QoS-aware sensor allocation for target tracking in sensor-cloud

Dr. Anish Kumar Choudhary, CDGI Indore
anish.choudhary@cdgi.edu.in
Dr Rupesh Shukla
rupesh.dbms@gmail.com
Dr. Manoj Verma
manoj.verma1511@gmail.com
Mr. Shreyas Pagare
shreyas.pagare@gmail.com
Mr. Ashutosh Khemeriya
ashutosh.khemaliya07@gmail.com
Ms. Shivani Katre
shivani.katare@cdgi.edu.in

ABSTRACT

The wireless network has become a magnet for many research and development efforts. A variety of application sectors, including as medicine, communication, and environmental analysis, continue to draw new researchers. The wireless sensor network is the primary focus of inquiry in this work. A wireless sensor network is made up of sensing nodes. The sensing nodes are intelligent gadgets that perceive their surroundings and can analyse the data they collect. This capability enabled it to use sensor networks for a variety of applications such as monitoring, weather forecasting, and others. In this study, a comparable application that allows for the monitoring and tracking of a moving target is proposed; to detect and anticipate the moving target's new location.

In addition, two other parameters are computed using prior patterns to discover the forecast, namely the direction of movement and the speed of the moving point. The new coordinate of the target is predicted using the speed, direction, and prior location. The suggested work is simulated using the MATLAB tool and demonstrated in a projectile scenario. Following implementation, the system's performance is described using the density function, sensor availability, prediction accuracy, and dwellingtime. The estimated performance demonstrates the system's acceptable performance and functionality with various target tracking applications.

Keyword: Cloud, QoS,WSN

INTRODUCTION

The use of target following in remote sensing systems (WSNs) requires high quality of service (QoS). When an objective appears, it will cause an event to be triggered by at least one sensor. If the sink receives a specific number of event bundles within a predetermined identification time interval, an objective must be precisely recognized.A WSN has a large number of densely transmitted detecting devices that detect the marvel or occurrence of an event. Sensor hubs may be required to collect and combine information locally. Even more crucially, the sensor hubs must send their estimates to the sink. Interactions in WSN, like those in traditional end-to-end systems, suffer from delay and tragedy. To ensure system execution, Quality of Service (QoS) support is necessary [1]. Applications providing various mixed media data in distant mixed media sensor systems (WMSNs) have specific QoS requirements for transport speed, latency, and bundle misfortune. Impression of QoS requirements for applications and identification of connection conditions are critical for the design of a QoS-conscious directing component.

This addresses the issue of Quality of Service (QoS) conscious sensor component for target tracking in a sensor-cloud environment. In a sensor-cloud scenario, whenever a goal enters a sensor sent zone, physical sensor hubs are forcefully planned and assigned to the corresponding target. SudipMisra et al. [3] address the challenge of selecting an optimal sensor array to monitor a given target in this study. In any event, the concealed physical sensor hubs in sensor-cloud are diverse in terms of their proprietor, detecting capacity, transmission routes, and unit cost of convenience. Given the heterogeneity of the hubs, the inventors suggest the QoS-conscious Sensor Allocation Algorithm (Q-SAA), which takes into account a set of characteristics that determine QoS. Following that, we use a closeout-based system to find the best solution for a subset of available sensors to achieve productive target following. Exploratory results on the use of this arrangement show that, in comparison to the selected benchmark, the suggested design plans roughly 20-30% less sensors for target following applications while still achieving the desired QoS while tracking the target.

Wireless Sensor Network: General

Wireless sensor networks (WSNs) have captured the interest of the scientific community in recent years, owing to a plethora of theoretical and practical issues.Remote Sensor Networks (WSN) are a challenging and emerging innovation for examination due to their basic degree in the field mixed with their poor handling power and associated low vitality [4]. Today, remote sensor systems are widely used in ecological control, observation tasks, checking, following, and controlling, and so on. On top of that, remote sensor systems demand incredibly secure correspondence because they are in the open field and are based on communicating innovation. This dynamic study in WSNs studied several novel uses enabled by larger scale networks of sensor hubs equipped to detect data from the ground, process it, and transfer it to a remote place. WSNs are commonly used in low transmission capacity and delay tolerant applications ranging from common and military to natural and medicinal services observation.A remote sensor organize is a circulated ongoing framework. A typical question is how many arrangements from dispersed and continuous frameworks may be used as a portion of these new frameworks. Regrettably, almost no previous work can be linked, and new arrangements are required in every aspect of the framework [5].

