Combination of Cloud Computing and Internet of Things (IOT) in Medical Monitoring Systems

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Abstract

With the fast development of cloud computing and computer science technology, the combination of the IOT and clod computing in the medical-assisted environment is urgently needed. The prior research focus more on individual development of the single technique, quite a less research on the field of medical monitoring and managing service application have been conducted. Therefore, in this paper, we study and analyze the application of cloud computing and the Internet of Things on the field of medical environment. We are trying to make the combination of the two kinds of technology monitoring and management information system in hospital. Remote monitoring cloud platform architecture model (RMCPHI) set up medical information in the first place. Then the RMCPHI architecture was analyzed. Eventually, the last effective PSOSAA algorithm proposed the hospital medical information service cloud system monitoring and management application. Experimental simulation illustrates that the proposed algorithm outperforms the other state-of-the-art algorithms. Further potential research areas are discussed.

Keywords: Cloud Computing, Internet of Things (IOT), Medical Monitoring; Big Data; Theoretical Analysis

1. Introduction

The Internet of Things (IoT) paradigm is based on intelligent and self-configuring nodes (things) interconnected in a dynamic and global network infrastructure. It represents one of the most disruptive technologies which make the ubiquitous and pervasive computing scene. Internet of things is usually refers to the real world and little things limited storage and processing ability, and the important problems about reliability, performance, security and privacy. On the other hand, cloud computing has the almost unlimited capacity of storage and processing power which is a more mature technology at least to a certain extent to solve the problem of most of the Internet of things [1-3]. Thus, a novel IT paradigm in which Cloud and IoT are two complementary technologies merged together is expected to disrupt both current and future world. We call it Cloud-IoT new paradigm. This paper reviews the literature integration of cloud computing and Internet of things promising subject research and industry. We have conducted a review work to propose an integrated usage of Cloud and IoT. In the Figure 1, we illustrate the both topics gained popularity in the last few years and the total amount of papers handling with these two topics, respectively. The Internet of things is the generation of information technology. This is a major development in the field of information and conversion opportunity [4]. The commission believes that development of the Internet of things application will solve the problems of modern society in the future, [5] make a big contribution. Modern logistics use modern information technology in modern logistics

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management instruction. The three basic requirements are: good service, low cost, speed faster. Health information technology has a wide range of function in modern applications [6].

Medical information technology and healthcare service are closely related to the national welfare and the people's livelihood. Cloud computing and Internet of integration in the application of modern medicine would be a great breakthrough. Because in large-scale cloud computing has its advantages such as high reliability, virtualization, high efficiency and scalability, the construction of public cloud in hospital and the patients can promote resource sharing, cost savings, build medical monitoring and management system with high efficiency. Internet as an important support to realize the safe, efficient and high quality of the medical monitoring and management, the main technology of RFID and photos and other acoustic electromagnetic sensors which can achieve breakthroughs in medical information transmission, intelligent health monitoring and precise location [7-10]. IoT also brings great convenience to hospital, especially in the patient monitoring and tracking management. With the rapid development of Internet, cloud computing and Internet integration of medical monitoring and management platform is to provide new opportunities for the hospital, even in social fields [11-14]. This research paper summarizes the health information technology in the field of cloud computing and Internet of things, especially in health monitoring and management application fields of the current study situation. In this article, we put forward and analysis model of medical information architecture of remote monitoring and management platform (RMCPHI) clouds. Then an efficient PSOSAA algorithm of medical monitoring and management of cloud computing applications is proposed. The Figure 2 shows the references we have adopted to finalize our research. The experimental analysis and simulation illustrates the effectiveness of our proposed method.
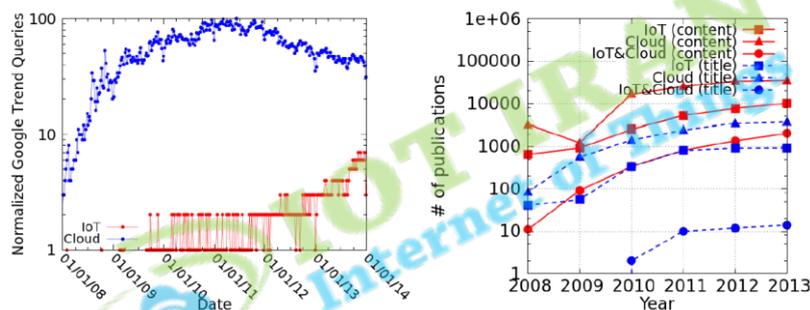

