Efficient Integer Categorical Particle Swarm Optimization Algorithm and Cloud IoT for Health Service

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Abstract. Cloud computing plays a very important role in healthcare services (HCS).

Cloud computing for HCS can restore patients’ records, diseases diagnosis and monitoring patient from wearable device as medical body area network other medical domains in less time and less of cost execution time. In cloud computing using cloud broker that provide service, optimally chosen of best server virtual machines (VMs) is very significant to interest in healthcare services (IHS) (patients, doctors, etc.) in HCS to implementation time and speed of response to medical requests. The proposed system cloud IoT for ICU health system which implement using the new release PSO (ICPSO) algorithm is finding position optimal server(VM) minimum response time this is because the particle represents distribution instead of candidate solution for (MBAN) by leveraging on IoT and cloud computing service providing health system services. Also, this paper proposes optimization algorithms are integer categorical particle swarm optimization(ICPSO) to find optimal chosen of VMs of server in a cloud environment. For that, this paper uses MATLAB tool to find optimal chosen of VMs in a cloud environment. The results proved that ICPSO algorithm is better than approach PSO algorithms.

Keywords: Internet of Thing, Cloud Broker Health System, ICPSO.

1 Introduction

HCSs are considered of the most medical domains of interest to the world at present. The optimal utilize of HCS protects much public from death. IHS of the HCS such as the patients and the doctors use old methods to restore patients records to detect the patients’ health condition in a long time, but using new methods such as cloud computing can restore patients records in less time and less cost. Cloud computing has become critical to IHS in many fields for transmitting medical services over the Internet. Cloud computing is sending
application, infrastructure services to huge numbers of IHS with assorted and dynamically changing requirements [1].

The cloud broker creates the negotiations layer between the stakeholders and cloud service providers where the stakeholders can obtain all of the healthcare services. Cloud broker consist of three types, cloud service intermediation, aggregation and cloud service arbitrage. Cloud broker is represented Amazon, Google, etc. Cloud broker is also responsible to receive data from sensors and to dispatch it to appropriate storage service hosted on cloud [2].

Internet of Thing (IoT) is a new revolution of the internet thanks to the facility to connect remote and mobile things or machines or assets through the use of wireless communications and low cost sensors computing and storage devices. So, the internet is now evolving from a network of computers to a network of things [4]. Wireless network wearable medical body space that monitors vital indicators of the body through sensors working to capture the signal and send data through low-energy technology such as blouooth the Phelps company put up a device to improve health services and reduce time and effort on both sides Caretaker is the worlds most innovative patient monitor Using only a simple finger cuff to measure Continuous Beat-by-Beat Blood Pressure, Heart Rate ,glucose press other physiological parameters enabling safe, secure, and accurate remote patient monitoring via our secure Android App, HIPAA-compliant Cloud Portals, or inter with other patient monitoring systems. Caretaker sets a new standard in mobility, simplicity, and cost, enabling continuous realtime monitoring as patients traverse the full continuum of care, within the hospital, during transport, and after discharge. The work advanced in this paper focuses on the study and the advance of an intelligent patient monitoring system in health environment. Indeed one of the specific sections of a hospital that are Intensive Care Units (ICU) are of great importance because of the importance of the health status of patients continuing and therefore need special attention. Due to the severity of patients treated in the (ICU), these units are commonly equipped by a variety medical equipment that is handled a multidisciplinary medical team in order to monitor ICU’s patients in real time. In addition, we find, nursing staff, the monitoring and life support devices necessary to run continuous care to patients that are severely ill and medically unstable [4].

ICPSO is a new discrete particle swarm optimization algorithm that is designed to handle both integer and categorical state variables. This is achieved by representing the particle’s
position as a set of probability distributions, one per variable, over the possible solution values. Solution values are produced by sampling from these distributions [5].

The rest of this paper is arranged as follows: Section 2 discusses the related works, Section 3 defines the proposed model of cloud computing and IoT for health services, Section 4 explains in details the proposed optimizer using (ICPSO ) Algorithm, Section 5 discusses the experimental results and finally, Section 6 concludes the paper

2 Related work

1- S.D.Yu and et al (2014)[6]: The propose a distributed parallel genetic algorithm (DPGA) of placement strategy for virtual machines deployment on cloud platform. It executes the genetic algorithm parallel and distributed on several selected physical hosts in the first stage. Ten it continues to execute the genetic algorithm of the second stage with solutions obtained from the first stage as the initial population. the solution calculated by the genetic algorithm of the second stage is the optimal one of the proposed approach. The experimental results show that the proposed placement strategy of VM deployment can ensure QoS for users and it is more effective and more energy efficient than other placement strategies on the cloud platform.