In any case, outlining security conventions is a testing errand for a WSN as a result the accompanying one kind of qualities:

Wireless channels are interested in everybody and has a radio interface arranged at a similar recurrence band. Accordingly, anybody can screen or take an interest in the correspondence in a remote channel. This gives an advantageous approach to assailants to break into a system.

• Because of the Internet, most WSN conventions do not include critical security instruments in their plan layout. However, because of the requirements for institutionalization, most conventions are widely known. As a result, attackers can easily dispatch attacks by exploiting security gaps in such protocols.

• Because of their multifaceted nature, the required assets in sensor hubs make it exceedingly difficult to execute solid security calculations on a sensor stage. Furthermore, large numbers of sensor hubs indicate a desire for basic, adaptable, and versatile security protocols.

A more solid security convention costs more assets in sensor hubs, which might result in utilization execution debasement. Often, a trade-off must be made between security and execution. Nonetheless, aggressors may effectively violate powerless security conventions.

A WSN is often communicated in hostile zones with no established base. It is difficult to conduct continuous reconnaissance once the system has been sent. As a result, it may face a variety of possible threats.

WSN Architecture

Remote Sensor Networks are useful in situations where wired connections are impracticable. Remote sensor hubs are made up of several types of sensors, including as attractive, warm, visual, seismic, infrared, and radar, that can monitor a wide range of physical and natural variables [7].The WSN is comprised of "hubs" ranging from a few to hundreds or even thousands, with each hub coupled with one (or, in some situations, a few) sensors. If a large amount of information is gathered, remote sensor hubs contain a cluster of sensors. The sensor hub may be used for constant or specific detection, area detection, and so on.

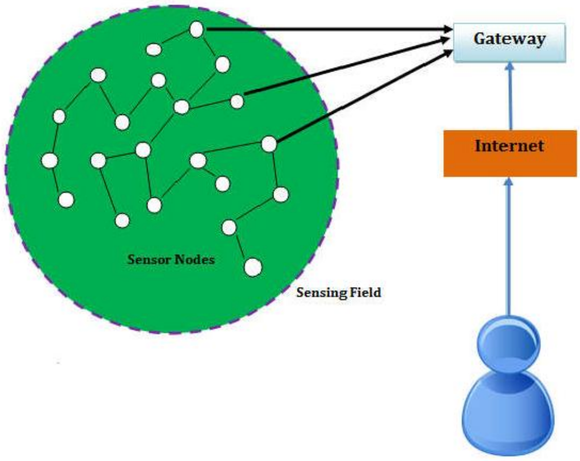


Figure 1.1 typical View of WSN

Literature Survey

The wireless communication is frequently adopted and new technology growing continuously, due to this the network maintenance and low cost installation. There are two key issues are exist performance and reliability of the sensor nodes.

Wireless Sensor Network Topology

There are several topologies for radio communications networks. The following is a quick summary of the network topologies that apply to wireless sensor networks:

Star Network (Single Point-to-Multipoint)

A star network (Figure 2.1) is a communication architecture in which a single base station may transmit and receive messages from numerous faraway hubs. The distant hubs can only send or receive messages from the single base station; they cannot send messages to each other.