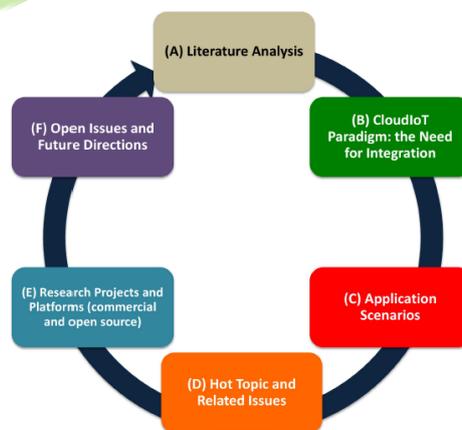**Figure 1. The Research and Interest Trends about Cloud and IoT**

Figure 2. The Research Methodology Adopted by Us

2. The IoT and Cloud Computing

2.1. The Necessaries of the Integration

The two worlds of Cloud and IoT have seen an independent evolution. However, plenty of common advantage is the result of their integration have been identified in literature, predict the future. On the one hand, the Internet of things can benefit from cloud almost unlimited capacity and resources to make up for the technical constraints. Specifically, cloud computing can provide an effective solution to realize management of Internet services and composition and use of things or data applications. Cloud computing can benefit from the Internet of things, on the other hand, by extending its scope to deal with things in the real world more distributed and dynamic way, and to provide new services on a large number of real life scenarios. The complementary characteristics of cloud computing and Internet of things is attractive because of the different proposals reported in literature and encouraging Cloud-IoT paradigm shown in Table 1. Essentially, the Cloud acts as intermediate layer between the things and the applications, where it hides all the complexity and the functionalities necessary to implement the latter. Below, we summarize the problem and gain the advantage when using Cloud-IoT paradigm.

Table 1. The Complementarity and Integration of Issues

Internet of Things	Cloud Computing
pervasive	ubiquitous
real world	virtual resources
limited computational	unlimited computational
limited storage	unlimited storage
point of convergence	service delivery
big data source	means to manage big data

IoT involves by definition a large amount of information sources. It produces a large amount of unstructured or semi-structured data of the three major characteristics of the data: volume, velocity and variety. Hence this means that the collection, acquisition, processing and visualization, archive, share, search large amounts of data. Provide almost unlimited and on-demand storage capacity, low cost, cloud is the most convenient and cost effective solutions to deal with the data generated by the Internet of things [15]. This integration realizes a new convergence scenario, where new opportunities arise for data aggregation, integration, and sharing with third parties [16]. Once to the cloud, data can be in a uniform way through a standard API, can use the top security protection, direct access from anywhere, and visualization. IoT equipment processing resources are not allowed to field data processing. Collected data are usually aggregated and transmitted to a more powerful node processing is feasible, but not an appropriate scalability challenges to achieve infrastructure. Cloud and its on-demand model of infinite capacity allows appropriate content, make the Internet of things to deal with unprecedented demand complex analysis. Data-driven decision making and prediction algorithms would be possible at low cost and would provide increasing revenues and reduced risks. One of the requirements of the Internet of things is to make the IP access devices communicate through dedicated hardware, and support the communication can be very expensive. Cloud connection provides an effective and cheap solution such as tracking and managing anything at any time from any place to use a custom portal and built-in applications. The integration with the Cloud solves most of these problems also providing additional features such as ease-of-access, ease-of-use, and reduced deployment costs. Using Cloud-IoT paradigm to make intelligent services and applications of new scene based on the expansion of the cloud by things: (1) Sensing as a Service, (2) Sensing and Actuation as a

Service, (3) Sensor Event as a Service, (4) Database as a Service, (5) Ethernet as a Service, (6) Identity and Policy Management as a Service, (7) Video Surveillance.

