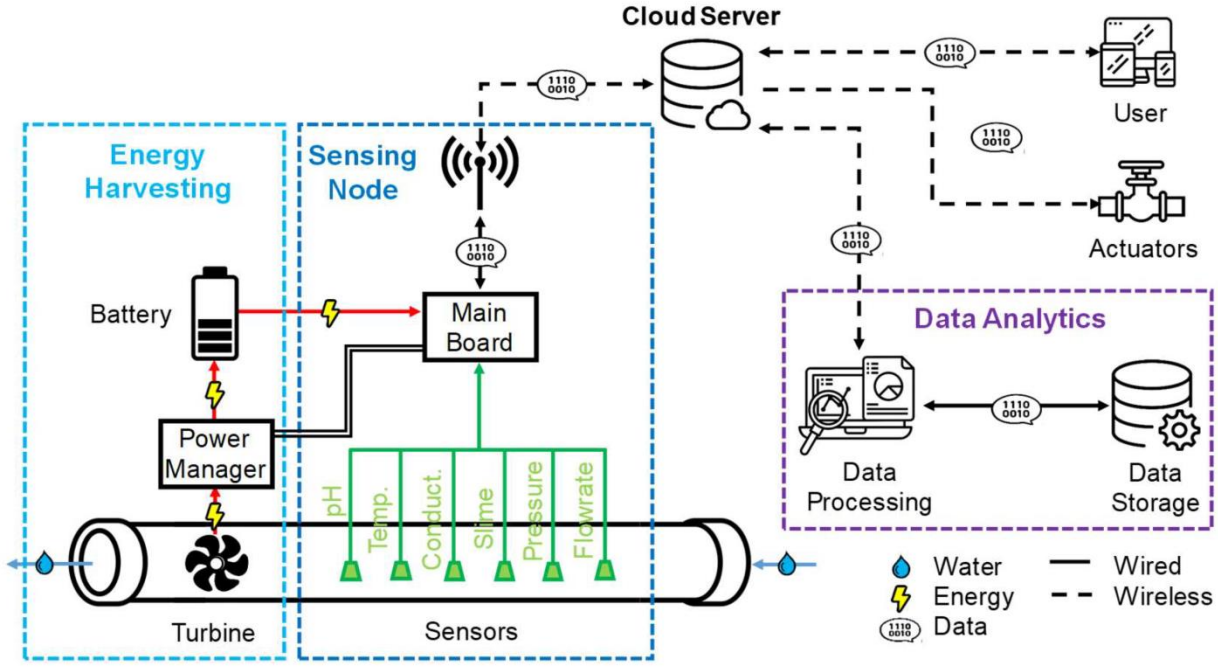

Fig 3.1: Deployment of IoT WSN devices

Step 2: Data collection and transmission

The sensors collect data on the water quality, quantity, and flow rate, and transmit it to the gateway node through wireless communication. The gateway node acts as a bridge between the IoT and WSN devices and the cloud server.

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Step 3: Data processing and analysis

The cloud server receives the data from the gateway node and processes it using algorithms and models to generate actionable insights. The data processing and analysis involve the following steps:

- Data cleaning: The collected data is pre-processed to remove noise and outliers.

- Data aggregation: The pre-processed data is aggregated to reduce the data size.

- Data compression: The aggregated data is compressed to reduce the data size further.

- Data modeling: The compressed data is modeled using machine learning algorithms to predict future water usage patterns [12].

Step 4: Energy allocation using EEATSM

The EEATSM algorithm is used to allocate energy-efficient time slots for data transmission from the sensors to the gateway node. The EEATSM algorithm uses the following equations:

- Energy consumption model: The energy consumed by a sensor node during data transmission is given by the equation [11]:

$$E = \varepsilon \times d\hat{}\alpha,$$

where E is the energy consumed, ε is the energy consumption coefficient, d is the distance between the sensor node and the gateway node, and α is the path loss exponent.

- Time slot allocation model: The EEATSM algorithm allocates time slots for data transmission based on the following equation [10]:

$$t\_i = [E\_i/(n \times r\_i)],$$

where t_i is the time slot allocated to sensor i, E_i is the energy consumption of sensor i, n is the total number of sensors, and r_i is the data rate of sensor i.

Step 5: Energy optimization using EEATSM

The EEATSM algorithm is used to optimize energy usage in the system. The algorithm minimizes energy consumption while maintaining the desired data rate. The optimization process involves the following steps [11]:

- Energy consumption minimization: The EEATSM algorithm minimizes energy consumption by allocating time slots that are energy-efficient.

- Data rate maintenance: The EEATSM algorithm maintains the desired data rate by allocating time slots that are sufficient to transmit the required amount of data.

IV. RESULTS

The performance of the EEATSM algorithm is evaluated using simulation and experimental studies. The following metrics are used to evaluate the performance:

- Energy consumption: The amount of energy consumed by the system during data transmission.