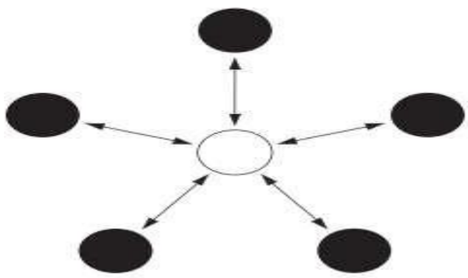
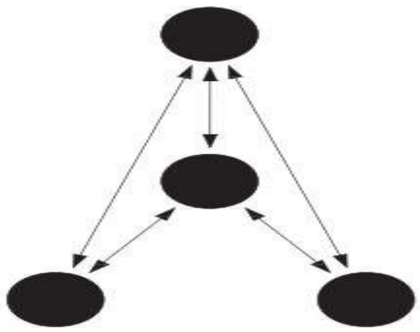


Figure 2.1 Star Networks

The benefit of this form of network for wireless sensor networks is its simplicity and ability to reduce distant node power consumption. It also enables communication between the distant node and the base station to be as fast as possible. The downside of such a network is that the base station must be within radio transmission range of all individual nodes, and it is not as resilient as other networks because it is managed by a single node [9].

Mesh Networks

A work structured (figure 2.2) allows each hub in the system to broadcast to another hub in the system that is within its radio transmission range. This takes into consideration multi-bounce exchanges; that is, if a hub has to create an effect on another hub that is not in radio correspondences run, it can use a moderate hub to send the message to the desired hub. The repeatability and adaptability of this system architecture are advantages.



Hybrid Star – Mesh Network

A hybrid (Figure 2.3) of the star and mesh networks provides a strong and adaptable communications network while keeping wireless sensor node power consumption to a minimum.

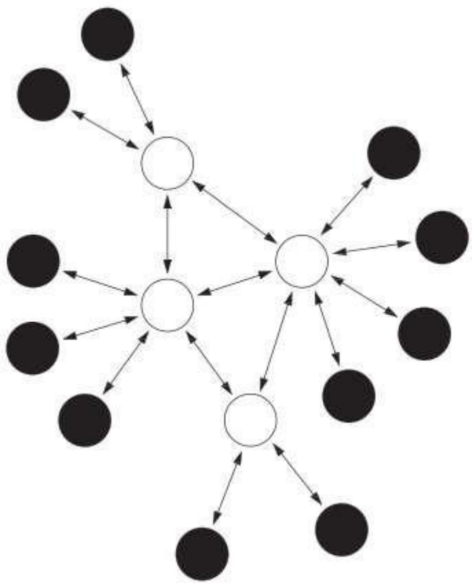


Figure 2.3 Hybrid Star and Mesh Networks

The lowest power sensor nodes in this network design do not have the capacity to forward messages. This ensures that power usage is kept to a minimum. Other network nodes, on the other hand, have multi-hop capability, allowing them to forward messages from the low power nodes to other network nodes. In general, nodes with multi-hop capabilities are more powerful and, if possible, are connected to the power grid.

Different types of nodes

There are three sorts of sensor nodes in a wireless sensor network: normal nodes, which gather information or sensor data, and sensor nodes, which collect sensor data. Sensor nodes are limited in terms of resources. That is why sensor hub does not have storage capability for large amounts of data or sensor information. It may need just information preparation if necessary; sink hubs in charge of acquiring, storing, and processing (e.g., collecting) information from ordinary hubs; and entrance hubs that connect sink hubs to outside substances known as spectators. In Wireless sensor systems, actuators may also be used to control or impel on a predetermined location

WSNs Design Challenges

The outline of WSN directing conventions is being tested as a result of a few system restrictions. WSNs suffer from the limitations of a few system assets, such as vitality, data transmission capacity, focal handling unit, and capacity [15]. The following primary perspectives [16] are included in the outlining difficulties in sensor systems:

a) Limited energy capacity: Because sensor hubs are battery-powered, their vitality is limited. Vitality is a crucial challenge for organizational planners in hostile settings, such as a front line where it is difficult to get to the sensors and recharge their batteries. Furthermore, when a sensor's vitality reaches a specific edge, the sensor will be clearly flawed and won't be able to work properly, which will have a significant impact on system execution. As a result, steering conventions meant for sensors should be as energy efficient as possible in order to extend their lifetime and, as a result, extend the system lifetime while guaranteeing exceptional overall performance.

