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# IoT Assisted Hierarchical Computation Strategic Making (HCSM) and Dynamic Stochastic Optimization Technique (DSOT) for Energy Optimization in Wireless Sensor Networks for Smart City Monitoring

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**Abstract**

Presently, Innovations and applications of the Internet of things (IoT) are empowering smart city activities worldwide. IoT technology is creating smart building frameworks with a heritage structure to enhance sustainability and energy optimization. The primary issue of energy consumption in sensor node depends on the average rate of power consumption of node times in Wireless Sensor Network (WSN) leads to several power optimization issues in the communication network during information sharing and processing. To address the optimization issues this research mainly focused to design and develop a Hybridized IoT assisted Hierarchical Computation Strategic Making (HCSM) Approach and Dynamic Stochastic Optimization Technique (DSOT) to oversee the energy optimization issue in a Wireless Sensor Network for smart city monitoring. Furthermore, the energy-constrained sensor node negotiates numerous activities associated with network and the selection of a sensor cluster node optimizes the energy consumption and sensing accuracy during information processing. The experimental outcomes show that the HCSM & DSOT approaches are found capable of improving the energy efficiency of wireless sensor network and sensor cluster node selection at lab scale experimental validation.

Keywords: Energy-constrained sensor node, Smart city monitoring, Wireless Sensor Network, IoT, Hybridized IoT assisted Hierarchical Computation Strategic Making (HCSM), Dynamic Stochastic Optimization Technique (DSOT).

## 1. Introduction

In the recent past, Internet of Things (IoT) technology is playing a vital role, in large scale applications such as smart factories, smart cities, smart homes and smart grids etc.., [1]. In General, The Operation of IoT is based on the cooperative functions of numerous sensors, mobile devices, video cameras in the cosmopolitan city for data sharing via internet [2]. In this IoT assisted Network, Wireless Sensor Network (WSN) is considered as the fundamental component of the IoT model and it have multiple sensor nodes in smart city circle for data management. Furthermore, each node in a WSN is notably used for some particular purpose and each node is operated by a battery which leads to energy consumption in all the smart city framework communication for data processing [3]. Nowadays, the infrastructure of both Smart Homes and Smart Cities demands an extensive information collection for monitoring and control. This has been made easier via WSN to assemble data by formulating the sensor nodes as self-sufficient framework. In the recent past for smart city monitoring, WSN's are being used extensively in smart cities, healthcare monitoring, home automation, and environmental monitoring [4].

Recent Survey Shows that significance of IoT technology is used to construct smart buildings with inheritance property to improve its sustainability and conserve energy [5]. Smart city energy management framework uses IoT devices for, designing nonstandard heating, cooling; connect disparate, lighting and fire-safety system to a focal management application to improve the standards [6]. For an instance, IoT can transform the way of consuming water in urban areas by employing smart meters, which are capable of enhancing leak detection and information integrity. Further it gives assistance to boost the production of several companies and helps to monitor the deflection of revenue losses due to disorganisation in time management for processing information [7]. Additionally, these smart meters can be intended to highlight the importance of technology to the users by implementing on residents with real-time access and it monitors the consumer-facing portals to collect data about their utilization and water supply management [8].

Besides IoT helps in monitoring Smart traffic signals to adjust shifts and traffic during holiday and keep cars moving without manual intervention. It helps City authorities to gather information about the traffic from road sensors, vehicles to traffic cameras, mobile phones and monitoring traffic accidents progressively without any troubles. This leads Drivers can be cautioned against incidents and coordinated to drive on less congested routes, Such prospective are unlimited but the outcomes will be generous [9]-[10].

Here with the help of IoT Assistance the Public transportation is obstructed markedly and monitored easier on road blocks, equipment breakdowns or due to heavy weather. IoT may provide the real-time insights for transport experts to execute emergency plans and assure residents to consistently access the reliable networks, efficient public transportation and safety and accomplished by utilizing the smart cameras or associated devices at transport covers or other open regions [11]-[13].

Nowadays, Smart cities have hundreds of cameras surveillance with smart gateway and monitoring control over the traffic for incidents of safety concerns in public streets. Video Monitoring software using IoT contributes that each camera connects the system into a sensor for sensing and measurements of data over the Cloud Assisted IoT, with edge analytics and computing from the source via WSN gateway. Machine-learning like Artificial intelligence technology will complete the investigation of study and would send video recording to people who can respond rapidly to explain the issues and keep residents protective as shown in the Figure.1 [14].

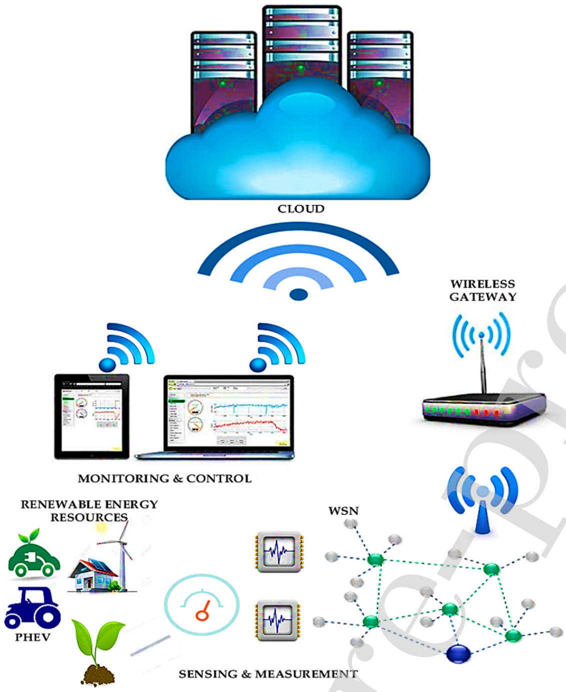


Figure 1: Basic Structure of Wireless Sensor Networks with Cloud assistance

The architecture WSN is made up of a sensor node. WSN sensor nodes consist of System-on-Chip (SoC), sensor arrays, power supply, distribution units, and wireless communication interfaces. The wireless communication view of a Wireless sensor network permits every node to function autonomously and figure.1 explains the basic structure of wireless sensor networks [15].