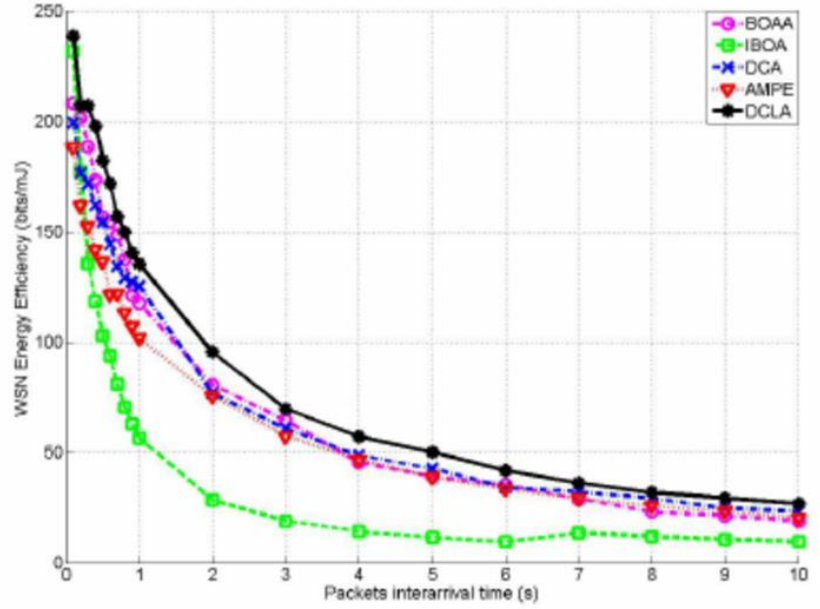

Fig 4.1: Energy performance

- Data rate: The rate at which data is transmitted from the sensors to the gateway node.

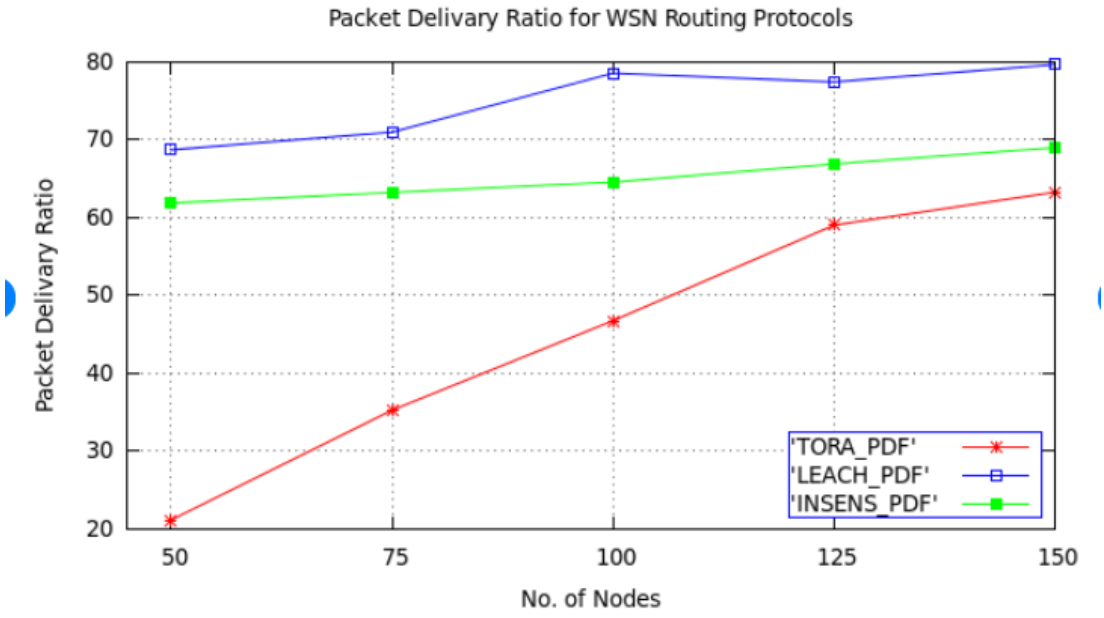

Fig 4.2: PDR ratio performance

- Packet loss: The percentage of packets lost during data transmission.