2- A.T. Parmar and et al (2015)[7]: The presented an approach to find optimal VM allocation in cloud environment based on FCFS algorithm. This study tries to find optimal VM allocation to reduce energy consumption, reduce time from users’ tasks and facilitate task scheduling. FCFS algorithm may discover optimal VM allocation in cloud computing environment. But, it needs to improve task scheduling.

3-M.M . Rathore, et al. (2016)[8]: They proposed IoT-based Real-time Medical Emergency Response System by exploiting Big Data analytics. The view to developing continuous follow up and monitoring individual vital signs anytime anywhere anyhow, a flexible system was designed based on Intelligent Building that analyzes the data received from various medical sensors attached to various persons. The system was implemented using hadoop ecosystem and Spark as a real-time processing tool. The performance of the system was tested on a hadoop.

The evaluation showed that the performance of the proposed network architecture fulfills the required needs of a city or nation, whether the input data are real time or offline, while taking actions in real time.
4- S.D. Ebrahim and et al (2016) [9]: The proposed to obtain the optimal VM placement based on modified PSO algorithm. This study tries to find the best VM placement to give the quality of services of users’ tasks and minimize energy consumption. This proposed method can find the optimal VM placement by a modified PSO algorithm to save power consumption and facilitate task scheduling.

5- J. Hanen and et al. (2016) [10]: The proposed system to help patients to treat heart rate signal remotely based on medical cloud computing system (MCCS). MCCS is applied to Google’s Android operating system and CloudSim for solution traditional problem in analysis heart rate. MCCS may find the better solution for analysis heart rate signal on mobile cloud computing.

3. The proposed Could-IoT for Intensive Care Units Health system

The proposed system depends on the medical body of the area networks, the wearable devices (Caretaker) in the ICU, and cloud computing using an important feature, so the mediator system stores and schedules the various tasks that represent the physiological medical signals of the patient (blood press stoic and diastolic and blood glucose and heart rate measurement), and that the scheduling problem is solved using new version the algorithm PSO discreet type (ICPSO), which assesses the effectiveness and efficiency of the proposed algorithm in terms of cost of tasks in the least time of implementation consists of four main components: (ICU (MBAN, patient ), IoT Router, cloud blocker, cloud server monitoring system) and monitoring system on line.
The description of each step of the proposed system at the figure 1 is given below:

1. ICU

This is the first step which are of patient care, wearable medical body space networks, and patient monitor screen.

1- **patient care**: Each patient connected to the wearable device that is equipped with wireless networks works to converge data that represents medical physiological signals the patient in the central care unit.

2- **Medical Body Area Network Device (MBAN)**

generated data from a sensor device system for people working in a medical environment. The requirement is that the sensors device be unobtrusive to the patient as possible the hardware sensors used must be small and wireless. By meeting the latter requirement, more reflective and natural values of the measured bodily parameters will be acquired; any chance of hindrance to the data collection is reduced significantly. Further, as the sensor devices are wireless, adequate battery life must be ensured to guarantee continuous and reliable monitoring without interruption. Potential hardware design of the sensors is a health
monitoring as a caretaker device that is capable of measuring an array of physiological measures. An ‘all-in-one’ device such as this is ideal to eliminate any variability in the readings from the sensors that transform using technology Bluetooth using computers and mobile phones will be used to extract accelerometer data.

2. IoT Router

The router provides a wireless connection send and receive information through the health application, which sends data to the system center, storage and scheduling tasks, providing health services to the patient in the least time of implementation.

3. Cloud Broker (center system)

This step cloud broker is creates the intermediate layer between the "IoT" router and cloud service providers where the patient can obtain all of the healthcare services. Cloud broker consists provides three services in task scheduling.

a) The Data Receiver: A personal server which receives data using wireless communications. The role of the receiver is to also store previous readings from the sensors into the medical server.

b) The Data Aggregator: an aggregator which collates data from the various sensors in the patient module. It should be noted that before the aggregation of data occurs, the raw data must be processed to obtain only the necessary values.

c) The Data Analyser: An analyser which provides advantageous meaning to the data values. It applies the scheduling algorithm on the processed and aggregated data. Also responsible to receive data from IoT router and to send it to appropriate storage service in the monitoring system. Cloud broker distribution of data patient to the cloud server (monitoring center) the suggested modified PSO algorithm (ICPSO) find best server depend on the probability of distribution tasks in the particle search space get the best solution reduces execution time task patient and service monitor.

