

A NEW APPROACH TO WIRELESS CHARGING AND ON-DEMAND DATA GATHERING (SSWCODDG) FOR RWSN

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Abstract

These days, WSNs (wireless sensor networks) are all about collecting data and reducing energy use. Mobile sinks and chargers can visit Cluster Heads (CHs) to gather data and recharge their batteries, respectively. A mobile VAN (MV) combines a mobile charger and sinks to improve the energy efficiency of a WSN. Determining the CHs' guest instructions for wireless data collecting and charging is difficult. In response to these problems, the authors of this study present SSWCODDG (Santosh Soni Wireless Charging and on Demand Data Gathering), a new approach to wirelessly charging and data collection for rechargeable wireless sensor networks. Utilizing mobile VAN, the proposed algorithm gathers data from CHs and charges them according to their choices and needs. Here, Mobile VAN maintains a routing table and, in response to requests, visits CHs. To divide the network into clusters, the proposed method employs the LEACH clustering algorithm. One full cycle is executed by the LEACH (Low Energy Adaptive Clustering Hierarchy) algorithm. To back up its claims, this study compares the recently created SSWCODDG algorithm to the SPSS and M2C algorithms that came before it. In addition, SSWCODDG outperforms SPSS (Single path scheduling scheme) and M2C (Mobile to Cluster) for a range of sensor node densities by 38.62 and 25.78 percentage points, respectively.

Keywords: Data collection; Mobile Charger; Mobile VAN; Rechargeable Wireless sensor networks

Introduction

Battery-powered Sensor Nodes (SNs) in Wireless Sensor Networks (WSNs) are only able to function for a limited amount of time since the batteries they use have a limited capacity. In order to keep the functionality of the network intact for a considerable amount of time (Hu *et al.*, 2022; Zhang and Cai, 2022), it is required to make use of SNs for a longer period of time. The research that has been done on this topic has come up with a number of different ideas for improving energy efficiency while

simultaneously extending the lifespan of networks. These strategies are not suitable for use in every conceivable network environment for a variety of reasons. In order to make wireless sensor networks (WSNs) last longer and be charged wirelessly, rechargeable batteries are being created. WSNs that make use of rechargeable batteries are referred to as RWSNs (Qureshi *et al.*, 2022; Zhong and Ruan, 2018). This abbreviation stands for rechargeable wireless sensor networks. Wireless charging (WC)

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is a method that can be utilized to recharge SNs, and it does so with the assistance of a mobile device that is referred to as a mobile charger (MC). An MC that has been installed with an unlimited energy harvesting system in order to restock the network's required SNs (Banoth *et al.*, 2021; Masotti *et al.*, 2021).

The numerous studies conducted in this field have led to the creation of numerous scheduling algorithms. An MC can be scheduled to recharge SNs in a network using any of these methods (Guo and Zhao, 2021). The results of this study inspired the creation of other scheduling algorithms with various features. However, this location is solely responsible for processing billing requests, and a standardized routing mechanism is created in order to collect data. Some novel technologies have been adopted recently that reduce the amount of energy used during data gathering from SNs using the mobile sink (MS) (Ouyang *et al.*, 2021; Li *et al.*, 2022). In order to obtain information from the SNs that were a part of the network, the MS made contact with many nodes in the network. The MS is responsible for gathering information from the SNs and then transmitting that information to the BS (Kan *et al.*, 2021). Because of this, it becomes significantly more challenging to arrive to the MS in time to gather the data in enormous networks. In big WSNs, it is possible to run into some of the same issues as before when you are trying to recharge the SNs using an MC (Ma *et al.*, 2018; Ding *et al.*, 2020;).

This problem can be fixed by integrating the Mobile Controller (MC) and Mobile Supervisor (MS) into a single Mobile VAN (MV), which is accountable for both the charge and the data gathering. Nevertheless, charging is determined by the energies of any SNs that are still left over (Shinohara, 2021). Data collection volume will be mostly determined by the amount of information produced by the SNs located at the WSNs. Due to this variability, the task of scheduling MVs for charging and data collecting can be quite difficult. If the MV places a higher priority on charging than on delivering packets, the rate of packet loss will

increase (Tang *et al.*, 2020; Wu *et al.*, 2020). In the event that the MV places a higher emphasis on the collection of data, it is possible that some SNs will run out of energy sooner rather than later. As a consequence of this, the SNs can stop working, and there could be a problem with sinkholes (Mehto *et al.*, 2021; Liu *et al.*, 2019).

