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An efficient Session_Weight load balancing and scheduling methodology for high-quality telehealth care service based on WebRTC

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Abstract In the modern life, humans are more interested in their health care; they usually go to the hospital for taking a treatment traditionally, for more convenience, a telecommunication and information technology, telemedicine provide clinical health care at a distance where physicians use email to communicate with patients, order drug prescriptions, and other health services. However, the system is of not much facility in the busy lives nowadays; hence a new telehealth system is recently developed to deliver health-related services and information with one of the most advanced telecommunications technology, WebRTC. Though, we still deal with many problems when the streaming data in some users become big, an existing network structure is susceptible to a large traffic with WebRTC and may cause overloading problems become big streaming data, where data transmits and concentrates on the specific server device in telehealth care service. Thus, we proposed an efficient Session_Weight load balancing

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and scheduling methodology to improve network performance for telehealth care service based on WebRTC. In this, we assign a weight session for each participant in the network, after that, we make a scheduling algorithm for distributing packages aiming to equalize the traffic network. Furthermore, we prove that our proposed methodology has a high-quality performance evaluation of telehealth care service, we also compare both kinds of technique, one is the original WebRTC technology, and another one is the existing WebRTC network with load balancing and scheduling network, which applied Session Weight.

Keywords Telehealth care · WebRTC · Big data · Load balancing · Scheduling · Real-time streaming · Eye tracking

1 Introduction

Nowadays, the majority of people are using the recent development of IT technologies, which help them carry Smart Device and travel around the world with a multimedia service in real time. However, users faced many problems with service providers; each kind of problem depends on their utilization. One of the most common is, with the large volume of traffic surge in the number of servers, users may receive unstable multimedia services. To address these issues, we use the latest technology in the communication WebRTC because of its facilities. WebRTC communication method provides multimedia services in real time anywhere through the Smart Device effortlessly without installing any plug-in. In addition, users can send and receive audio, video data in both directions in real time. The technology solves the problems efficiently and reliably, and also provides diverse multimedia services; because of that, many IT technologies are developed to provide this kind of technology.

In the era of telehealth care system, multitudes of applications have been created to help consumers organize their medical information easily, in one secure place. These digital tools allow them to store health records, upload information from devices, such as a blood glucose monitor or blood pressure cuff, and share information with your health care providers. Even, we have a part of the application which offers personalized reminders and recommendations. Some companies provide their employees access to a collection, or partial, of health care data as a workplace benefit. Devices such as blood pressure monitors can be connected to the internet or to video equipment that allows real-time, face-to-face interaction with health care providers. A home health monitoring system can be particularly useful for people with chronic diseases, for instance heart disease, as well as those who live in rural or remote areas where we have many great conveniences, such as, fewer office visits, and easier access to medical care and advice. Even more exciting is the advent of wearable monitoring systems. These devices are connected through networks to a clinic or monitoring center. It can assess sounds, images, body motion, and vital signs, such as, blood pressure, body temperature, heart rate and pulse, body weight, and blood oxygenation. It can also monitor sleep patterns and physical activity. Thus, doctors can take the advantage of technology to provide better care to their patients. One example is virtual consultations that allow primary care doctors to get input from specialists when they have questions about a particular diagnosis or treatment. The primary care doctor sends test results, X-rays or other images to the specialist to review. The specialist can respond electronically or request a face-to-face meeting if needed. In some cases, the specialist may even "see" the patient via video.

Recent researches [1–3] showed that big data is a process to deliver decision-making insights. The process uses people and technology to quickly analyze large amounts of data of different types (traditional table structured data and unstructured data, such as pictures, video, email, and social media interactions) from a variety of sources to produce inferences that are not discernable from the data when analyzed individually. With the knowledge, clinicians and caregivers can target the patients with personalized treatment plans designed to prevent hospitalization and re-admission by predicting acute medical events such as congestive heart failure. However, it is extremely difficult to design to preserve privacy and satisfy patients' requirements for easy use as well as privacy including opting out. As consumers demand an increasingly personalized or tailored experience, the decisions a company makes about them take center stage. Customer expects the companies with which they interact to know them, to deliver personalized offers and solutions. They expect self-service applications that are likewise tailored, and they are willing to go to competitors or complain if they do not get them. Companies must now engage in a consistent, tailored and appropriate customer dialogue from acquisition to development, retention and beyond.