In this paper, IoT assisted Hierarchical Computation Strategic Making (HCSM) and Dynamic Stochastic Optimization Technique (DSOT) approaches have been proposed for energy optimization in a Wireless Sensor Network for smart city monitoring for data management application. By practicing HCSM & DSOT methods in smart city would help to decrease maintenance costs, minimize the energy consumption, lower environmental impact and make energy management simpler that leads to enhance the efficiency by adopting disparate element under a single framework.

## 2. Literature Survey

Karan Nair et al [16] suggested Bluetooth Low Energy (BLE) method for optimizing energy consumption in IoT based Wireless sensor networks. They used a hybrid topology to decrease the energy consumption and minimize the cost. Further, BLE approach can be proposed to operate the utilized network topology and multi-hop mesh topologies are used in hybridization of the mesh and star topologies. Here, Authors compared Zigbee and RF wireless networks with Bluetooth low energy model for low power applications to improve the functionality of the network and costing low energy.

Henrich C. Pohls et al [17] introduced the RERUM framework (REliable, Resilient and secUreIoT for sMart city) for Smart city privacy and their security which employs IoT application. This method efficiently senses the environment effectively, trustworthily, and timely to improve the smart city architecture. RERUM aims to improve the reliability of the IoT by giving security protection system for smart city applications. RERUM framework provides the attacker model and application scenario to achieve protection in the smart city.

Xue Wang et al [18] initialized the parallel sensor deployment optimization and parallel particle swarm optimization (PSDO-PPSO) algorithms for target tracking energy optimization in a wireless sensor network. Parallel particle swarm optimization algorithm is used in cluster head to minimize the communication power and to enhance the coverage area in every cluster. Parallel sensor deployment optimization algorithm is used for energy consumption and is minimized for target tracking.

Vasileios A. Memos et al [19] suggested Media-based Surveillance system (EAMSuS) method for an Efficient Algorithm in IoT Smart city system. They propose the routine security system that will assure a lighter and more secured transmission for rapid media sharing among the people of the smart city, for instance, in the case of a cybercrime social cloud; they achieved low memory consumption at the WSN of IoT assisted smart city management.

GulShahzad et al [20] suggested the Traffic Adaptive Control (TAC) approach for the energy-efficient intelligent street lighting framework. This method provides energy optimization for Smart Street lighting and also used for smart grid construction based system framework for minimum power utilization. Here author discusses, The Zigbee mesh wireless sensor networks which offers high adaptive traffic control for energy efficiency on the road.

TAC uses electronic control and Smart Street LED lighting using both wireless and wired technology.

Our research study targets to overcome these issues by IoT assisted Hierarchical Computation Strategic Making (HCSM) Approach and Dynamic Stochastic Optimization Technique (DSOT), which have been proposed for energy optimization in a Wireless Sensor Network for smart city monitoring in data management. Both of these proposed approaches, namely HCSM & DSOT achieve the energy efficiency in smart cities and the utilization of energy cost is low as validated experimentally at lab scale testing. Moreover, wireless sensor networks with IoT help to increase the node battery life and enhances the network lifetime which has been discussed as follows,

## 3. Discussion on IoT assisted Hierarchical Computation Strategic Making Approach and Dynamic Stochastic Optimization Technique

In General, WSN and Artificial Intelligent (AI) are considered as a prominent component for rising IoT concept and the recent improvement in smart computer systems that converts maximum computing energy for performance procedure and high memory limits. Moreover, the IoT concepts close to cyber security system, which targets consistent incorporated physical frameworks with processing and communication assets. Additionally, in the urban zones for smart city monitoring, the IoT sensor act as a service concept and the integration of the software-defined sensor networks with the inheritance of wireless sensor networks based frameworks is prompting to change the ordinary city services towards smart cities.

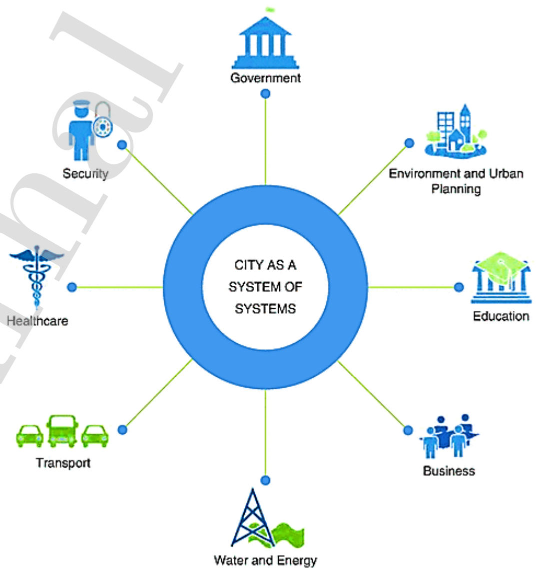


**Figure.2. Systems of smart cities upon various sectors**

The WSN concepts are prominently used in smart city monitoring which is used to analyse the sensor loop by decision-making process, actuating and participating in sensing as well as measurement during information processing. Smart homes, smart living, smart energy, smart health, smart governance, smart driving and other services might be provided by smart cities as shown in the Pictorial Representation in Figure.2. The transformation of IoT assisted WSN introduces the unique solution for the data communication plan of smart cities. The WSN concept aims at making the Internet even more enveloping and easy reach whereas figure.3. explains the key aspects of smart cities.