2.2. The Applications of the Integration

In this section we describe a wide set of applications that are made possible or significantly improved thanks to the CloudIoT paradigm. The instruction is shown in Figure 3. We discuss the usage for heal care specially.
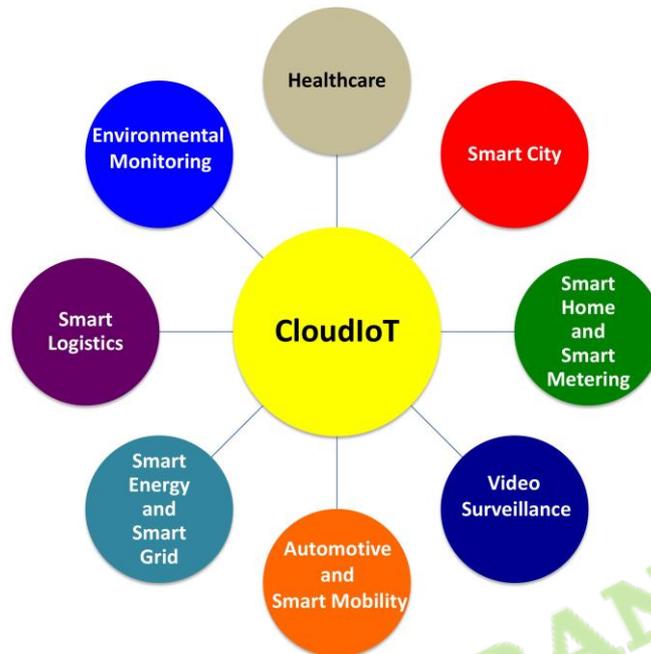

Figure 3. The Application Scenarios

IoT and multimedia technologies have made their entrance in the healthcare field thanks to ambient-assisted living and telemedicine [17-20]. The adoption of Cloud in this scenario leads to the abstraction of technical details, eliminating the need for expertise in, or control over, the technology infrastructure. In addition, it makes the implementation of security (cloud) multimedia health services, to overcome the problem, on the device running a large number of multimedia & security algorithm with limited computing power and small batteries. In this area, the common problems with the management, technology, safety, and legal investigation: interoperability, system security, the streaming media quality of service (QoS) and dynamically increased storage is usually considered a barrier. Hypertension is one of the most common cardiovascular diseases. It is reported that there are about 160 million people who suffer from it. The incidence of hypertension and heart disease is trending to ascend. It ensures that early detection. When users in emergency or dangerous state, it can notify the emergency mechanism. Therefore, improvement of medical treatment is captured. In addition, it is ease to establish national health records, in order to provide decision-making basis for regional disease through the comparison and analysis of medical information. Remote monitoring cloud platform of medical information including body sensors, sensor networks, communication module, family gateway, medical information analysis and processing platform, the medical staff and so on. Medical sensor network to collect information is different. Personal health record data is huge and growing rapidly. Therefore a large amount of data need to automatic classification, analysis and processing as information service provider. For example, security service center to provide security services; Centers for disease control emergency organization disease detection and control status in advance; Emergency

services according to the emergency first aid information extraction; The hospital provides remote diagnosis in medical information; Rehabilitation center provide remote rehabilitation guidance according to the variety of recovery information; Health service center to provide health instruction, through the extraction of the user's health information. Therefore, the network resource sharing means should be required and they need an effective method to extract information. The following sections illustrate our proposed work.