4. Cloud Server

In this section, we describe an improved patient monitoring system through the establishment of an automatic medical data gathering system in real-time and analysis in order to assist clinicians in decision making in ICUs. It responsible for determining the best services that it uses to find the optimal server (VM) in cloud to enhance the task scheduling process which leads to reduce total time of patient service and maximize utilization of resources. The control center is connected to 10 servers the probability of each server connected.
4. The proposed ICPSO Algorithm for scheduling cloud broker

In this part, we will explain the scheduling algorithm, tasks that depend on the possibility of finding the best server for the virtual machine, which represents the distribution of these tasks to the virtual machine database, and thus the development function depends on finding the best solutions for the virtual machine tasks, less time to cost implementation, which depends on several scheduling properties will be done explain it later. Assume that there are N particles (VMs) = 100, C1 = 2, C2 = 2,C3 and the number of iterations = 100. Inertia weight is an important parameter in ICPSO, which significantly affects the convergence and exploration, exploitation trade-off in ICPSO process. Each task (VM) in the cloud is considered a particle which represents a potential solution task (VM) that can be allocated for executing the tasks. Compute fitness function an optimal selection of best server for (VMs) by using the cloud broker scheduling attribute. Then Compare the calculated fitness function of each particle (VM) in server with its LBest Position. If the current value is better than LBest Position, then put the current location as LBest Position location. If the current value is better than G Best Position, then reconstruct GBest Position to the current index in particle array. Assign the best particle (VM) as GBest Position. Update each Particle Velocity and position as follows:

The velocity value is computed by Eq (1).

\[ \text{Pvelocity}(t) = W \times \text{Pvelocity}(t-1) + C1 \times r1 \times \min(\text{Pposition}(t) - \text{Pposition}(t)) + C2 \times r2 \times (\text{LBest Position} - \text{Pposition}(t)) + C3 \times r3(\text{GBest Position} - \text{Pposition}(t)) \]

The position value is computed by Eq (2).

\[ \text{Pposition}(t) = \text{Pposition}(t-1) + \text{Pvelocity}(t) \]

That will outline the steps in the algorithm flow chart figure(2).
Input: data MBAN sensor (systolic blood pressure, diastolic blood pressure, blood glucose, heartbeats rate)

Output: (Optimal best server (VM), optimal cost execution time best server (VM) with latency, optimal execution time no latency)

1: Initialization Step:
a. \( P_{\text{position}}(t) = 1 - \frac{\text{Cost}(t)}{\sum_{n}\text{Cost}(t)} \)
b. \( P_{\text{velocity}} = \text{random} \)
c. \( G_{\text{BestPosition}} = \text{Index}(\max(P_{\text{position}})) \)
d. \( L_{\text{BestPosition}} = \text{Index}(P_{\text{position}}(1)) \)

2: Initialize Weights
3: For MBAN requests x
4: For Iterations t
5: Update Velocity
\[
P_{\text{velocity}}(t) = w \times P_{\text{velocity}}(t - 1) + C_1 r_1 \min(P_{\text{position}}) - P_{\text{position}}(t) + C_2 r_2 (L_{\text{BestPosition}} - P_{\text{position}}(t)) + C_3 r_3 (G_{\text{BestPosition}} - P_{\text{position}}(t))
\]
6: Update Position
\[
P_{\text{position}}(t) = P_{\text{position}}(t - 1) + P_{\text{velocity}}(t)
\]
7: Update local and Global values:
8: If \((\min(\text{Cost}) \leq L_{\text{BestPosition}})\):
9: \( L_{\text{BestPosition}} = \text{Index}(P_{\text{position}}(t)) \)
10: End
11: If\((L_{\text{BestPosition}} \leq G_{\text{BestPosition}})\):
12: \( G_{\text{BestPosition}} = L_{\text{BestPosition}} \)
13: End
14: End
15: End
16: Return \( G_{\text{BestPosition}} \)
4.1 The fitness function attribute find the best server for (VM).