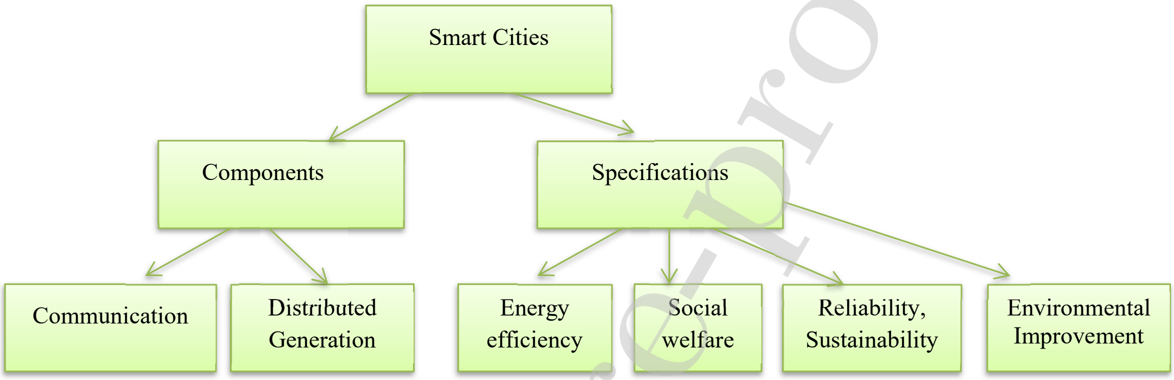


**Figure.3. The features of Smart cities**

### a) Hierarchical Computation Strategic Making (HCSM) Algorithm

In this paper, IoT assisted Hierarchical Computation Strategic Making (HCSM) Approach and Dynamic Stochastic Optimization Technique (DSOT) Approach has been proposed for energy optimization in a Wireless Sensor Network with framework for smart city monitoring. To enhance the scalability and to avoid the maximum amount of distance data transmission is analysed using clustering methods. Here, the clustered IoT sensor nodes are designed to determine the energy-efficient structure for coverage issue in smart city. The Proposed HCSM & DSOT algorithms improve performance of the network and the optimization function is allocated within the Cluster heads (CHs).

***Analysis:1- Computation strategic of WSN based on Loss Function and Entropy***

Let's consider the “m” sensor node, “n” mobile sensor nodes, and "$\varphi_{jl}$" which denote the membership function that grades the “m” sensor node. The coordinate’s used in the sensor nodes $(y_j, x_j)$ can be determined based on the “j” values as represented as j= 1, 2…m. Further, The sensor nodes partitioned into “b” clusters. The coordinates of cluster centroid as denoted by $y_j^u, x_j^u$ is represented as j=1,2..b. From the above assigned parameters, the following mathematical Eqs (1), (2) and (3) satisfy the condition of computation strategic of WSN for data management as follows,

$$\varphi_{jl} \in [0,1], 1 \leq j \leq b, 1 \leq l \leq m \quad (1)$$

$$\sum_{j=1}^{b} \varphi_{jl} = 1, 1 \leq l \leq m \quad (2)$$

$$0 < \sum_{l=1}^{m} \varphi_{jl} < m \quad (3)$$

As shown in the above Eq $\varphi$ denotes the membership function of every IoT sensor as denoted as $\varphi = \{\varphi_{jl}\}_{b\times m}$. From the membership definition, the loss function and entropy can be calculated using $\varphi$. Further, the objective function of HCSM is expressed by the following Eq (6) is,

$$G = \sum_{j=1}^{b} \sum_{l=1}^{m} \varphi_{jl} (s_{j,l}^{u})^2 + \delta \sum_{j=1}^{b} \sum_{l=1}^{m} \varphi_{jl} \ln \varphi_{jl} \quad (4)$$

As shown in the Eq (4) $s_{j,l}^{u}$ indicates the distance between the cluster centroids j and sensor nodes i, where $\delta$ is the constant. The resulting entropy is maximized and the loss function minimized using HCSM approach during data management via WSN gateway has been mathematically computed in Eq(4).

From the WSN gateway the cluster centroid coordinates has been calculated as denoted as $y_j^u, x_j^u$ then the following Eq (5) is calculated based on the centroid positions based on the strategic conditions as given below,

***Condition:1-{$y_j^u, x_j^u$}***

$$y_j^u = \frac{\sum_{l=1}^{m} \varphi_{jl} y_l}{\sum_{l=1}^{m} \varphi_{jl}}, x_j^u = \frac{\sum_{l=1}^{m} \varphi_{jl} x_l}{\sum_{l=1}^{m} \varphi_{jl}} \quad , j = 1,2, \dots b \quad (5)$$

From the derivative Eq(5) The membership matrix $\varphi$ is expressed in the Eq (6) as Follows,

***Condition:2-{$\varphi_{jl}$}***

$$\varphi_{jl} = \frac{e^{-\left(s_{j,l}^{u}\right)^2/\delta}}{\sum_{d=1}^{b} e^{-\left(s_{j,l}^{u}\right)^2/\delta}}, j = 1,2 \dots b, l = 1,2, \dots m \quad (6)$$

As shown in the Eq (6) the cluster nodes are divided into b parts of sensor field.