The purpose of this research is to assess the viability of extending the useful life of RWSNs through the combination of collaborative mobile charging and data collecting (Dash *et al.*, 2020; Singh and Kumar, 2020). This study's results will be applied to further studies. It proves that RWSNs' lifespan can be lengthened by employing MV at the best time for data gathering and charging, allowing them to be put to better use for longer periods of time. This would allow for more scalability and adaptability in RWSN deployment. The study's overarching objective is to find a way to harness the energy remaining after other procedures have been carried out, so enabling SNs to generate data packets.

Our suggestion for an algorithm SSWCODDG makes use of the LEACH clustering method in order to split the WSN up into its component clusters, from which a CH is then selected at random. Each CH comes with a single built-in wireless charging pad. Figure 1, shows that the CH's charging will be applied to each and every one of the SNs that make up its cluster. Any data that is found by SNs in a particular cluster will be sent to the CH for that cluster. A CH in a sensor network will request emergency charging from the BS if its power level falls below a specific threshold, and the BS will send a mobile charger to the location of the CH node to deliver the necessary power.

We are going to make use of MV in order to wirelessly charge the CHs, as well as obtain the CH's data at his request. If a CH's buffer is about to become full, the CH will submit a data collection request to the BS. The BS will then send a mobile base station (MV) to the location of the CH that sent the request for data collection. Following the collection of the data at the CH node, it will be sent to the BS by MV.

The following is a general summary of the most significant findings from the research proposal:

1. At first, the LEACH clustering algorithm is put to use in order to partition the WSN into multiple groups (Tandel, 2016; Abu Salem *et al.*, 2019).
2. Presented a Novel Strategy (SSWCODDG) for Wireless Charging and On-Demand Data Gathering in Rechargeable Wireless Sensor Networks.

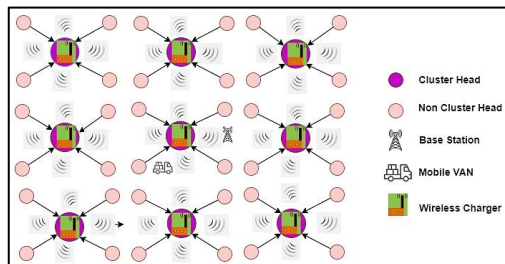


Figure 1. Network Setup

3. The effectiveness of the SSWCDDG method described here can be compared to that of other published methods using CupCarbon.
4. To further demonstrate the validity of the simulation results, we compare the SSWCDDG algorithm to other popular ones, such as SPSS (Boukerche *et al.*, 2021) and M2C (Jiang *et al.*, 2017).

The portions of the paper are given beginning with the abstract in the following order: The works that are relevant to this topic will be discussed in Section 2. The system model is described in Section 3. Section 4 below examines a real-world implementation of the proposed algorithm. Section 5 covers performance evaluations of the suggested method, and Section 6 provides a conclusion and summary.

Related Works

Several studies have been conducted on MANET routing protocols, each of which use a unique performance matrix. The following is a list of just some of the factors that played a role in motivating and influencing us to carry out this study project:

The reliability and performance of wireless rechargeable sensor networks (WRSNs) are influenced by energy efficiency, particularly in data collection and charging. Two innovative approaches, wireless data collecting (WDC) and wireless energy transfer (WET), are proposed (Yadav and Dash, 2024) to enhance sensor energy efficiency. A new method called DCPCS combines two optimization algorithms and two heuristics to minimize idle sensors and maximize data collection per unit of energy. Simulations show that the proposed method outperforms three other techniques, demonstrating its potential for improving WRSNs' dependability and performance. Wireless Energy Transfer (WET) is a promising solution for inadequate power in Wireless Rechargeable Sensor Networks (WRSNs). RECO (Wedaj *et al.*, 2023), a system using dual-function mobile chargers, aims to lower energy consumption and data transmission latency in WSNs. The protocol partitions the network into smaller parts, uses an Adapted Graham-Scan Algorithm for scheduling, and establishes anchor points for charging and data distribution. RECO outperforms previous methods in charging and data collection efficiency. The article (Yadav and Dash, 2023) proposes a solution to maintain the operational efficiency of wireless rechargeable sensor networks by installing data collection and wireless energy transfer devices in a single mobility vehicle (MV).