b) Sensor locations: Another problem that routing protocol designers encounter is managing sensor locations. The majority of the proposed protocols require that the sensors are either equipped with GPS receivers or utilize some sort of localization mechanism [17] to learn about their positions.

c) Limited hardware resources: In addition to a limited power supply, sensor hubs have confined handling and capacity restrictions, limiting their ability to execute limited computing functions. These equipment needs highlight several challenges in sensor system programming development and system convention planning, which must address the vitality necessary in sensor hubs, as well as the handling and capacity restrictions of sensor hubs.

d) Massive and haphazard node deployment: Sensor hub placement in WSNs is application dependent and can be either manual or haphazard, influencing the steering convention's execution. Sensor hubs can be spread randomly in predicted area or dumped massively across a difficult to reach or inhospitable place in numerous applications. If the resulting distribution of hubs is not uniform, optimal bunching becomes imperative to enable availability and empower vitality productive system operating.

e) Network characteristics and unreliable environment:A sensor organizes as a rule works in a dynamic and inconsistent condition. The topology of a system, which is characterized by the sensors and the correspondence interfaces between the sensors, changes regularly because of sensor expansion, erasure, hub disappointments, harms, or vitality consumption. Likewise, the sensor hubs are connected by a remote medium, which is loud, blunder inclined, and time differing. Hence, steering ways ought to consider organize topology progression because of restricted vitality and sensor portability and in addition expanding the measure of the system to keep up particular application necessities regarding scope and availability.

f) Data Aggregation:Since sensor hubs may create critical repetitive information, comparative parcels from various hubs can be accumulated so that the quantity of transmissions is diminished. Information accumulation procedure has been utilized to accomplish vitality productivity and information move enhancement in various directing conventions.

g) Diverse sensing application requirements: Sensor systems have a wide range of applications. There is no system convention that can suit the requirements of all applications. In this regard, the guiding conventions should provide information conveyance and accuracy so that the sink may assemble the necessary learning about the physical marvel on time.

h) Scalability: Directing conventions should be able to scale with the system estimation. Similarly, sensors may not have the same capabilities in terms of vitality, handling, detecting, and, most importantly, communication. As a result, correspondence connections between sensors may not be symmetric, which means that a couple of sensors will be unable to communicate in both bearings. This should be addressed in the steering conventions.

Related Study

Some work has been done on communication protocols that provide QoS in WSNs. This section describes many contemporary strategies and algorithms created with the aid of Sensor node target tracking in wireless sensor networks by various network utilities. Traded-off sensor hubs in distant sensor systems might introduce erroneous information into both information collecting and information transmission. Current false information detection algorithms only examine false information infusions during information transmission and do not permit any alteration in the information by information total. SuatOzdemir et al. [25] present the DAA, an information aggregation and verification convention, to combine incorrect information location with information accumulation and privacy.

Area data of sensor hubs has turned into a fundamental piece of numerous applications in Wireless Sensor Networks. The significance of area estimation and protest following has made them the objective of numerous security assaults. Different strategies have attempted to give area data high precision, while loads of them have ignored the way that WSNs might be conveyed in threatening conditions. In this paper, Ali P. Fard [26]address the issue of safely following a Mobile Node (MN) which has been seen almost no already. A novel secure following calculation is proposed in view of Extended Kalman Filter (EKF) that is fit for following a Mobile Node (MN) with high determination within the sight of bargained or conspiring malevolent signal hubs. It sift through and distinguishes the vindictive guide information during the time spent following. The proposed technique impressively beats the beforehand proposed secure calculations regarding either location rate or MSE. The test information in light of various settings for the system has indicated promising outcomes.

Sandy Mahfouz et al. [27] present a novel approach to target tracking in distant sensing systems. To estimate the immediate location of a moving object, the suggested technique combines machine learning with a Kalman channel. The growing velocities of the goal, together with network data, are utilized to obtain an accurate estimate of its position.To that purpose, radio-fingerprints of received flag quality markers (RSSIs) are collected over the observation area initially. The obtained information is then used in conjunction with machine learning algorithms to create a model that calculates the location of the target using just RSSI data. This model suggests a first position gauge of the under research target.