In the smart city environment, the sensing coverage area complies that the specified probability of the reliable detection with threshold value R is shown in the Eq(7),

$$Cr(j,k) = 0 \quad j,k = 1,2,..h \quad (7)$$

The mobile sensor node "b" as located in cluster centroids respectively based on the clustering result during data transmission via gateway to the storage. The coverage area matrix for the data transmission has been expressed in the Following Eq (8) is,

$$Cr(j,k) = 1 - (1 - R_l) \cdot [1 - TR(j,k)] \quad (8)$$

From the mathematical formulation it is concluded that there may be enormous amount of energy consumption for data transmission from the sensor node to the destination node which are separated by far distance. The sensor nodes and cluster detects the target in the sensing region and then it transmits the data to the CH. Further the weight function $\sigma$ can be expressed as in the following Eq (9) as follows,

$$\sigma_{j,k} = q_1 + q_2 s_{j,k}^2 \qquad j,k = 1,2, \ldots . m^d + n^d, j \neq k \quad (9)$$

To determine the lowest-cost path in a network, $S_j$ is the adopt variable in the following Eq (10) as expressed by

$$S_0 = 0, S_j = \sigma_{j,0} \; j = 1,2 \ldots m^d + n^d \quad (10)$$

$$S_j = \min_{l=1}^{m^d+n^d} S_l \quad (11)$$

From the Eq(11),The lowest cost parameters are analysed based on the data transmission from $v_0$ to $v_j \in W$ is expressed as in the following Eq (12) is,

$$W = W \cup \{v_j\} \quad (12)$$

$$S_k = \min\{S_k, \sigma_{k,j_0} + S_{j_0}\} \quad (13)$$

The energy metric $F^d$of every cluster in the wireless sensor network which is deployed using Eq (14) for energy consumption analysis,

$$F^d = \sum_{j=1}^{m^d+n^d} S_j \quad (14)$$

As shown in the Eq (13) where $F^d$ $(d = 1,2 \ldots b)$ shows the energy consumption of every cluster sensor node during the data transmission to CH with the low-cost path via gateway. Table 1 shows the Parameters and its description of IoT assisted hierarchical computation strategic making approach and dynamic stochastic optimization technique.

**Table 1. Parameters and its description**

| Parameters | Description |
|---|---|
| $\varphi$ | Membership function of every IoT sensor |

| | |
|---|---|
| $\beta$ | Weight coefficient |
| $n^d$ | Mobile sensor node |
| $B^d$ and $F^d$ | Energy metric |
| $U_j$ | Velocity |
| $S_j$ | Adopt variable |
| $\sigma$ | Weight function |
| $A_d(Y)$ | Objective function |
| $y_j^u, x_j^u$ | Cluster centroid coordinates |
| $(y_j, x_j)$ | Sensor nodes |

***Analysis:2-Dynamic Stochastic Optimization Technique(DSOT)***

Here in the dynamic stochastic optimization technique, every cluster can acquire the energy metrics and partial coverage area. In this research, DSOT approach achieves better accuracy using cluster heads computing capacity without any other hardware help. The optimization outputs are broadcasting along with network and the wireless sensor network has the capability to self-organize the data.

As represented in the smart city data management framework, the mobile sensor node is represented as $n^d$and sensor nodes as $m^d$ in d cluster. The coordinate's function of mobile sensor nodes$y_j^d, x_j^d$ in WSN can be expressed as the following Eq (15) is,

$$Y_j = \left(y_{m^d+2}^d, x_{m^d+2}^d, y_{m^d+3}^d, x_{m^d+3}^d \dots \dots y_{m^d+n^d+1}^d, x_{m^d+n^d+1}^d\right)$$

$$= \{y_k^j | k = 1,2, \dots .2n^d\} \quad (15)$$

The velocity $U_j$of current position sensor node for data analysis has been shown in the following Eq (16) is,

$$U_j = \{u_k^j | k = 1,2, \dots .2n^d\} \quad (16)$$

The best position $Z_j$of the sensor node is expressed by the following Eq (17) is,

$$Z_j = \{z_k^j | k = 1,2, \dots .2n^d\} \quad (17)$$

From the best position of data management, Initialize $y_j$with random position $y_j(1)$ using the Eq (18) as follows as with best position$Z_j$,

$$Z_j(1) = Y_j(1) \tag{18}$$

The objective function $A_d(Y)$ and energy-efficient coverage area in WSN is stated as Y position sensor nodes are denoted as,

$$A_d(Y) = (B^d)^{\beta-1} \cdot (F^d)^{\beta} \tag{19}$$

As shown in the Eq (19) where $B^d$ and $F^d$ energy metrics and coverage area correspondingly during data transmission via WSN gateway, where $\beta$ is the weight coefficient.

Dynamic Stochastic Optimization best position is calculated using based on the above mathematical computation and the derivative formulae is represented as Eq (20),

$$Z_g(t) = \min\{A[Z_1(t)], A[\,Z_2(t)], \ldots\ldots A[Z_{pop}(t)]\}$$

$$= \{z_k^g | k = 1,2, \ldots 2n\} \tag{20}$$

The optimization procedure of proposed HCSM & DSOT method has significant potential to determine the optimal implementation of wireless sensor networks. Further networklife and clustering issues has been analysed and resolved using clustering selection algorithm based on HCSM & DSOT

***Algorithm 1: HCSM & DSOT assisted Cluster head Selection node Algorithm***

***Input j,k ;***
***Output Cr (j,k);***
***For j=1,2,…,h***
***For k=1,2…..,h***
***For l=1,2,,…..h***
***Update*** $\boldsymbol{Cr(j,k) = 1 - (1 - R_l) \cdot [1 - TR(j,k)]}$
***If*** $\boldsymbol{Cr(j,k) \geq R^q}$
***Update***
***O=O+1***
***Else***
***Record the grid points***
***End***
***End***
***End***