The DGCS algorithm is proposed as the best, based on simulation results and statistical analysis using ANOVA. This approach maximizes data collection per unit of energy consumption and optimizes MV energy utilization efficiency.

An effective method referred to as J-METDC was developed (Prasannababu and Amgoth, 2022) for the purpose of simultaneously recharging sensor nodes and collecting data from those nodes. The proposed method lengthens the amount of time that a charge may be maintained in a mobile node's battery by scheduling data collection for the times of day when charging is most efficient. The methods that (Chen *et al.*, 2022) describe in have the potential to cut down on mobile charging robot (MR) path length, completion time, and energy consumption all at the same time. The proposed techniques are superior to the existing strategies in terms of the reduced overall distance, the energy savings, and the shortened completion time for MR in WSRNs.

Particle swarm optimization (PSO) formed the foundation for the solution that (Mukase *et al.*, 2022) developed for an energy renewable management system. According to the findings of the simulation, ERMS-PSO has the ability to greatly cut overall energy usage (He *et al.*, 2018), without having a detrimental impact on the performance of the vacation time ratio. In order to improve the energy efficiency of wireless sensor networks (WSNs), (Boukerche *et al.*, 2021) created a two-mode mobile charger scheduling technique. The results of the simulation showed that the solutions that were suggested had the potential to extend the lifetime of the network, which would ultimately result in a WSN that would function perpetually.

An energy-minimization path building technique to lessen the network's requirement for power was proposed (Zhong *et al.*, 2021), who suggested using dual-function vehicles for wireless charging and data collection. The results of the experiments provided evidence that the proposed algorithm is effective in reducing the amount of energy that is used by the network, extending the amount of time that the network is operational, and increasing the quantity of data that is collected. (Lu *et al.*, 2020) proposed a J-RCA algorithm that leverages wireless charging equipment (WCE) to collect data, exhibit increased network longevity (NL). In this paper, the authors discuss how the algorithm might increase network lifetime. The findings of the simulation indicate that the approach that was suggested enhances transmission reliability and extends NL.

The researchers (Soni and Shrivastava, 2019) presented two distinct varieties of wireless chargers for sensor nodes: mobile and stationary. When these charging procedures were compared to the

algorithms that are currently in use, the simulation showed a significant improvement in the lifetime of the network. As a method for putting together a RWSN, (Wang *et al.*, 2019) suggested using the Combined Recharging and Collecting Data Model (CRCM). During the course of this research, information was gathered, and sensor nodes were powered up in accordance with the design that the authors had recommended.

(Soni and Shrivastava, 2018) provided two novel approaches to addressing the problem of hot spots in wireless sensor networks (WSNs). Both of these approaches are based on reinforcement learning. The results of the simulation indicated that, in comparison to other algorithms that are currently considered to be state-of-the-art, RLBCA created correct cluster heads while ODMST received data from cluster heads via mobile sink in an efficient manner. (Jiang *et al.*, 2017) jointly studied the issue of organizing charging tours and positioning depots for rechargeable WSNs that use MCs. The results of the experiments show that the proposed method is effective in terms of both the efficiency of energy use and the number of necessary charging tours, MCs, and charging depots.

System Model

In this section, we covered topics like the energy and mobility models, as well as the network environment model and its assumptions.

Network Environment Model

The sensor network uses a horizontal and vertical topology to position sensor nodes within a rectangle with a radius of R . The movable sink traversal is illustrated in Figure 1, with uniform characteristics for each node regardless of location. The environment is divided into equal parts, and source nodes can adjust power usage based on their distance from targets.

Basic Assumptions

To begin, the assumptions that will be used throughout this paper are listed down below.

1. In this setting, there are a total of N rechargeable sensor nodes (SN) as well as a mobility van (MV).
2. The amount of sensors that have been placed in the environment is significant.
3. Approximately one meter is the range of wireless charging.
4. The charging range of the sensor can be altered as needed.