Xinbing Wang et al. [29] investigate the issue of range sharing between essential (or "authorized") and optional (or "unlicensed") customers in this study. Creators consider the issue in light of data transfer capacity closeout, in which every optional client makes an offer for the measure of range and every essential client can appoint the range among auxiliary clients independently of anyone else as indicated by the data from auxiliary clients without undermining its own execution. They show that the sale is a disagreeable amusement and that Nash equilibrium may be used to solve it. The designers first evaluate a single important client system to investigate the presence and uniqueness of Nash balance, and then discuss the reasonableness among auxiliary clients under specific conditions.

Proposed work

Wireless sensor network is a group of wirelessly connected sensors. These sensors are used to sense the information from their surroundings and send it to their base station. The information transmission from the sensing node to base station is performed by passing information from one sensor node to another. According to the nature of sensor networks these networks can be divided as static network or dynamic or mobile sensor networks. The mobile sensor network's sensors are dynamic in nature and moving frequently in random directions on the other hand in static networks the sensor nodes are placed in a specific location and perform their task. In this presented work the combination of both kinds of sensor node is used to demonstrate the application of wireless sensor network. In this application the sensor network is remain static and a moving target is tried to locate or predict their next possible position in the simulation area.

The proposed system includes static wireless sensor networks which are statically deployed in a simulation area. The deployment of sensor nodes is assumed random positioning based technique. These sensor nodes are connected wirelessly from each other. In addition of that the sensor node collect the information regarding the moving sensor node which is the target whose next position is need to be predict. The prediction of the moving target is performed by the base station which is assumed as the cloud server. The cloud server collects the information about the mobility pattern such as speed, current and previous position and direction of mobility. Using these parameters the cloud server predicts the next possible location of the moving target. In order to perform this task and making the relativity among the previous and new position the regression analysis technique is used and new accurate position is predicted. This section provides the overview of the proposed work. The next section provides the methodology for predicting the moving target location prediction.

Methodology

The proposed system architecture of the proposed target tracking system is defined using figure 3.1. The diagram contains the two modules of the system first the network which is used to sense the target and next is used for making decision which is established as the base station.

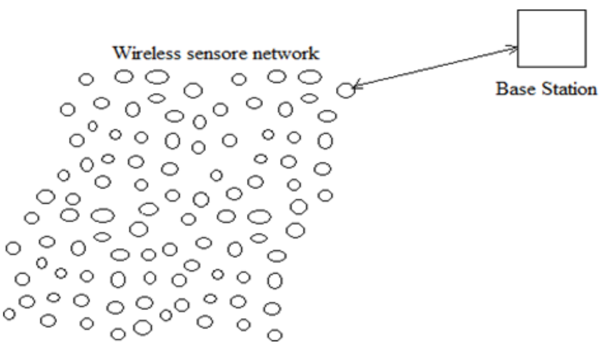


Figure 3.1 System Environment

Sensor Network

The wireless sensor network is setup in a random placement way, as shown in the diagram. In addition, a target node moves between the sensor nodes. The sensor nodes detect the moving target and transmit the information to the base stations. The information is transmitted by the base station to the server, which analyzes the data and predicts the next position of the node. At least three sensor nodes must identify the target sensor node in this situation.Let us suppose there are three sensor nodes that have detected the target node and have the locations (x1, y1), (x2, y2), and (x3, y3). Furthermore, the moving target location is given by (x, y). Thus, the moving target's distance from these sensors is calculated using the equations below.

d2 = (x − x1)2 + (y − y1)2 d2 = (x − x2)2 + (y − y2)2 d2 = (x − x3)2 + (y − y3)2

Where d2 is the distance of moving target at the time t.The distance computed by the sensors s1, s2 akd s3 and some additional information is communicated to the server. The communicated information contains the location of sensors s1, s2 akd s3. And the distance sensed by the sensorsd2, d2, akd d2.