3. Our Proposed RMCPHI Architecture

3.1. The Sensing and Communication Center

The Figure shows the data flow chart from sensor data to data transferred by gateway. Some important research issues include real time location, routing, medium access scheduling, *etc*. Communication system may be soft real-time or hard real-time. Real-time communication module is to create a real-time abstraction layer needs to be distributed real-time computing and real-time communication methods in the dynamic network topology.
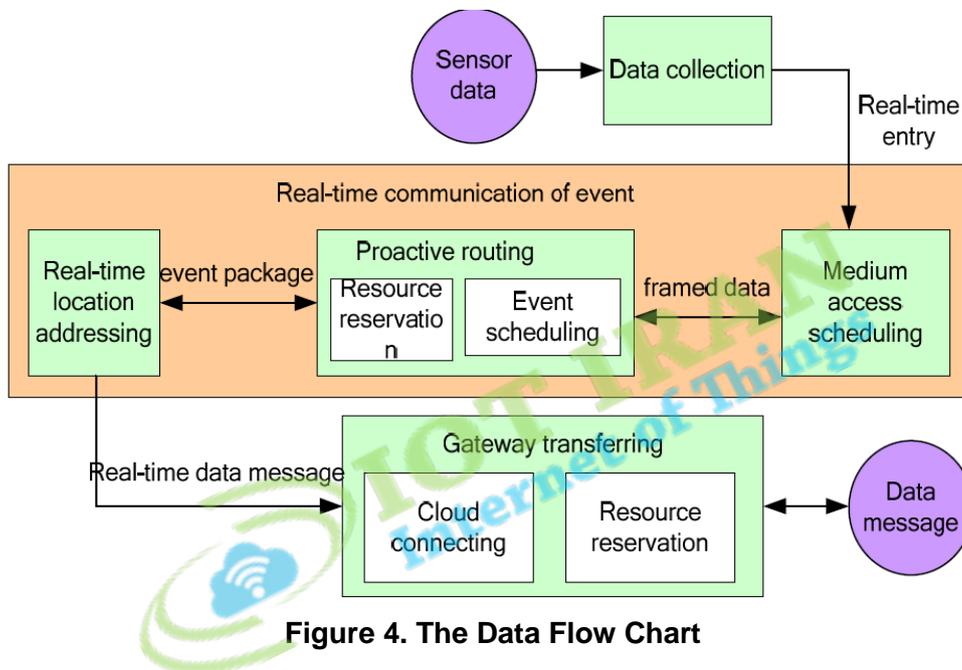

Figure 4. The Data Flow Chart

3.2. The Cloud Computation Center

Cloud services can offer upper user applications, such as social networking environment data analysis and monitoring the patient's health care doctor. Cloud computing part plays an important role in support of different types of operating system platforms and provides high-performance computing technique. Figure 5 shows the cloud computing model in computation center.
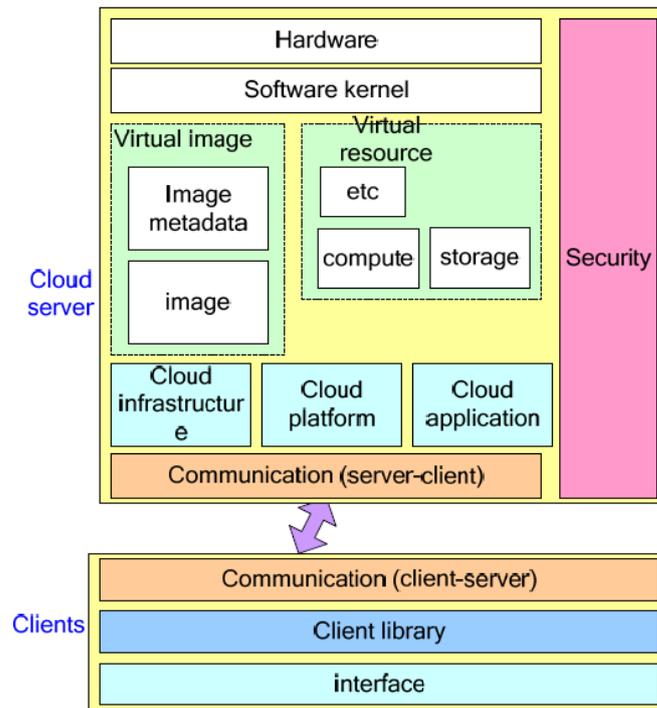
Figure 5. The Cloud Computing Model