Clustering is one of the main concepts in WSN to increase the network lifetime. Clustering involves the collection of the sensor nodes to select the cluster head for all the clusters. The proposed clustering inputs are j and k and the output is Cr which denotes the coverage area in sensor node. In clustering technique, to compute the reliable detection matrix using $Cr(j,k)$ probability function, threshold value R is used to determine the reliability detection point by point in sensor area. Here, the Cluster head selection collects the data from the corresponding cluster node and is transmitted to the base station in a WSN. In the proposed algorithm O denotes the grid point of reliable detection. In this paper, HCSM & DSOT assisted Cluster head Selection node Algorithm has been used to select the cluster head and maximize the lifetime of the network by using the minimum sensor node in a network. Cluster Heads to distribute the energy load within the sensor nodes in the entire system helps to optimize the energy utilization. Cluster head has been selected by each node on the basis of probabilistic plan and communicates its accessibility to all the sensor nodes present in the region. The obtained signal quality is the prime parameter for deciding the correspondence separation between the nodes. The Cluster Heads performs the collection of the packets which has been received for every one of the nodes present in their cluster. Furthermore, every one of the nodes gets an opportunity to turn into the Cluster Heads to adjust the overall energy utilization over the network. The cluster-head selection algorithm provides energy saving cluster structure and stable system in wireless sensor network and further clustering issue has been optimized using HCSM & DSOT assisted Unsupervised K-means Clustering Algorithm.

***Algorithm 2: HCSM & DSOT assisted Unsupervised K-means Clustering Algorithm***

***Input:*** $Y_j$

***Output***: $Z_j$

***For*** $Y_j = \{y_k^j | k = 1, 2, \ldots. 2n^d\}$

***For every cluster the dynamic set as K.***

***End for***

***End for***

***For j=1,2,…K***

***For*** $Z_j = \{z_k^g | k = 1, 2, \ldots 2n\}$

***If*** $j \neq k$

***Else***

***Repeat cluster head iteration***

***End if***

***End for***

***End for***

The K-means clustering algorithm is one of the most learning unsupervised algorithms that resolve the illustrious clustering issue. This procedure follows easy and simple way to categorize the data set through certain number of clusters which is fixed to appropriate inputs in random position of mobile sensor node $Y_j$ and output best position of mobile sensor node$Z_j$. The principle thought is to characterize K centers, in one for every cluster. The coordinates of the mobile sensor node has the best position to determine $Z_j = \{z_k^g | k = 1,2, \ldots 2n\}$and K center sought to be placed in various area to seek different outcomes. So, the improve decision making approach is to position them to take each direct having a place toward a given data collection region which is nearer to the closest center. When no point is pending, the first step is finished and an early collection of data is validated. The advantages of the k means clustering centroids, is huge variable analysis and K-Means is computationally faster than hierarchical clustering. K-Means produce tighter clusters than hierarchical clustering, especially if the clusters are globular and the IoT frame has been discussed as follows for upon different layers during data transmission.

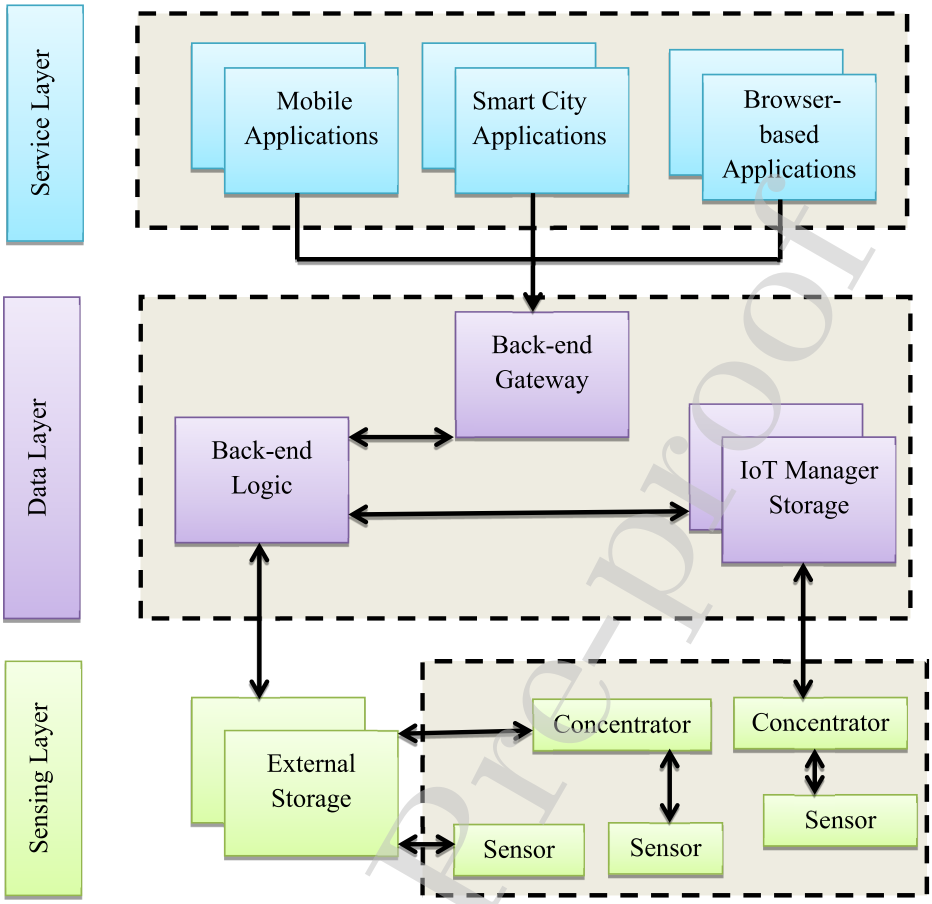


**Figure 4: IoT assisted framework for Smart cities**

The IoT architecture configured to handle the various subsystems in smart cities. This paper represents the proposed architecture of IoT manager storage with middleware. Here, there are three main layers in the IoT: sensing layer, data layer, and application layer as shown in the Figure.4.