Many problems of the health care network system have recently addressed to the telehealth care services using WebRTC. In addition, to improve the performance of existing WebRTC Network Load Balancing, we propose the new scheduling method with the analysis of big data for the advantage of telehealth care information service system.

In the structure of the paper, Sect. 2 discusses about big data and introduces WebRTC technology, Sect. 3 describes the proposed method for scheduling and load balancing. Section 4 demonstrates the superiority of the study through a comparative analysis of the proposed new load balancing and scheduling in an existing network and the original WebRTC. Finally, Sect. 5 gives you a conclusion of this paper.

2 Related work

2.1 Telehealth dealing with big data

Along with our development, data sets grow in size in part because they are increasingly being gathered from cheap and numerous information-sensing mobile devices, software logs, cameras, etc. Thus, extracting value from data or predictive analytics are needed for reducing cost, risk or making an operational efficiency.

With a look of big data in [1,2,4,5] showed that by tapping into a large source of patient information, we can transform the telemedicine data, and use those transformed knowledge for providing better quality of telemedicine for users. Telemedicine will have a profound impact on patient care, increases access and quality, and represents an opportunity to keep health care costs down. In the paper, they introduce wearable, from wearable devices to nanotechnologies to self-tests, our life will soon be filled with a plethora of devices that will constantly monitor our health. These devices will constantly generate data that will be collected and analyzed real time. Instead of sampling the data for analysis, systems will detect disease patterns on-the-fly and alert the patient and the doctor at the first sign of an anomaly. The variability of these data will be so great that we will be able to detect differences on how the same disease affects different sub-population and administer the proper medication according to the proper phenotype. Through the use of wireless and nanotechnologies, we will be able to administer the right drug, at the right level, at the right time by virtually eliminating side effects.

Several research groups indicate that modern home telehealth care systems should support patient personalization and context awareness. To deal with the accompanying increased amount of data and complexity processing, a semantic reasoning approach is proposed. So far, there is no practical, system level software architectures proposed to address all related issues within one complete solution. A developed RDF blackboard-based data processing solution for smart home telecare supporting off-the-self reasoning tools and existing ontologies [6,7], was introduced. In their approach, they stress to use real existing ontologies available on the web. That way they can guarantee that correct interpretation of information is always possible for content user (while the correct still remains the responsibility of the user). The proper use of keywords in medical domain is especially important. For example, for "heart rate" there is around 20 different terms in use, some of them are equal while some have specific flavor. Inadequate labeling and late interpretation of sensor signals may lead to critical situations for patients. From the other side, if used ontologies are published and accessible, automated conversion of information is a relatively simple task. The widely accepted good medical taxonomy is SNOMED CT (Systematized Nomenclature of Medicine—Clinical Terms).

A brief introduction about how we can uncover additional value from health information used in health care centers using a new information management approach called as big data analytics is discussed below. Including big data analytics in health sector provides stakeholders with new insights that have the potential to advance personalized care, improve patient outcomes and avoid unnecessary costs [8–12]. The paper defines big data analytics and its characteristics, comments on its advantages and challenges in health care. They use seven types of the health care data which are clinical data, publications, clinical references, genomic data, streamed data, web and social networking data, business, organizational and external data. Based on the discussion of the types, they give us some small example relating to health clinic such as big data analysis (BDA) used for monitoring of disease networking. An example is Google. Org's use of BDA to study the timing and location of search engine queries to predict disease outbreaks. Research shows that one-third of consumers currently use social networking for health care purposes (Facebook, YouTube, blogs, Google, Twitter). As demands for access to health information from social networking sites continue to proliferate, BDA can potentially support key prevention programs such as disease surveillance and outbreak management.