The proposed fitness function is composed of four essential attributes which are execution speed time, physical latency, physical no latency, cost time. The calculations of these attributes depend on five secondary attributes arrival time, completion time, barst time, turnaround time and waiting time as follows:

Flow chart (3): ICPSO Algorithm used cloud broker.
1. **Arrival Time (AT):** The time at which the task arrives in the ready queue. Generate it random time N(VM) the task arrival time find in (VM) to the server. It is expressed as shown in equation (3).
   \[ AT = \text{random}(N) \]

2. **Completion Time (CT):** The time at which the task completes its execution. It is expressed as shown in equation (4).
   \[ CT = AT + (N) \]

3. **Turnaround Time (TT):** Time difference between completion time and arrival time. It is expressed as shown in equation (5).
   \[ TT = CT - AT \]

4. **Burst Time (BT):** The time required by a task for CPU execution.
   It is expressed as shown in equation (6).
   \[ BT = \frac{(TT - (N))}{N} \]

5. **CPU Utilization (U):** The percentage of CPU capacity used during specific period of time. It is expressed as shown in equation (7).
   \[ U = 100\% - \text{(%time spent in the idle task)} \]

6. **Waiting Time (WT):** Time difference between turnaround time and burst time. It is expressed as shown in equation (8).
   \[ WT = TT - BT \]

This section presents the formulas for calculating the three important attributes essential using the formerly aforesaid attributes to find the best server of (VM) as follows:

7. **Execution Speed Time:** Attribute is the speed of server execution task execution speed depends on doubling the processor usage speed. It is expressed as shown in equation (9).
   \[ \text{Execution Speed time} = (2^U - TT + WT) \]

8. **Physical Latency:** The time it takes for some task (VM) to get to its destination across the network. Generated random N(VM) available in the network it is expressed as shown in equation (10).
   \[ \text{Physical Latency} = \text{random}(N) \]

9. **Cost Time:** The total execution time for each task (VM) in the server depend on a factor physical latency end execution speed time. It is expressed as shown in equation (11).
Cost Time = \frac{\text{Physical Latency}}{\text{Execution Speed Time}}

5. Experimental results

In this part, the results of experimental of the suggested cloud-IoT model by the suggested algorithm ICPSO will be discussed. These algorithms are executed by diverse tools to guarantee their consistency. The principal tool is MATLAB. The funding of this algorithm is been compared to assess their performance concerning the time of implementation, the processing speed of live data and the efficiency of the system. The tests are implemented depending on suggest performance metrics that are comprised of speedup and efficiency. Throughout the implementation and testing, the proposed system is implemented by using Matlab2018 a is used as programming language for implementation of the proposed system and the applied on operating system Window 7 and processor the platform of Intel Core i3 Due with 16GB memory(RAM).

Step1: This section presents calculate fitness function attributes, table (1) shows the results sample of attributes for each task (VM) that scheduling for cloud server, the first attribute (AT) by using equation (3) generate it random time for (VM), attribute (CT) calculate by using equation (4), attribute (TT) calculate by using equation (5), attribute (BT) calculate by using equation (6), calculate (U) attribute by using equation (7), attribute (WT) calculate by using equation (8).

Table 1: Result from sample second attributes of the scheduling of tasks (VM) by using the ICPSO algorithm on cloud broker.

<table>
<thead>
<tr>
<th>N</th>
<th>AT</th>
<th>CT</th>
<th>TT</th>
<th>BT</th>
<th>U</th>
<th>WT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>797</td>
<td>1368</td>
<td>571</td>
<td>0.325</td>
<td>9533</td>
<td>570.675</td>
</tr>
<tr>
<td>2</td>
<td>362</td>
<td>633</td>
<td>271</td>
<td>0.689</td>
<td>6490</td>
<td>270.311</td>
</tr>
<tr>
<td>3</td>
<td>431</td>
<td>810</td>
<td>379</td>
<td>0.588</td>
<td>10501</td>
<td>378.412</td>
</tr>
<tr>
<td>4</td>
<td>133</td>
<td>959</td>
<td>826</td>
<td>0.199</td>
<td>4489</td>
<td>825.801</td>
</tr>
<tr>
<td>5</td>
<td>635</td>
<td>1548</td>
<td>913</td>
<td>0.836</td>
<td>5656</td>
<td>912.164</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>616</td>
<td>606</td>
<td>0.307</td>
<td>4051</td>
<td>605.693</td>
</tr>
<tr>
<td>7</td>
<td>398</td>
<td>471</td>
<td>73</td>
<td>0.849</td>
<td>7771</td>
<td>72.151</td>
</tr>
<tr>
<td>8</td>
<td>810</td>
<td>1682</td>
<td>872</td>
<td>0.05</td>
<td>2027</td>
<td>871.95</td>
</tr>
<tr>
<td>9</td>
<td>617</td>
<td>963</td>
<td>346</td>
<td>0.096</td>
<td>3988</td>
<td>345.904</td>
</tr>
<tr>
<td>10</td>
<td>589</td>
<td>607</td>
<td>18</td>
<td>0.915</td>
<td>5498</td>
<td>17.085</td>
</tr>
</tbody>
</table>
Step 2: Calculate execution speed time attribute by using equation (9), calculate the physical latency attribute of each task (VM) in the network is variable by using equation (10), calculate cost time by using equation (11). The essential attribute from speed time and physical latency from the results sample are illustrated in a table (1).