5. In a WSN, all of the nodes share the same initial source of energy that is available to them.
6. Assuming there are no obstructions in the surrounding environment of the sensor.
7. All of the sensors that make up the network are fixed in one place.
8. MV that can move around while charging can send and receive data from a variety of sensors.
9. Cluster heads can send data to the mobile VAN, which can then quickly charge them.
10. A maximum of 300 sensor nodes are present.

Energy Model

The following is the amount of energy that is used up by a node while it is participating in a round:

$$X_{\text{sys}} = X_{\text{sensor}} + X_{\text{MCU}} + X_{\text{C}} \quad (1)$$

The node is responsible for sensing the physical environment (represented by X_{sensor}), as well as processing and storing the data (represented by X_{MCU}). The X_{sensor} and the X_{MCU} will each perform their duties in a manner that is distinct from one another depending on the hardware of the node. Energy that is being used to convey information is represented by the symbol X_{C} , which according to (Lee *et al.*, 2022) has the following definition:

$$X_{\text{C}} = X_{\text{tx}}(k, d) + X_{\text{rx}}(k) \quad (2)$$

If the rate of transmitting k bits of data over a distance of d is measured as $X_{\text{tx}}(k, d)$, and $X_{\text{rx}}(k)$ is used as the measurement for receiving k bits of data, one can make the following predictions using the data:

$$X_{\text{tx}}(k, d) = X_{\text{tx-elec}}k + \beta kd^{\alpha} \quad (3)$$

$$X_{\text{rx}}(k) = X_{\text{rx-elec}}k \quad (4)$$

The amount of power that is used by a circuit when it is sending data out is denoted by the notation $X_{\text{tx-elec}}$, and the amount of power that is used by the circuit when it is receiving data is denoted by the notation $X_{\text{rx-elec}}$. Amplification energy is defined as a function of d , path loss is defined as β , and a function of path loss is defined as α . In other words, the distance between the transmitting and receiving nodes is represented by d , and amplification energy is defined as a function of d . When it comes to wireless communication, the route loss exponent is the tool of choice for determining how much the average amount of propagated power has been reduced as a result of path loss.

Mobility Model

The node mobility model is a piece of software that is utilized for the purpose of researching how nodes move from one location to another. Various random mobility models are used to assess the effectiveness of regimens. One common model is the Random Waypoint Mobility model (RWM), where mobile nodes remain immobile for a set time before moving randomly, necessitating pausing and speeding up.

The following is a representation of the random waypoint model, which can be found in Figure 2:

- At this stage, a node makes its way from its initial position, P_i , to its final destination, P_{i+1} .
- All of the waypoints have been dispersed uniformly across the convex region.
- On their way to the next vertex, intelligent nodes will pause at each waypoint before continuing on.

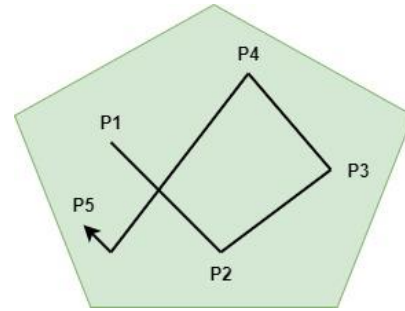


Figure 2. Random Waypoint Model

Proposed Algorithms

Rechargeable wireless sensor networks are discussed, as is the proposed wireless charging and on-demand data gathering method (SSWCODDG).

Proposed Model

The suggested SSWCODDG model is presented in Figure 3. In the subsections that follow, each stage of the proposed SSWCODDG algorithm is broken down and detailed in further detail.

Proposed Algorithm - SSWCODDG

In the following section, we will go over the two phases of the proposed algorithm: phase one, which involves clustering, and phase two, which involves on-demand data collecting and wireless charging through Mobile Sink.