4. Our Proposed Monitoring Algorithm

The particle swarm optimization (PSO) algorithm is based on the idea of distributing the search procedure among a large number of "agents", which act independently of each other. Each agent moves through the search space with a simple dynamics, reacting to fictitious forces drawing it towards its own current best solution and the global best solution for the whole swarm. In this way, when an agent finds a better solution than the current global best, it becomes the new global best and all the other agents react instantly, the swarm is directed towards the new solution. For a set of n particles represented by their positions the velocity for the i-th particle and the k-th step is denoted as the following, and the position is denoted in the formula 2:

$$V_i^k = w V_i^{k-1} + c_1 r_1^k \left(X_B - X_i^{k-1} \right) + c_2 r_2^k \left(X_G - X_i^{k-1} \right) \tag{1}$$

$$X_i^k = X_i^{k-1} + V_i^k \tag{2}$$

In the initial speed and position of each particle set random search space. In the process of evolution, the particle evaluation is according to its present location. If the present fitness is better than the fitness of p_{in}^{best} is will stores the best solution, then the p_{in}^{best} will be replaced by the current solution that includes the position and fitness. At the same time, the algorithm selects the best p_{in}^{best} of the swarm to be the globally best, which is regarded as G_{in}^{best}. Then, each particle's speed and position using the following two equations will be updated:

$$x_{in}(t) = x_{in}(t-1) + v_{in}(t) \tag{3}$$

$$v_{in}(t) = q v_{in}(t-1) + k_1 r_1 \left(p_{in}^{best} - x_{in}(t-1) \right) + k_2 r_2 \left(G_{in}^{best} - x_{in}(t-1) \right) \tag{4}$$

Parameter q is weight which improves the overall performance. Small weight value tends to promote local exploration and encourage global exploration. Suitable generally provides a balance weight selection asked local and global exploration and reduces the iterative search for the optimal solution of average number. In order to achieve good performance, we asked linear increase the value of the weight from about 0.5 to 0.9 during the operation. From the point of evolutionary process, particle swarm optimization algorithm (PSO) has fast convergence speed in initial phase, but through several iterations, particles tend to the same and the convergence speed becomes slow. Simulated annealing (SA) algorithm for fast random global search ability and is easy to implement. However, the defect of simulated annealing algorithm is obvious. For example, it has large calculation and low efficiency. In addition, it is easy to fall into local optimum condition with serial search. Large-scale optimization problem, it's easy to fall into local optimum conditions and low convergence speed. This paper argues that the SA and PSO hybrid optimization algorithm. Therefore, the simulated annealing algorithm is added the iteration of the particle swarm optimization algorithm, in order to improve the convergence speed and precision. At the same time the relative variation strategy is adopted, which avoids sinking into the local optima, increases or keeps population diversity. The Figure 6 is the flowchart of the PSOSAA algorithm.
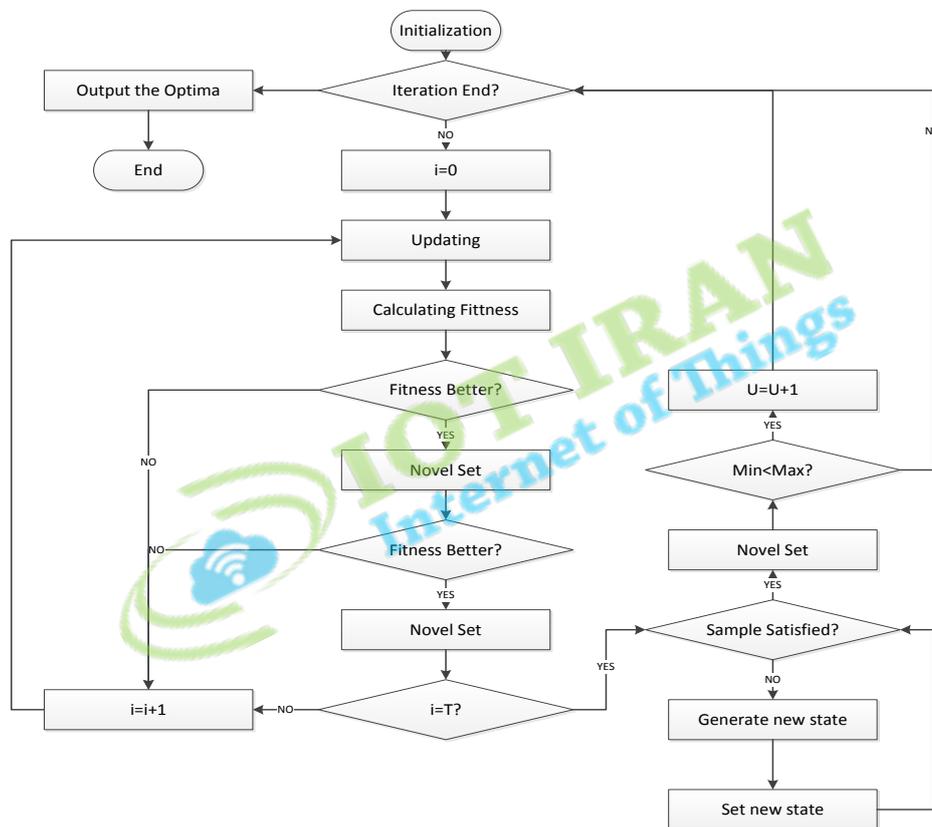