Cloud Server (Base Station)

The received information at the server end is used to find the current coordinate of sensor node at a time t. therefore the following formula is used.

$$x = \frac{(y_1 - y_2)X_S - (y_1 - y_3)X_v}{2((x_1 - x_3)(y_1 - y_2) - (x_1 - x_2)(y_1 - y_3))}$$

$$y = \frac{(x_1 - x_2)X_S - (x_1 - x_3)X_v}{2((x_1 - x_2)(y_1 - y_3) - (x_1 - x_3)(y_1 - y_2))}$$

Where

$$X_S = (x^2_1 - x^2_3) + (y^2_1 - y^2_3) + (d^2_3 - d^2_1)$$

$$X_v = (x^2_1 - x^2_2) + (y^2_1 - y^2_2) + (d^2_2 - d^2_1)$$

Now it is responsibility of the server to identify the sensors which are used to detect the new position of the moving target. Therefore it is required to predict the new position of the moving sensor node. In this context the additional parameters are need to be compute, these parameters are help to provide the accurate prediction about the moving target. The computation of these parameters is given as:

Velocity

In order to compute the velocity of the moving target we need the two steps information about the moving node. Therefore let the current time is Ti and the current position of the sensor node is (xi, yi). In the similar manner one steps previous for time Ti–1 the previous position of node is (xi–1, yi–1). Using these two point information it is required to compute the next prediction for time Ti+1the new position (xi+1, yi+1). To compute the speed of movement performed by the moving sensor is computed using the previous step position and current position. Thus velocity v is given by the following equation.

$$v = \frac{\sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}}{t_i - t_{i-1}}$$

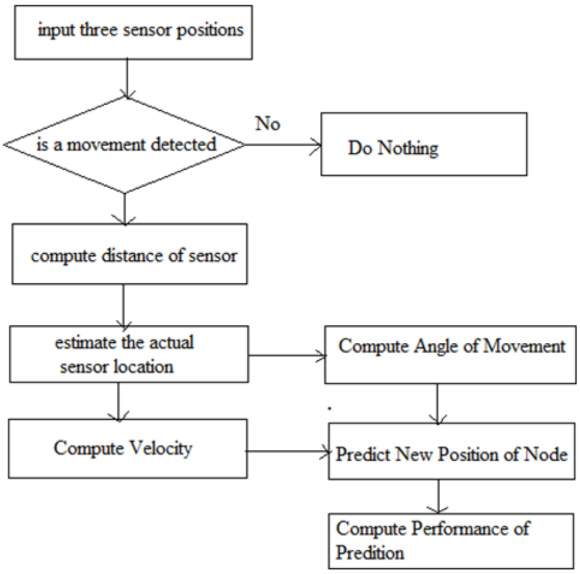
Direction

Now need to approximate the direction of movement of the sensor node therefore the similar information is used to compute direction of the node movement. That is denoted using θ.

$$\theta = \cos^{-1}\frac{x_i - x_{i-1}}{\sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}}$$

Both the information is computed on the server side and the prediction for the next location is performed. To compute the next coordinates of the sensor node the following equations can be used.

$$x_{i+1} = x_i + vt \cos\theta \quad y_{i+1} = y_i + vt \sin\theta$$



The overall system flow is described in figure 3.2. In this model initially the three node position which is established in sensor network is known, when these nodes detect a sensor movement then these sensors are initiating the process for finding the distance of sensed node. Using this coordinate of mobile sensor node is computed. Now the issue is that what the next position of the mobile sensor node is Therefore based on their mobility pattern the two required parameters velocity of node and angle of mobility is computed on the basis of previous and current position of node. This computed parameter is used for finding the new location of node. This section demonstrates that how the simulation is configured and how the experiment is performed for tracking of the moving sensor node. As discussed in the methodology section the entire system has two parts first the area where the sensor network is deployed and Seconds the cloud server where the prediction or computation of sensor node position is performed. First a simulation area is considered which is available in 2D plane.

Conclusion

The wireless sensor network is a fully distributed computational and communication network. That is connected through the wireless links and sense the information from surroundings. This sensed information is communicated to the base station and the base station uses this information for making decisions. In this similar scenario an application of wireless sensor network is presented for target tracking of mobile sensor node Therefore different techniques of target tracking technique is investigated in this work a new technique using statically analysis is proposed.