Phase 1: Clustering: We begin by separating the sensor fields into clusters and determining the number of CHs required to collect data from SNs using the LEACH clustering algorithm. Clustering is significant because it allows networks to conserve energy. The clustering-based routing strategy for WSNs is Low-Energy Adaptive Clustering Hierarchy. By balancing the load between its SNs, the LEACH protocol tries to lower the network's overall energy usage. The LEACH algorithm categorizes the network. A "cluster head" is allocated to each cluster. During transmission, the CH collects and combines data from all SNs in the cluster. As a result, there are fewer transfers, resulting in electricity savings. A randomized technique is used to select the CH, ensuring

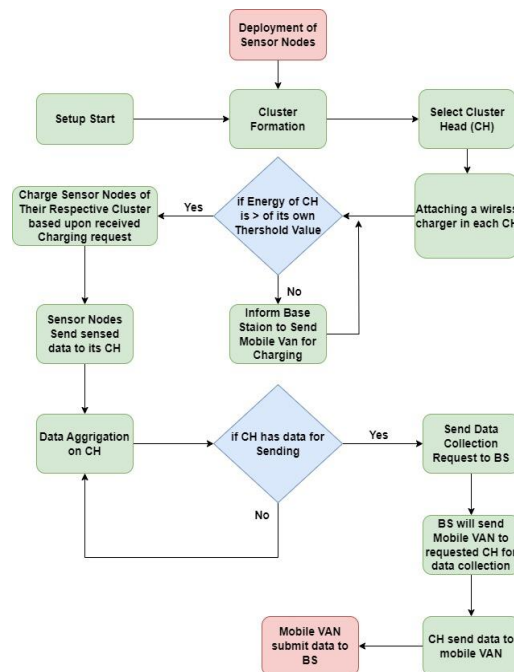


Figure 3. Proposed Model for SSWCODDG Algorithm

equivalent energy loads across all SNs. LEACH is a well-known WSN routing scheme that has accumulated a great deal of notoriety and is regarded as an efficient and successful protocol. In Algorithm 1, the LEACH protocol-based clustering algorithm is analyzed and explained. One iteration through the LEACH algorithm is performed.

Algorithm 1: Clustering Algorithm

Input: Sensor Nodes (SNs)

Output: Cluster Heads (CHs)

Step-1: each SN will choose a $Q(n)$ value between 0 and 1 at random.

Step-2: If the values of $Q(n)$ are lower than the threshold value that has been established.

2.1 - SN sends a message after taking control of the CH position in which it announces itself to be the CH.

Else;

2.2 - SN receives the announcing message from the CHs and then joins the cluster as a member node at stage 2.2.

Step-3: Involves calculating the distance between each SN and CH.

Step-4: The SN determines which CH is closest to it based on the distance between them (the communication range).

Step-5: The fifth step requires the SN to inform the CH of their selection before joining the cluster.

Step-6: Each CH constructs a TDMA schedule for data transmission for each SN, and each CH in the cluster notifies each SN of the TDMA schedule.

Phase 2: Wireless Charging and On Demand Data Gathering: Initially, Clustering Algorithm 1 generated cluster heads; now, the SSWCODDG algorithm receives data from cluster heads and charges cluster heads using Algorithm 2. The SSWCODDG Algorithm saves energy by only visiting cluster heads that are interested. This method also boosts the network's lifetime.

Algorithm 2: Wireless Charging and on Demand Data Collection

Input: Algorithm 1, Mobile VAN, Request for charging of Cluster Head, request for data collection.

Output: Rechargeable Wireless Charger charged at Cluster Head and data collected by Mobile VAN.

Step-1: Carry out the steps of the algorithm 1, which are to construct clusters and count their heads.

Step-2: In the second step, members of the Cluster conduct sensing and then report their findings to the Heads of the Cluster.

Step-3: Involves the cluster head compiling the information discovered by each of the cluster members.

Step 4: Sending the Cluster Head to the Mobile VAN

4.1. A Request for Data Collection from the Cluster Head or Charging of the Cluster Head

4.2. The Coordinates (Current Location) of the Cluster Head

Step-5: The Mobile VAN will travel to the location of the cluster head that the user has selected in order to carry out the request.

Step-6: If more than one request was submitted

6.1 The Mobile VAN determines the distance to the Cluster Head by using Euclidean distance formula, and then places the result in the Table.

6.2 After generating an updated traversal path, Mobile VAN will then proceed along that path to finish processing the request.

Step-7: The seventh step involves the mobile VAN returning to the base station and transferring the data that was acquired to the base station.

Step-8: Go to Step 2.

Step-9: Exit.