Figure 6. The Flow of PSOASA Algorithm

5. Experimental Analysis

5.1. The Simulation Environment

In order to verify the effectiveness of the proposed method above, we took some experiments and simulation. The simulation environment of CloudSim computing environment is as the follows. Six physical machines equipped with 2 TB hard disk and 8

GB of RAM, and the simulation software is installed on Windows XP platform and Intel core 2 quad core 3.2 GHz and 4 GB of RAM. CloudSim, USES the simulator cloud infrastructure. In the same condition, the simulated annealing algorithm (SA) and ant colony optimization algorithm (ACO) and particle swarm optimization combined with simulated annealing algorithm (PSOSAA) was taken to solve the problem of medical monitoring and scheduling management. The experiment setting parameters are shown in the Figure 7.

Algorithm	Parameter	Value
ACO	Ant number	6
	Updating constant	9
	Evaporation parameter	0.3
	Heuristic information weight	6
	Hormone tracking weight	1
SA	Operation times before adjusting	25
	Initial temperature	55
	Temperature decrease factor	0.88
	Controlling step vector	2
PSOSAA	Population size	25
	Inertia factor	0.87
	Self consciousness study factor	1.5

Figure 7. The Experiment Parameter Setting

5.2. The Simulation Result Analysis

The execution time of each task is shown in Figure 8. As a whole, the ant colony optimization algorithm and the simulated annealing algorithm spend more time as the number of tasks increases. Ant colony optimization algorithm to perform a task slowly at first, but later when the increase is less than the improved simulated annealing algorithm, because the positive feedback. The experimental results show that the PSOSAA algorithm execution time than other two algorithms. The main reason is that PSOSAA algorithm combines the fast searching ability of simulated annealing technique, which not only can improve the convergence speed, but also avoid falling into local optimum conditions. Thus PSOSAA algorithm shortens the average operation time of tasks.
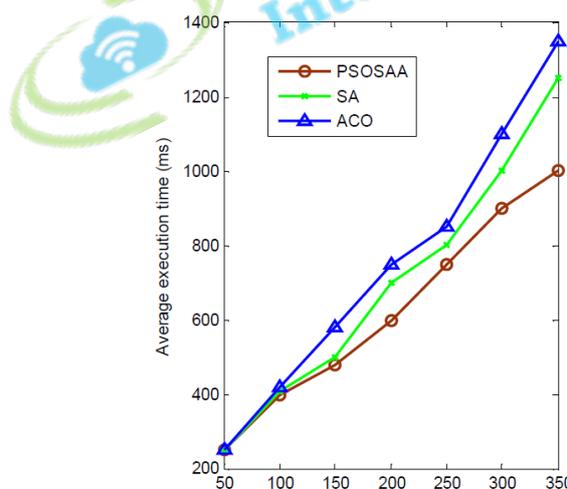