A. **Sensing Layer**

- The sensing layer contains numerous wireless sensor networks and is used to collect the raw data. It helps to analyse the every sensor node which knows another node location for effective data transmission.
- The network node in sensing layer is able to treat either simple senor node or concentrator. Here the Back-end gateway permits to receive the request from the user to connect the simple sensor and concentrator in a network.

- The raw data from concentrator and sensor has been transmitted to the middleware and IoT manager storage connects the sensor network in back-end gateway to external storage.

**B. Data Layer**

The data layer acts as a repository for all sensed data and it provides the application program interface by the client application to query about the information. In Extension it has been retrieved in a properly organized format. The back-end logic is used to revise the records with help of back-end gateway; HTTP and API expose the communication with the user's application. The IoT Manager Storage has an internal memory, and set of the predefined application program interface, it is conceivable to integrate the information from sensor networks whose memory is external to the back-end. The key part of the solution: it is potentially for any third party, for example, an individual, to associate with sensor network.

The service layer provides a large amount of possible user application which communicates with back-end gateway via API which made integration with the required client application easier for smart city data management. Service layer consists of user application and smart cities applications like smart lighting, surveillance, WiFi, smart scale environment sensor.

**C. Application Layer**

The IoT based WSN sensors placed in smart cities provides commercial buildings, government offices, facial recognition for better security within apartment buildings,

- Sensors inside buildings to detect the presence of individuals rooms from inside, and thereby controlling the utilization of heating, air, lighting, and other systems to limit energy consumption when it is unnecessary.
- Sensors incorporated with buildings to sense things like the seismic activity, foundation subsidence, and force of the wind.
- Sensors incorporated with bridges to sense things like the effect of seismic forces and degradation at work.
- Sensors incorporated with roadways to detect things like subsidence and mileage, just as traffic stream.

The energy-constrained sensor node negotiates numerous activities associated with network and the selection of a sensor cluster node optimizes the energy consumption and sensing accuracy during information processing in this research and the experimental outcomes show that the HCSM & DSOT approaches are found capable of improving the energy efficiency of wireless sensor network and sensor cluster node selection at lab scale experimental validation.

## 4. Experimental Results

### (i) Performance Ratio

The Performance of the proposed HCSM & DSOT methods has been evaluated and the performance metrics like energy efficiency, Average end-to-end network and Packet Delivery Ratio are discussed. The proposed methods IoT assisted Hierarchical Computation Strategic Making (HCSM) Approach and Dynamic Stochastic Optimization Technique (DSOT)for energy optimization in a Wireless Sensor Network with framework for smart city monitoring achieves better performance ratio when compared to Bluetooth Low Energy (BLE), Resilient and secUreIoT for smart city RERUM framework, parallel sensor deployment optimization and parallel particle swarm optimization (PSDO-PPSO), Efficient Algorithm for Media-based Surveillance system (EAMSuS), Traffic Adaptive Control (TAC). The figure 5 shows the performance analysis of proposed HCSM & DSOT methods. From the mathematical formulation of the HCSM-DSOT, it is concluded that there may be enormous amount of energy consumption for data transmission from the sensor node to the destination node which are separated by far distance [21]. The sensor nodes and cluster detects the target in the sensing region and then it transmits the data to the CH with optimized energy level with high performance [22]. The proposed HCSM & DSOT methods achieves higher performance ratio (95.3%) when compared to other traditional methods.

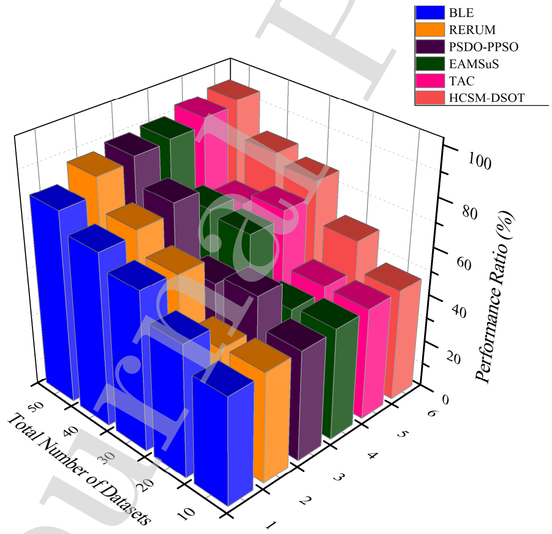


**Figure 5: Performance Ratio analysis**

**Table 2. Performance Ratio analysis**

| Total Number of Datasets | BLE | RERUM | PSDO-PPSO | EAMSuS | TAC | HCSM & DSOT |
|---|---|---|---|---|---|---|
| 100 | 65.4 | 56.3 | 73.4 | 65.4 | 70.8 | 75.6 |
| 200 | 75.67 | 64.56 | 65.12 | 70.8 | 66.5 | 72.3 |
| 300 | 63.5 | 76.56 | 72.34 | 63.4 | 71.3 | 85.7 |
| 400 | 78.6 | 81.4 | 76.5 | 74.5 | 74.5 | 89.8 |
| 500 | 81.34 | 85.4 | 82.34 | 85.56 | 85.6 | 95.3 |

In table 2, the proposed methods IoT assisted Hierarchical Computation Strategic Making (HCSM) Approach and Dynamic Stochastic Optimization Technique (DSOT)for energy optimization in a Wireless Sensor Network with framework for smart city monitoring achieves better performance ratio when compared to other existing methods.

