Transforming Public Health Data Management in IoMT Networks Based on Innovative Offloading Scheme

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KEYWORDS

Internet of Medical Things (IoMT), public health, mutated barnacles mating optimization (MBMO), medical services

ABSTRACT

Healthcare platform monitoring IoT-oriented technologies constitute the idea of Internet of Medical Things (IoMT) in public health and medical services. The amount and quality of created data have a substantial influence on data management and privacy compute offloading solutions are unable to keep up with the growing needs of the health industry, especially when fast and dependable communication was needed. The study suggests a unique approach called Mutated Barnacles Mating Optimization (MBMO) for assisting the data management issues in IoMT systems. The suggested MBMO framework successfully addresses problems that are common in the medical industry by using a data offloading technique. To overcome the issues of discrete tasks and resource allocation, guarantees the needs of dependable and efficient communication. We implemented Java software. The evaluation of the performance step encompasses several measures, such as energy consumption (J/ms) and Time delay (ms)model to assess the efficiency of the suggested forecasting algorithm. We performed an assessment of comparison with other established approaches results indicate that the suggested model produces superior results for assisting the data management issues in IoMT systems.

1. Introduction

The substantial paradigm change in the provision of healthcare was termed by incorporation that constitute IoMT (Internet of Medical Things) systems into public health data management, which promises increased accessibility and efficiency [1]. In light of growing pressures from aging populations, chronic illnesses, and the need for quick responses to public health emergencies, IoMT is emerging as a disruptive force has the potential to change data management procedures in healthcare systems [2]. The combination of cutting-edge technology and healthcare maximizes the use of available resources constitute individualized patient care, which eventually improves healthcare outcomes [3]. IoMT constitute a wide range for networked medical equipment, sensors, apps gather, process, and send health data instantly [4]. Patient data security puts specific demands on encryption, transfer pathways and the level of access in IoMT networks. In addition, data interchange and integration are established on the perfect coordination of the wide variety of IoMT systems and platforms and compatibility continues to be a severe concern [5]. Early identification, timely action and effective management of conditions as well as illnesses constitute real time information that aids in managing hospital readmissions and healthcare costs [7]. Mobile applications used for monitoring interactions helped identify potential carriers with the help of IoMT applications, which stopped the further spread of the disease [6]. IoMT helped simplify the monitoring of the production and distribution of the vaccines, thus allowing fairness and efficiency in the distribution of the same. The cultural change needs to be effective in healthcare organizations if IoMT has to be incorporated when managing public health data [8]. The offloading strategy was essential for the efficiency of IoMT systems. They optimize resource consumption and lower latency by allowing data processing duties to be dynamically distributed among different network nodes. Healthcare providers may guarantee quicker and more dependable data processing by shifting computationally demanding operations to cloud-based platforms. The public health data was frequently collected through IoMT networks, which raises anticipate about security and illegal access. Study aims to develop a novel Mutated Barnacles Mating Optimization (MBMO) for assisting with the data management issues in IoMT systems [9].

Related works

In [10] suggested an IoMT (Internet of Medical Things) system that offers features to handle large amounts of data, comprehension extraction and standard healthcare treatments [12]. They ensure connectivity, high recognition efficiency and adaptability in Machine-to-Machine (M2M) design. The experimental outcome demonstrates the exchange of healthcare information and the combination of various IoMT technologies. In [11] examined safe administration and access to patient data on IoMT, and MMSDDF (Multi-Modal Secure Data Dissemination Framework) designed by block-chain technology was developed. They possess healthcare management of data in IoMT technology were able to optimally fulfill the confidentiality and safety criteria. IoMT devices provide real-time individual sensor information for analysis and processing in healthcare operations. The result shows that the proposed MMSDDF approach provides a high level accuracy. In [13] examined task data offloading with priority considerations in healthcare edge delivery [14]. The purpose of edge technology is to provide users access to more processing power, so they can complete tasks that require less time to complete. The results demonstrated the processing time for cutting-edge technology in computing. In [15] introduced ETSDNN (Efficient Training Scheme-Deep Neural Networks) model on cutting-edge analysis enriches the IoMT. When the IoMT equipment detects a patient, it sends the collected information to edge analysis that uses ETSDNN paradigm for diagnosis. The experimental outcome displays the patient's data that are transmitted to edge computing. In [16] proposed a unique framework for intelligent health care for AAL (Ambient Assisted Living) monitor the patient and individual activity through the use of IoMT for quicker analysis, improved treatment suggestions and making choices. IoMT possesses the ability to transform the medical field. The experimental outcomes shows the path to identify physical activity and check the public health.

Problem description

Public health data management scenarios in 5G environments entail setting up several devices, or multi-user systems, such as clinical imaging equipment, intelligent health monitors and AR-assisted diagnostic instruments. The amount of data handled in healthcare settings was massive, frequently requiring numerous MEC (mobile edge computing) servers termed multi-MEC servers to manage the functions of IoMT. The research intends that task offloading results may be produced by applying the Mutated Barnacles Mating Optimization (MBMO) offloading approach to discover the ideal position for task offloading and minimize the task processing latency overall.