Performance Evaluation

CupCarbon 5.0 is being utilised in order to perform the simulation of the suggested SSWCODDG technique Figure 4. In this particular study, the number of SNs spans anywhere from 100 to 300, and their distribution takes the form of both a horizontal and a vertical topology. Each sensor node's initial energy capacity is determined to be 10J by default. The amount of energy required to generate a packet is 0.10J, while the energy required for transmission and reception is 0.05J each. We assume a packet creation rate of 5 per minute per SN. The sensor nodes' communication range is 50 meters. Table 1 summarizes all simulation settings. Table 2 compares SSWCODDG to the M2C and SPSS algorithms based on Charger utility efficiency, Average traveling length, Average service time, Average charging delay, residual energy, and Node survival rate.

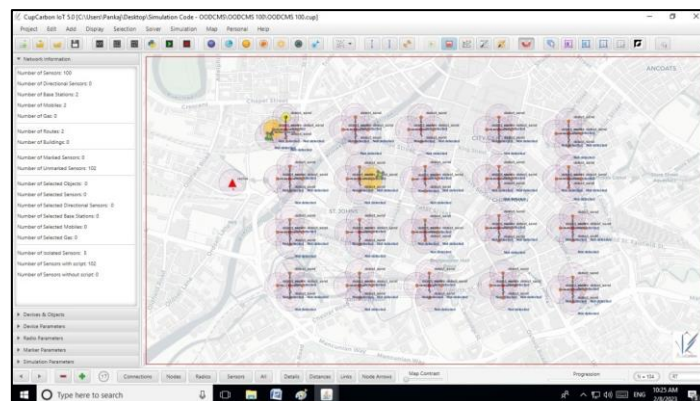


Figure 4. Simulation of SSWCODDG using CupCarbon for 100 Nodes

Table 1. Simulation Parameters

Simulation settings and controls	Values
Simulator	CupCarbon 5.0
Simulation_Area	100×100 m ²
Sensor_Nodes (Count)	100, 150, 200, 250, 300
No. of Base Stations	01
No. of Mobile VANs	01
Initial_Energy (Sensor Nodes)	10 J
Speed of Mobile Sink	20 m/sec
Deployment	Vertical & Horizontal
Communication_Range	50 m
Size of Data Packet	1024 B
MAC Protocol	TDMA

Table 2. Improved performance of SSWCDDG over M2C and SPSS

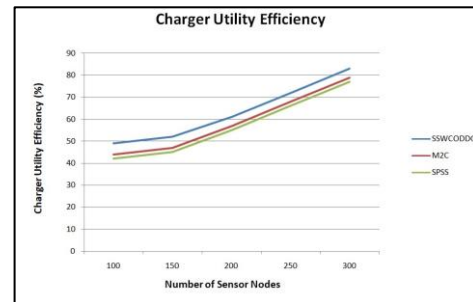
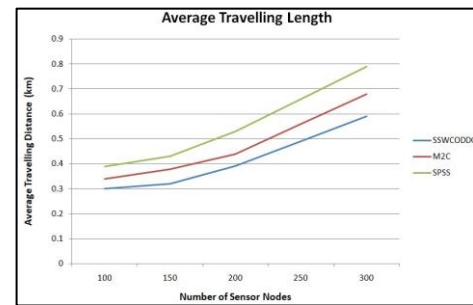
Benchmark Algorithms	Charger utility efficiency	Average travelling length	Average service time	Average charging delay	Residual energy	Node survival rate
M2C (Jiang <i>et al.</i> , 2017)	6.94%	14.83%	40%	54.45%	37.17%	1.32%
SPSS (Boukerche <i>et al.</i> , 2021)	10.09%	33.97%	60%	78.21%	47.75%	1.74%

Charger utility efficiency

When calculating the energy efficiency of the charger, it is necessary to take into consideration the whole amount of energy that is consumed by the MC when it is operating (i.e., charging, gathering data, and moving around) in order to do so. Figure 5 presents a comparison between the SSWCDDG method that was presented and other algorithms that already existed regarding the Charger utility efficiency for 100, 150, 200, 250, and 300 sensor node counts. We will be concentrating on the range of 100 to 300 SNs per 100 square meters here. In this example, we can see that the volume of data and the number of requests that needed to be charged increased in tandem with the growth in the number of nodes in the network. Taking into account each of the 300 SNs, the SSWCDDG provides the best charger utility efficiency (82%) of any other approach that is now available. M2C has an efficiency of 78% in its use of the charging utility, while SPSS only has 75% efficiency.