**(ii) Prediction Ratio**

Here $\varphi$ denotes the membership function of every IoT sensor as denoted as $\varphi = \{\varphi_{jl}\}_{b\times m}$. From the membership definition, the loss function and entropy can be calculated using $\varphi$, This calculation has been derived mathematically in the Eq(4) with high prediction ratio when compared to Bluetooth Low Energy (BLE), Resilient and secUreIoT for smart city RERUM framework, parallel sensor deployment optimization and parallel particle swarm optimization (PSDO-PPSO), Efficient Algorithm for Media-based Surveillance system (EAMSuS), Traffic Adaptive Control (TAC). Because the existing [23] counterparts failed to analyse the membership function of the IoT sensors and the figure 6 shows the Prediction Ratio analysis of proposed HCSM & DSOT method. The proposed HCSM & DSOT methods achieves higher prediction ratio (96.54 %) when compared to other traditional methods.

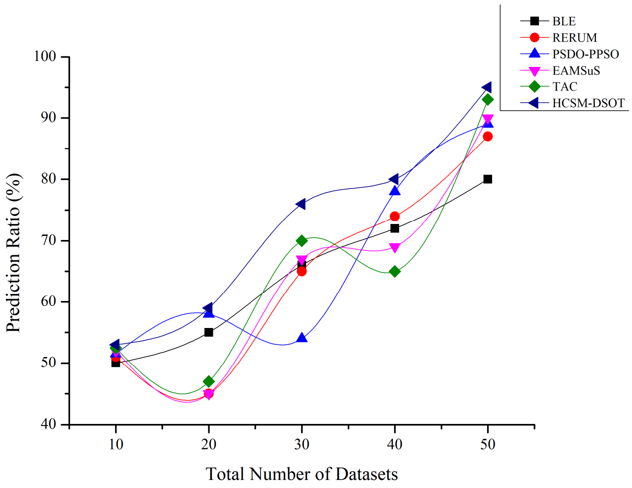


**Figure 6: Prediction analysis**

**(iii) Reliability Ratio**

The reliability is defined as the packets obtained by the end node to the entire packets produced by the transmission. The proposed IoT assisted Hierarchical Computation Strategic Making (HCSM) Approach and Dynamic Stochastic Optimization Technique (DSOT) has the $B^d$ and $F^d$ parameters as defined as energy metrics and coverage area correspondingly during data transmission via WSN gateway which achieves better reliability ratio as shown in the figure 7. The proposed HCSM & DSOT methods achieves higher reliability ratio (92.4%) when compared to other traditional methods.

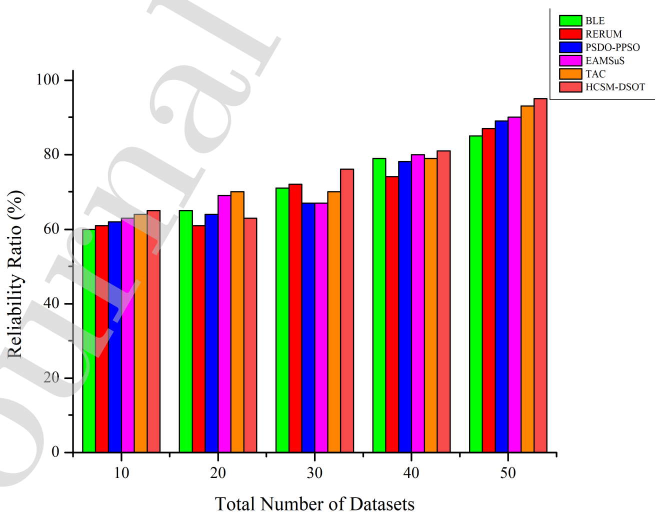

**Figure 7: Reliability Ratio validation**

**(iv) Energy Consumption**

Energy Consumption is one of the common issues in a WSN. Each node in a network is operated by batteries and it has been computed for the reliable detection matrix using $Cr(j,k)$ probability function, further, threshold value R is used to determine the reliability detection point by point in sensor area with less energy consumption. Here, the Cluster head selection collects the data from the corresponding cluster node and is transmitted to the base station in a WSN with less energy utilization metric and the comparison ratio has been shown below in the Figure.8.

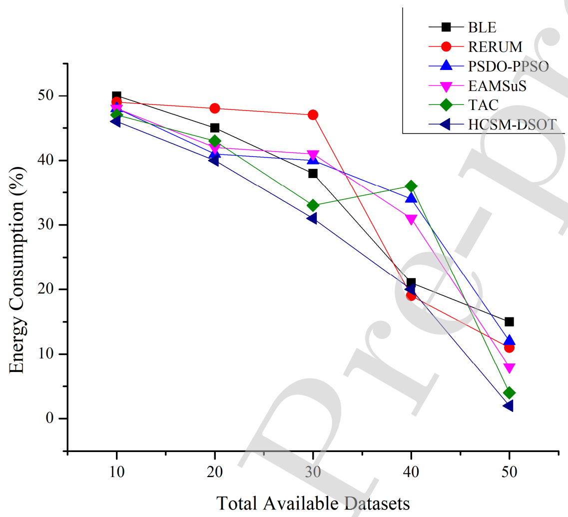


**Figure 8: Energy Consumption analysis**

**(v) Coverage Ratio**

The coverage ratio denotes the ratio of the entire area to covered area by the sensor and the the data set through certain number of clusters which is fixed to appropriate inputs in random position of mobile sensor node $Y_j$ and output best position of mobile sensor node$Z_j$. This principle helps to characterize K centers, in one for every cluster enhance the coverage area when compared to Bluetooth Low Energy (BLE), Resilient and secUreIoT for smart city RERUM framework, parallel sensor deployment optimization and parallel particle swarm optimization (PSDO-PPSO), Efficient Algorithm for Media-based Surveillance system (EAMSuS), Traffic Adaptive Control (TAC). The figure 9 shows the Coverage Ratio of proposed HCSM & DSOT methods.