The Internet of Medical Things (IoMT) was examined in this research for the assumption of N connected devices and server MMEC. Every connected device's responsibilities can be delegated to a particular server MEC. Our consideration was limited to non-divisible tasks, with each smart device submitting a single task. Each assignment can be completed through $M + 1$ potential places. Specially, offloading for both local and M MEC server execution. Two primary constraints are examined in this paper such as the energy consumption model and the time delay model.

Energy consumption model

Energy usage of two components of j^{th} tasks of jth MEC server are the communication energy consumption and the computation consumption of energy. The quantity of computing tasks will have an impact on computation energy usage.

$$F_{calc,j} = Q_j . V^2 . D_{t,i} . C_j . D_j \quad (1)$$

Here the voltage was represented by V and effective switch resistance was determined by C_j. The tasks are sent to MEC server that constitutes to need transportation energy usage. Here T_j denotes broadcast energy of every system. Consequently, overall power usage was represented as

$$F_{ij} = C_j . D_j \left(Q_j . V^2 . D_{t,i} + \frac{T_j}{q_{j,i}} \right) \quad (2)$$

Time delay model

When calculating overall postpone to complete j th job for ith server MEC constitute communication postpone and server MEC computation period.

$$S_j^i = S_{tran,j}^i + S_{mec,j}^i \quad (3)$$

We specify that C_j shows the quantity of data utilized to perform the job, and $D_i$shows the number of CPU cycles required for the data handled. Since job quantity was separated by MEC server's CPU frequency, the current task quantity calculation was designated as $C_j.D_j$, the postpone calculation of MEC may be expressed as follows:

$$S^{i}_{mec,j} = \frac{C_j.D_j}{D_{t,i}} \quad (4)$$

Here M_0represents the noise power spectral density, X stands for transmission bandwidth, and $T_j$denote as transmission energy. $B_{j,i}$ represent gain of channel among j th system to i th serverMEC. The time used for i th job to j th server MEC was determined as

$$S^{i}_{tran,j} = \frac{C_j.D_j}{X.log_2\left(1+\frac{T_j.B_{j,i}}{X.M_0}\right)} \quad (5)$$

The time delay model consists of three distinct delay, such as average, transmission and execution delay. To overcome this our proposed MBMO method was utilized for assisting the data management issues in IoMT systems.

Mutated Barnacles Mating Optimization (MBMO)

An improved evolutionary technique called Mutated Barnacles Mating Optimization (MBMO), which was used to solve complicated problems, was inspired by the mating habits of barnacles. MBMO has the potential to enhance the efficacy and precision of handling and evaluating extensive health data in the context of IoMT networks for public health, guaranteeing prompt and efficient medical treatments [17]. The MBMO utilizes self-adapting community approach together with opposition-based instruction. The former may be used to create a broadly dispersed initial population used to change the population size throughout each cycle. These two phrases offer an appropriate change in separate phrases. The original population was created at random and it has a solution that was near the optimum point.

$$W_j' = W_{max} + W_{min} - W_j \quad (6)$$

Here W_{min} and W_{max}represent the lower and higher boundaries of the factors in the issue, respectively, and W_j'denotes the reverse location asW_j.Reaching the optimal solution made possible by new location. The cost function analysis was performed as W_j'. Likewise, it will be restored if $W_j'$is in an improved location W_j.

Self-adaptive population was the next phrase for modification. MBMO uses a population-centered optimization approach that begins with randomized initialization constitute metaheuristic algorithm. To specify the dimension of growth, a control parameter was needed. However, it was crucial to remember that choosing the population size to address case difficulties was tough and demanding undertaking. Throughout the iterations, Population dimension was determined by the self-adapting community. The phrase eliminates the need of user choose the ideal value to change automatically by adjusting the community size throughout optimization process. Population constitute self-adapts in this case reaches the starting size of the initial iteration in the following manner:

$$PopSize = 10 \times c \quad (7)$$

The problem dimensions are represented by$c$. Following that, equation (8) yields the new population size:

$$PopSize_{new} = \max\,(c.round(PopSize + q \times PopSize)) \quad (8)$$

The randomized value in the range of -0.5 to 0.5 was described by q.When the population of the subsequent iteration surpasses the preceding iteration, represent as $PopSize_{new} > PopSize$, and remaining individuals will be created through inequality. The optimal outcome from the preceding iteration are utilized. The population was sorted and people are preserved and the unsuccessful individuals are removed from population size was smaller than the prior version as $PopSize_{new} > PopSize$.There won't be any population changes if the population size remains constant, $PopSize_{new} > PopSize$.A population size adjustment will be made to bring the new population size into line with the problem dimensions if it is smaller than the problem dimensions ($PopSize_{new} < c$).