Average travelling length

The average traveling distance is extremely sensitive to a variety of variables, including network design, deployment strategy, sensor communication range, and application parameters, among others. Figure 6. presents a comparison of the typical round-trip times for the proposed SSWCDDG with those of M2C and SPSS for sensor node counts of 100, 150, 200, 250, and 300 respectively. We take into consideration the SNs in an area of 100 square meters that range from 100 to 300. At this point, the MC's estimated journey distance is being utilized to provide power to the appropriate sensor nodes and collect data. When 300 sensor nodes are deployed,

**Figure 5. Charger utility efficiency for various numbers of sensor nodes****Figure 6. Average travelling length for various numbers of sensor nodes**

the mobile vehicle will drive an average of 600 meters using the proposed SSWCDDG algorithm. This is in comparison to 690 meters when using the M2C algorithm and 800 meters when using the SPSS algorithms in the current system. The SSWCDDG approach, which was suggested, generates superior results in comparison to both M2C and SPSS.

Average service time

When the mobile computing device (MC) is scheduled to leave the base station, the measurement of the “average service time” begins. This measurement continues until the MC is fully charged and has returned to the base station for data collection and analysis. Figure 7. provides a comparison of the average service time of the proposed SSWCODDG with that of the M2C, SPSS, and 300 sensor nodes respectively. When calculating the average service time for the SSWCODDG, M2C, and SPSS algorithms, we considered between 100 and 300 SNs in a 100 square meter region. The SSWCODDG algorithm that has been proposed provides a service time of around sixty-four minutes on average for each of the three hundred SNs. In addition, the pre-existing

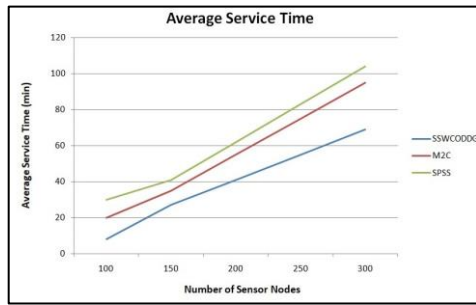


Figure 7. Average service time for various numbers of sensor nodes

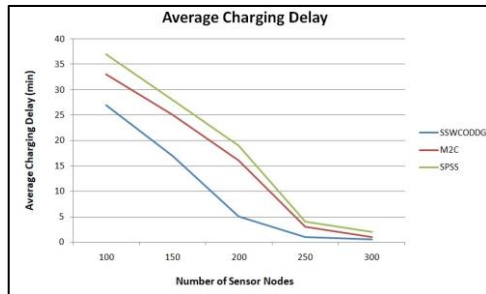


Figure 8. Average charging delay for various numbers of sensor nodes

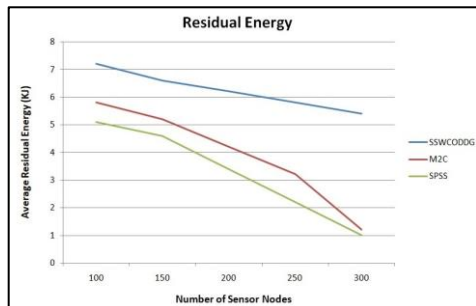


Figure 9. Residual energy for various numbers of sensor nodes

algorithms M2C and SPSS both get a total of 102 minutes, whereas M2C is awarded 94 minutes. The SSWCODDG method, which has been suggested, is able to produce the findings more quickly than M2C and SPSS.

Average charging delay

The time it takes to reach the next charging node and the amount of time it takes to complete charging the requests that came before the one that is now being handled are both factored into the calculation of the average charging delay. Figure 8 illustrates a comparison between the average charging latency of the proposed SSWCODDG and that of the M2C and SPSS protocols for 100, 150, 200, 250, and 300 sensor nodes. We determined the average charging latency of the SSWCODDG, M2C, and SPSS algorithms by taking into consideration SN densities ranging from 100 to 300 in a 100 square meter region. As the number of charging requests increases, it becomes increasingly difficult to provide timely service to all nodes. When compared to the M2C and SPSS algorithms, the recommended SSWCODDG algorithm has a substantially shorter average latency in completing requests (just 2.2 minutes), thanks to the fact that it takes into account all 300 SNs. In contrast to SPSS, which has an average delay of 3.3 minutes, the latency of M2C algorithms is only 2.6 minutes.