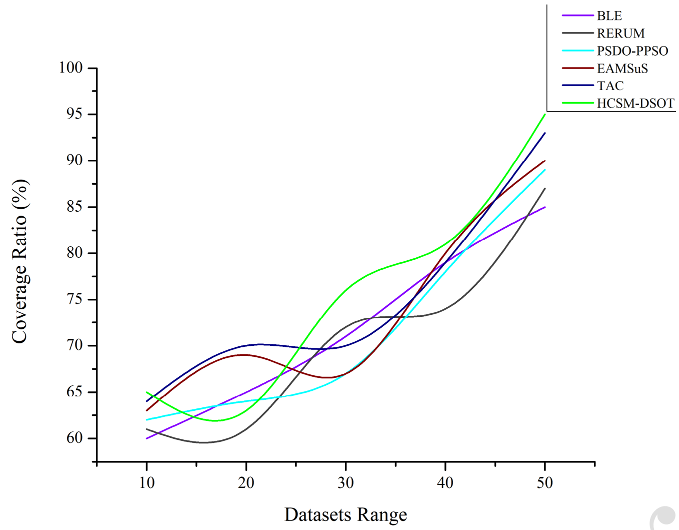


**Figure 9: Coverage Ratio**

**(vi) Sensing Error**

Sensing error caused by the noise or other impairments during packet delivery from one node to another node. In the proposed method, where $F^d$ $(d = 1,2 \ldots b)$ shows the energy consumption of every cluster sensor node during the data transmission to CH with the low-cost path via gateway decrease sensing error when compared to Bluetooth Low Energy (BLE), Resilient and secUreIoT for smart city RERUM framework, parallel sensor deployment optimization and parallel particle swarm optimization (PSDO-PPSO), Efficient Algorithm for Media-based Surveillance system (EAMSuS), Traffic Adaptive Control (TAC). The figure 10 shows the Sensing error analysis of proposed HCSM & DSOT methods.

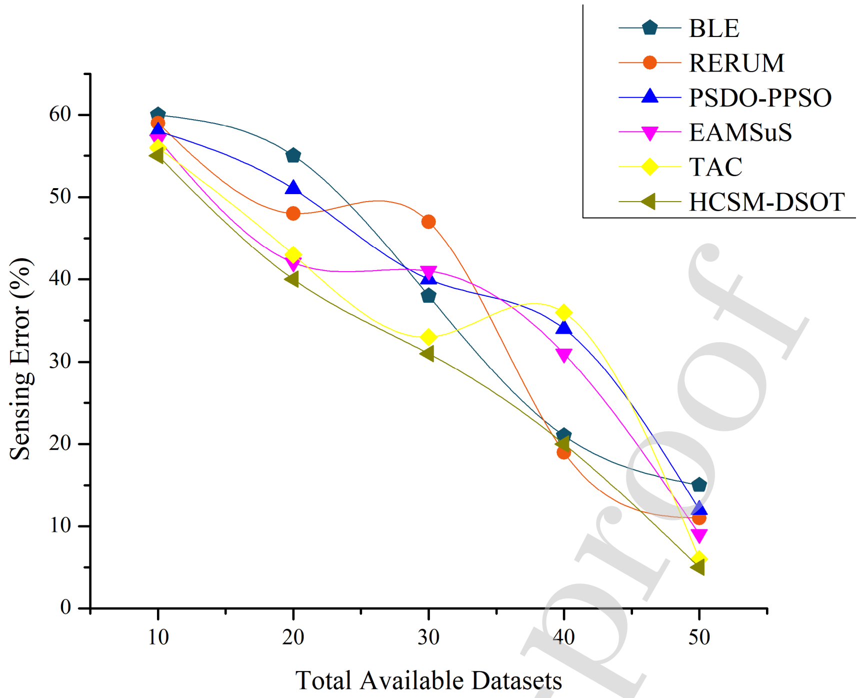


**Figure.10. Sensing Error calculation**

From the lab scale testing Both of these proposed approaches, namely HCSM & DSOT achieve the energy efficiency in smart cities and the utilization of energy cost is low as validated experimentally at lab scale testing.

## 5. Conclusion

This paper proposed the IoT assisted Hierarchical Computation Strategic Making (HCSM) and Dynamic Stochastic Optimization Technique (DSOT) Approaches for energy optimization in a Wireless Sensor Network for tracking a smart city. The Cluster head selection node and K-means algorithm have been utilized to increase the network lifetime and energy efficiency. Our proposed methods achieve low maintenance costs, minimize the energy consumption, lower environmental impact and make energy management simpler and enhance the efficiency by bringing disparate element under a single framework than existing counterparts. In future machine learning based hybridized approach are planned to include in the HCSM-DSOT.

## Conflicts of Interest

None.

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**Category 2**

Drafting the manuscript: K.Jaikumar

revising the manuscript critically for important intellectual content: R. P. Meenaakshi Sundhari

**Category 3**

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| K.Jaikumar | | 18.11.2019 |

# IoT Assisted Hierarchical Computation Strategic Making (HCSM) and Dynamic Stochastic Optimization Technique (DSOT) for Energy Optimization in Wireless Sensor Networks for Smart City Monitoring

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## Conflicts of Interest

None.