Figure 8. The Average Execution Time

Figure 9 shows the accumulated counts of completed service applications in the form of a comparison among the above three algorithms. We can observe that the algorithm has

better performance than other algorithms. Pointed out that PSOSAA algorithm efficiency is about 50% higher than other algorithms.
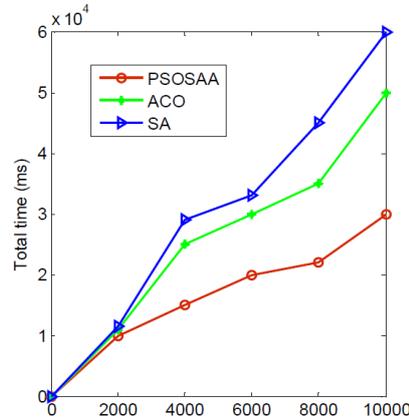

Figure 9. The Comparison of the Completed Service Applications

6. Conclusion and Summary

This paper is focused on the research of the application and implementation of the medical monitoring service based on the Internet of Things (IoT) technique and cloud computing methodology in the hospital information system. Based on the model of medical information remote monitoring cloud platform architecture (RMCPHI) was founded in the first place. Then RMCPHI architecture is analyzed. Finally an efficient PSOSAA algorithm was proposed for the medical monitoring application in the hospital information system. The simulation results show that the proposed algorithm is superior to the analog anneanling algorithm and ant colony optimization algorithm and our proposed scheme can improve the efficiency of about 50%. In the future, we plan to modify our method in the following three aspects: (1) Apply our method to non-coordinate system; (2) Find out more solutions to the scattering and optimization. (3) Conduct more in-depth research on mathematical analysis of our method, [21-29] is our potential research basis.

Acknowledgment

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2015 IEEE International Conference on Services Computing Health Monitoring and Management Using Internet-of-Things (IoT) Sensing with Cloud-based Processing: Opportunities and Challenges Moeen Hassanalieragh∗ , Alex Page∗ , Tolga Soyata∗ , Gaurav Sharma∗ , Mehmet Aktas† , Gonzalo Mateos∗ Burak Kantarci‡ , Silvana Andreescu§ of ECE, † URMC University of Rochester Rochester, NY 14627 {mhassan3,apage4,soyata,sharma,gmateosb}. @ece.rochester.edu Mehmet ∗ Dept. ‡Â
Utilizing a similar cloud based medical data storage, a health monitoring system is presented in [12] in which medical staff can access the stored data online through content service application. Internet of Things is a big science which deals with the collected data, interconnectedness and devices. There are three things which are required in the main process of IoT —. People. Doctors do not require spending much time to understand the medical condition of the patient because they are already aware of the required actions which can save a lot of time and efforts. Manufacturing. The idea behind using IoT tools in the manufacturing industry is to attach sensors to their devices and collect data from customers. Cloud Computing and IoT (Internet of Things) are different technologies. Both of them are providing many facilities in various aspects. IoT is all about connectivity and real-time interactions whereas Cloud computing is about saving data securely on the cloud. The Internet of Things (IoT) describes the connection of devices — any devices — to the internet using embedded software and sensors to communicate, collect and exchange data with one another. With IoT, the world is wide open, offering a virtually endless array of opportunities and connections at home, at work or at play. 2 | Internet of Things — Media & Entertainment. In the sci- classic "The Matrix," the protagonist, played by Keanu Reeves, has the power to manipulate physical objects with his mind. Computing systems/platforms such as enterprise and cloud with real-time processing and data analytics capacity, storage and content delivery, application hosting. Network (connectivity). Internet access: wireless/wired, Wi-Fi, Bluetooth, ZigBee, VPN, Cellular 2G/3G/4G.