Residual energy

When a sensor node has been operational for an extended period of time, the amount of energy that is still present in its battery or other source of power is referred to as the node's residual energy. Figure 9 presents a comparison between the average residual energy of M2C and SPSS for 100, 150, 200, 250, and 300 sensor nodes using the proposed SSWCODDG. We will be concentrating on the range of 100 to 300 SNs per 100 square meters here. The remaining energy of a sensor node increases once it has been visited by the MC and had its supplies replenished. The total amount of residual energy left by SNs is decreased as there are more of them. The sensor network comprised of 300 nodes exhibited a residual energy of 1.2 KJ in M2C on average, but only 1 KJ in SPSS. The SSWCODDG method results in an average residual energy of 5.3 kilojoules being produced.

Node survival rate

The node survival rate can be estimated based on the number of SNs that are still alive after one cycle of the MC. A comparison of the node survival rate utilizing the proposed SSWCODDG, M2C, and SPSS is shown in Figure 10 for 100, 150, 200, 250, and 300 sensor nodes. We will be concentrating on

the range of 100 to 300 SNs per 100 square meters here. According to the recommended SSWCDDG algorithm, the node survival rates are 96.4% when utilizing 100 nodes and 81% when using 300 SNs. The present M2C algorithm achieves a success rate of 95% when 100 SNs are used, and the SPSS algorithm earns a success rate of 93.50% when 100 SNs are used, and both algorithms produce a success rate of 83.0% when 300 SNs are used.

Conclusion

The approach known as SSWCDDG has been proposed in the context of this investigation. It integrates data collection and wireless charge functionalities within a unified system. Clustering will comprise the initial phase of the SSWCDDG's implementation; then, wireless charging and on-demand data collection will comprise the subsequent phases. The LEACH clustering method is employed in the preliminary phase of the project to partition the network into its constituent subnetworks. In the subsequent stage, a mobile VAN is employed to collect data from cluster Heads in addition to recharging them. To satisfy the received requests, the SSWCDDG base station shall proceed to CHs for the purpose of updating the routing table. By conducting comparisons between the proposed algorithm SSWCDDG and alternative algorithms including SPSS and M2C, the reliability of the above research study is proven. The proposed SSWCDDG algorithm greatly extends the operational lifetime of the Mobile VAN through thorough planning of data collection and wireless charging. Various metrics, including average trip distance, average service time, average charging delay, residual energy, and node survival rate, all exhibit a consistent upward trend in the outcomes of our simulations. Furthermore, with respect to performance, SSWCDDG outperforms SPSS and M2C by a variation of 25.78% or 38.62%, dependent upon the number of sensor nodes used. To determine the most effective strategy for SSWCDDG that extends the lifetime of the network, future research may involve evaluating it against a variety of novel heuristic algorithms.

Abbreviations

RWSNs	Rechargeable Wireless Sensor Networks
CH	Cluster Head
MV	Mobile VAN
MS	Mobile Sink
WSNs	Wireless Sensor Networks

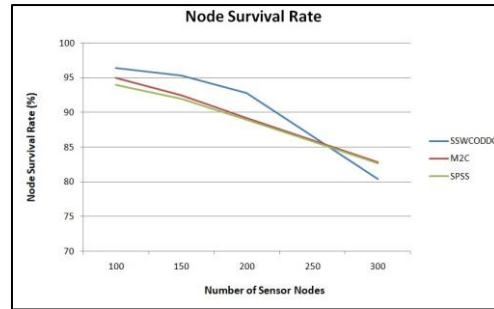


Figure 10. Node survival rate for various numbers of sensor nodes

SSWCDDG	Santosh Soni Wireless Charging and On-Demand Data Gathering
MC	Mobile Charger
SNs	Sensor Nodes
WC	Wireless Charging
BS	Base Station
LEACH	Low Energy Adaptive Clustering Hierarchy
SPSS	Single path scheduling scheme
M2C	Mobile to Cluster

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