2. Results and discussion

In this part, the java language was used to develop the Mutated Barnacles Mating Optimization (MBMO) algorithm, simulating the job offloading situation under the IoMT. In the segment, there are 12 MEC servers and N smart devices in turn, send offloading requests to 12 MEC servers.

We assess the proposed strategy and calculate its effectiveness using the following indicators: energy consumption (J/ms) and Time delay (ms). We also present an efficacy comparison between our proposed strategy and other current approaches (particle swarm optimization (PSO)), Genetic algorithm (GA), simulated annealing algorithm (SA)) [18].

Energy consumption describes the quantity of energy systems consume to carry out tasks, create products and keep themselves comfortable. Figure 1 illustrates the energy consumption comparison between the suggested and traditional methods. Compared to current techniques like GA, PSO and SA, the proposed MBMO attains a low level of energy consumption. Our proposed method provided superior results for assisting public health data management in IoMT systems.

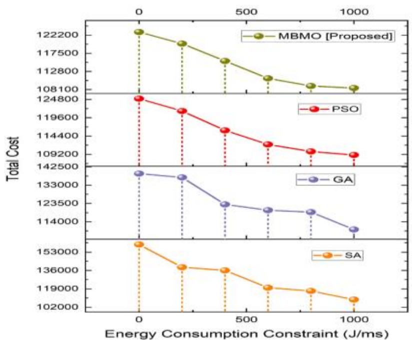

Figure 1 Outcome of Energy consumption

The time delay model consist of average delay that usually describes the normal length of time that a procedure takes longer than anticipated to complete or gets delayed. The number of iterations was increased the proposed approach achieves high superiority. Figure 2 illustrate the average delay of comparison between suggested and traditional methods. Compared to current techniques like GA, PSO and SA, the proposed MBMO attains a low average delay. Our proposed method provided superior results for assisting public health data management issues in IoMT systems.

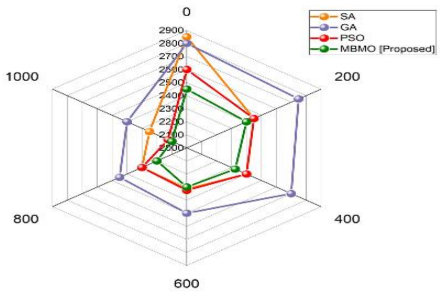

Figure 2 Outcome of Average delay

The duration of data transit via a network, from source to recipient was known as transmission delay. Figure 3 represent the transmission delay of comparison between suggested and traditional methods. Compared to current techniques like GA, PSO and SA, the proposed MBMO attains a lower transmission delay. Our proposed method provided superior results for assisting public health data management in IoMT systems.

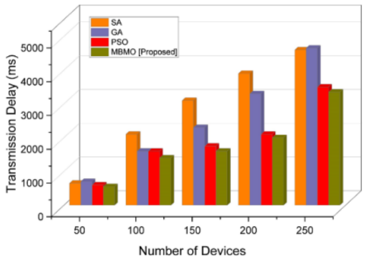

Figure 3 Outcome of Transmission delay

The execution delay describes, how long it takes a procedure or system to do a tasks after it has begun. Figure 4 represent the execution delay of comparison between suggested and traditional methods. Compared to current techniques like GA, PSO and SA, the proposed MBMO attains a low execution delay. Our proposed method provided superior results for assisting public health data management in IoMT systems. Table 1 shows that the results of various parameters.

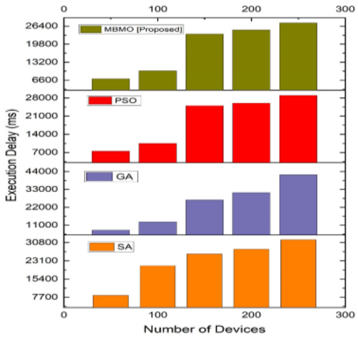

Figure 4 Outcome of execution delay

Table 1 Outcome value of result parameters

Methods	Energy consumption	Average delay	Transmission delay	Execution delay
SA	109000	2250	4600	32000
GA	110000	2400	4650	42000
PSO	109000	2125	3500	29000
MBMO [Proposed]	108500	2100	3350	27500

3. Conclusion and future scope

We proposed a revolutionary strategy called mutated barnacles mating optimization (MBMO) for assisting with data management issues in IoMT systems. The suggested MBMO framework successfully addresses problems that are common in the medical industry by using a data offloading technique. The evaluation of the performance step encompasses several measures, such as energy consumption (J/ms) and Time delay (ms), to assess the efficiency of the suggested forecasting algorithm. We performed an assessment of comparison with other established approaches and the results indicate that the suggested model produces superior results for assisting with data management issues in IoMT systems. Inadequate security protocols can expose personal health information. Future research is moving towards the development of IoMT devices that are simple to use and intuitive to promote patient and healthcare provider uptake and safe data transfer procedures.

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