The proposed methodology is based on the technique of regression analysis based technique that finds correlation between two points. This obtained correlation among two points is used to approximate the next value of location. The correlation and regression is a mathematical technique of prediction but for achieving the higher accuracy of the moving target it is need to consider the additional factors. These factors are required to select in such manner by which the characteristics of the mobile node can be identified. In this context the distance, velocity and the direction of node movement is considered. That helps to formulate the more accurate values of the next position of node.

References

[1]. Mohammed A. T. AlSudiari and TGK Vasista, King Saud University, KSA. “Cloud Computing And Privacy Regulations: An Exploratory Study On Issues And Implications” 2022.

[2]. Mrs. Ashwini Sheth1 , Mr. Sachin Bhosale2 , Mr. Harshad Kadam3. “RESEARCH PAPER ON CLOUD COMPUTING”. 2021.

[3]. Noha G. Elnagar, Ghada F. Elkabbany , Amr A. Al-Awamry , Mohamed B. Abdelhalim. “Simulation and performance assessment of a modified throttled load balancing algorithm in cloud computing environment. 2021.

[4]. Ms. Pooja Goyal , Dr. Sukhvinder Singh Deora. “Reliability of Trust Management Systems in Cloud Computing”. 2022

[5]. Daeyoun Won, Bon-Gang Hwang ,Nur Khairunnisa Binte Mohd Samion. “Cloud Computing Adoption in the Construction Industry of Singapore: Drivers, Challenges, and Strategies”. 2022.

[6]. Jinglin Zou, Debiao He ,Sherali Zeadally , Neeraj Kumar ,Huaqun Wang. “Integrated Blockchain and Cloud Computing Systems: A Systematic Survey, Solutions, and Challenges”. 2022

[7]. omeh basil. “Cloud Computing and Undergraduate Researches in Universities in Enugu State: Implication for Skills Demand”. 2022

[8]. Atakan Doğan ,Kemal Ebcioğlu.” Cloud Building Block Chip for Creating FPGA and ASIC Clouds”2022.

[9] S. Tilak, N. B. Abu-Ghazaleh, and W. Heinzelman, “A taxonomy of sensor network communication models,” ACM Mobile Computing & Communication Review, Vol. 6, No. 2, pp. 1−8, 2002.

[9] Han, Li, et al. "QoS-Aware Routing Mechanism in OpenFlow-Enabled Wireless Multimedia Sensor Networks." International Journal of Distributed Sensor Networks 12.7 (2016): 9378120.

[10] Misra, Sudip, et al. "QoS-aware sensor allocation for target tracking in sensor-cloud", Ad Hoc Networks 33 (2015): PP. 140-153.

[11] I.F. Akyildiz, T. Melodia, and K.R. Chowdhury, "A Survey on wireless multimedia sensor networks", Computer Networks (Elsevier) Journal, Volume 51, pp. 921- 960, 2007.

[12] By JeongGilKo, John A. Stankovic,Andreas Terzis, and Matt Welsh, "Wireless Sensor Networks for Healthcare", Proceedings of the IEEE, Vol. 98, No. 11, November 2010

[13] Jun Zheng and Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", a

book published by A John & Sons, Inc, and IEEEE, 2009.

[14] Anjali Potnis1, and C S Rajeshwari, "Wireless Sensor Network: Challenges, Issues and Research", Proceedings of 2015 International Conference on Future Computational Technologies (ICFCT'2015), pp. 224-228, March 29-30, Singapore, 2015.

[15] S. Tilak, N. Abu-Ghazaleh, W. Heinzelman, "A Taxonomy of Wireless Micro-sensor Network Models," ACM SIGMOBILE Mobile Computer Communication Rev., vol. 6, no. 2, Apr. 2002, pp. 28–36

[16] Xu, Guobao, WeimingShen, and Xianbin Wang. "Applications of wireless sensor networks in marine environment monitoring: A survey." Sensors 14.9 (2014): 16932-16954.