Table (2): Result from sample essential attribute of the scheduling of tasks (VM) by using the ICPSO algorithm on cloud broker.

<table>
<thead>
<tr>
<th></th>
<th>Execution Speed Time</th>
<th>Physical Latency</th>
<th>Cost Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.9065675</td>
<td>923</td>
<td>0.048411609</td>
</tr>
<tr>
<td>2</td>
<td>1.2979311</td>
<td>918</td>
<td>0.070727945</td>
</tr>
<tr>
<td>3</td>
<td>2.1001412</td>
<td>606</td>
<td>0.028855203</td>
</tr>
<tr>
<td>4</td>
<td>8.977801</td>
<td>35</td>
<td>0.003898505</td>
</tr>
<tr>
<td>5</td>
<td>1.1311164</td>
<td>473</td>
<td>0.041817093</td>
</tr>
<tr>
<td>6</td>
<td>8.101693</td>
<td>966</td>
<td>0.119234338</td>
</tr>
<tr>
<td>7</td>
<td>1.5541151</td>
<td>153</td>
<td>0.009844831</td>
</tr>
<tr>
<td>8</td>
<td>4.05395</td>
<td>139</td>
<td>0.034287547</td>
</tr>
<tr>
<td>9</td>
<td>7.975904</td>
<td>636</td>
<td>0.079740177</td>
</tr>
<tr>
<td>10</td>
<td>1.0995085</td>
<td>806</td>
<td>0.073305481</td>
</tr>
<tr>
<td>11</td>
<td>2.343719</td>
<td>842</td>
<td>0.359258085</td>
</tr>
<tr>
<td>12</td>
<td>7.763823</td>
<td>743</td>
<td>0.095700275</td>
</tr>
<tr>
<td>13</td>
<td>1.9557562</td>
<td>987</td>
<td>0.050466413</td>
</tr>
<tr>
<td>14</td>
<td>5.181.022</td>
<td>165</td>
<td>0.031846999</td>
</tr>
</tbody>
</table>

The following figure (2). The figure shows the Matlab interface. Executing by using 10 servers, each one separately from the other in the health care center, providing health services by storing the tasks that are scheduled using the proposed algorithm. The figure shows the cost of the default automated execution time in each server to find the possibility of the site, which has been tested. Results using a database of 100 patients whose vital indicators were collected from the health center according to a specialized staff that calculate the probability position best server (VM) using equation partial and velocity 1.2. Show in the figure below the best server and cost (VM) from attribute.
Figure (2): Illustrating probability location best server and Cost time execution in cloud server.

Figure (3): Illustrating probability location best server and Cost time execution for patient.

The figure (3). Shows the presence of an electronic record for each patient to monitor vital signs that contain the patient's complete information, and which these vital indicators are called, which are called virtual tasks using the proposed algorithm, which shows the efficiency and performance of the algorithm better than other algorithms.
6. Conclusion

This paper introduced proposed system for heath care based on optimization algorithm for discret (ICPSO) to get optimal chosen of best server (VMs) in a cloud server dependent on attributes of scheduling that fitness function finds less cost time solution problem. The goal of the suggested system to enhance the performance of the health services in a Could -IoT for Central Care Unit Health system depending on base behavior by selection optimal of server (VM) optimization and provide Patient monitoring. This paper showed the algorithm better than approach PSO to implementation time. Therefore, this paper proposes the application of ICPSO algorithm to obtain the best server chosen of VMs to support IHS in minimizing implementation time of medical requests (tasks), improve task scheduling, maximize resources utilization and applied this algorithm on Matlab program. The future work is to apply new swarm optimization algorithms such Markov ICPSO optimization algorithms to generate more features in system optimization to obtain an optimal selection of VMs on a cloud environment. Adapting the suggested system for problem big data health system in various environments to make the system more efficient.

REFERENCES