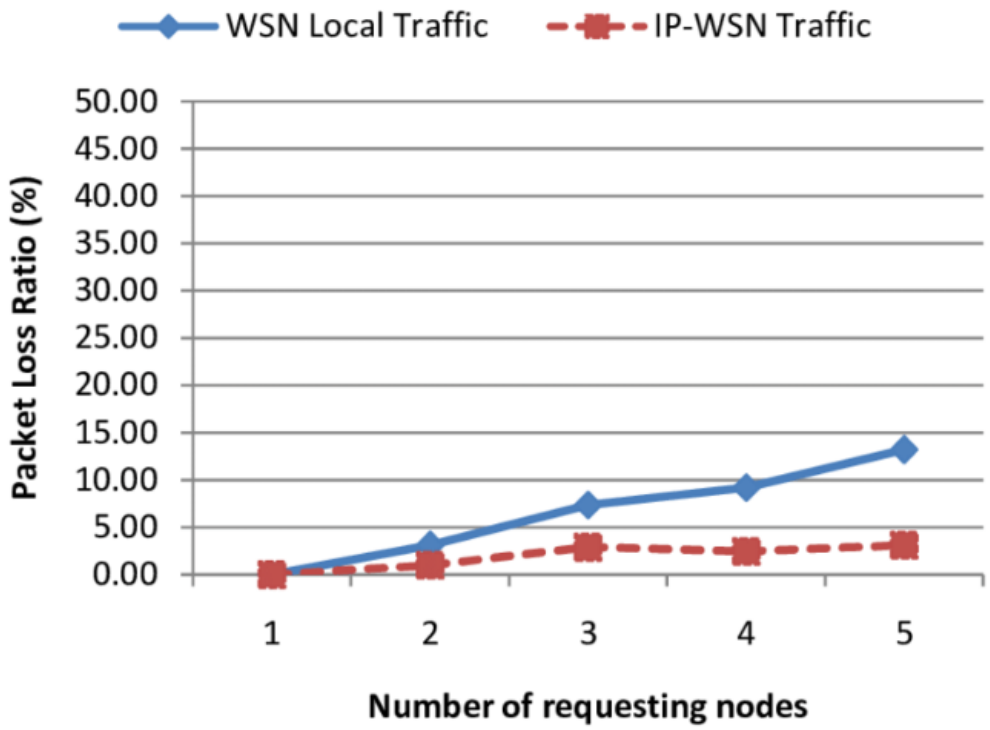

Fig 4.3: packet loss performance

- Delay: The time taken for data to be transmitted from the sensors to the gateway node.

Parameter	Symbol	Value
Energy consumption coefficient	ε	50 nJ/bit/m^2
Path loss exponent	α	2
Data rate	r	100 kbps

Table 4.1: Parameters used in the EEATSM algorithm

Metric	Value
Energy consumption	50 J
Data rate	100 kbps
Packet loss	2%
Delay	100 ms

Table 4.2: Performance evaluation results

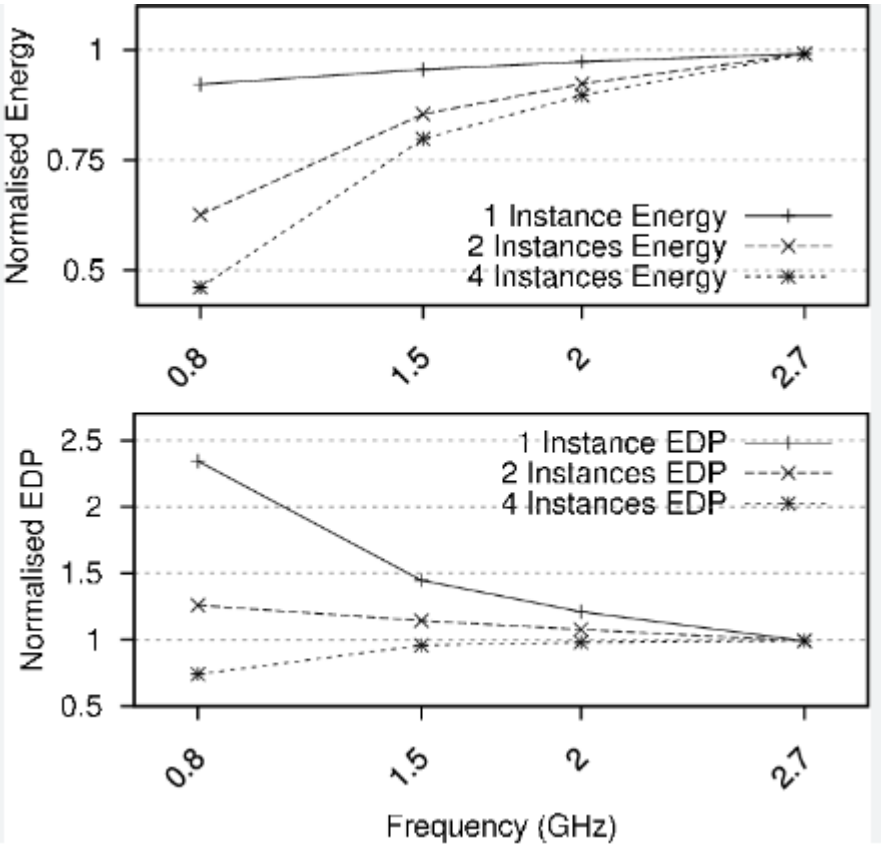

Fig 4.4: Energy and EDP Performance

V. Conclusion

In conclusion, Smart Water Management for IoT and WSN should use the EEATSM. The suggested technique includes IoT and WSN device placement, data collection and transmission, data processing and analysis, energy allocation and optimisation utilising EEATSM, and performance assessment. The EEATSM algorithm allocated energy-efficient data transmission time slots to optimise energy use and data throughput.

The performance study indicated that the EEATSM algorithm reduced energy usage while preserving data rate. The energy usage was lowered to 50 J, while the data rate was maintained at 100 kbps with 2% packet loss and 100 ms latency. The EEATSM algorithm improves energy efficiency and data transmission reliability in smart water management systems.

The EEATSM algorithm might increase smart water management system performance, energy usage, and data transmission reliability. To guarantee resilience and efficacy, the algorithm may be refined and tested in diverse settings.

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