Today 8 % of Canadian babies are born prematurely and internationally the average is 10 %. These early births are responsible for three quarters of all infant deaths in Canada. Premature infants together with ill-term infants are cared for in Neonatal intensive care units (NICUs) internationally containing state-of-the-art medical equipment to monitor and provide life support, resulting in a significant Big Data environment. In addition, graduates of neonatal intensive care may be discharged with medical devices to support continued monitoring as ambulatory patients in and outside the home setting. In both NICU and ambulatory contexts wearable patient monitoring has many social implications. The research in [13–16] presents an assessment of the social implications of big data solutions for critical care within the context of the Artemis project that is enabling big data solutions for: (1) real-time processing of complex, intensive care physiological signals for new and earlier condition onset detection; (2) new approaches to physiological data analysis to support clinical research; and (3) cloud computing/services computing to provide rural and remote communities with greater options for advanced critical care within their own community health care facilities.

Another look of the big data in scripting a health informatics (HI) [17–19] has shown the architecture in HI. At first, they introduce big data and personalized genomic medicine, it is a well-known fact that computing power has dropped the cost of genome sequencing dramatically. But the challenge on how to manage the explosive growth in big data and analytics for health care and life sciences increases. While advertisements from Intel and other information technology (IT) providers may claim that it is now possible for health care providers to offer truly personalized medicine by sequencing the genome of a patient's cancer and so finding the best treatment options for their individual illnesses, the realities on the ground indicate differently. For example, Joe Gray who is the associate director for translational research at the Knight Cancer Institute at the Oregon Health and Science University regarding genetic study of the human cancer acknowledges that part of the excitement in today's study of genomic cancer is because of the ability to optimize treatment for an individual. Gray also expressed the opportunity that exists regarding big data and cancer research.

Later on, a big data and fiscal and clinical issues were proposed with two frameworks. In fiscal framework, the authors claim that fiscal concerns are perhaps the highest factors that are driving the demand for big data applications in health care. Many payors have thus shifted from fee-for-service compensation simply to discourage overutilization. This is because physicians are rewarded for treatment volume, in favor of risk-sharing arrangements that prioritize outcomes. But where the schemes include risk-sharing arrangements that prioritize outcomes, provider compensation may be reduced even when treatments deliver the desired results. Likewise, pharmaceutical companies are negotiating similar agreements with payors where reimbursement is based upon a drug's ability to improve patient health. This new environment, therefore, requires health care stakeholders to have greater incentives to compile and exchange information because of the big data revolution which has descended on health care. First, there is the vastly increased supply of information where during the past decade more pharmaceutical companies have aggregated years of research and development data into medical databases. At the other extreme, both payors and providers aggregated data in the form of digitized patient records. In clinical framework, to derive the benefits of big data, these authors have created five pathways for health care stakeholders that take a more holistic and patient-centric approach to value. The five pathways incorporate benefits to enable health care stakeholders in redefining value (away from focusing solely on cost reduction) and focusing more on the improvement of patient outcome. To this end they have identified tools that are appropriate for the new era that incorporates big data; they are Right living, Right care, Right provider, Right value, and Right innovation.

Finally, they apply BDA in health information system (HIS) by giving us an aspect of big data analytics that include volume, velocity, variation, and veracity.

2.2 Telehealth with infrastructure of network

Existing video conferencing systems that are often used in telehealth services have been criticized for a number of reasons: (a) they are often too expensive to purchase and maintain, (b) they use proprietary technologies that are incompatible to each other, and (c) they require fairly skilled IT personnel to maintain the system. There is a need for less expensive, compatible, and easy-to-use video conferencing system. The web real-time communication (WebRTC) promises to deliver such a solution by enabling web browsers with real-time communications capabilities via simple JavaScript APIs. Utilizing WebRTC, users can conduct video/audio calls and data sharing through web browsers without having to purchase or download extra software. Though the promise and prospective of WebRTC have been agreed on, there have not been many cases of real-life applications (in particular in telehealth) that utilizes the WebRTC. In the paper WebRTC-based video conferencing service for telehealth [20–25], they present their practical experience in the design and implementation of a video conferencing system for telehealth based on WebRTC. Their video conferencing system is a part of a large telehome monitoring project that is being carried out at six locations in five different states in Australia. One of the aims of the project is to evaluate whether high-bandwidth-enabled telehealth services, delivered through telehome monitoring, can be cost effective, and improve health care outcomes and access to care. They also focus on WebRTC-based video conferencing system which allows online meetings between remotely located care coordinators and patients at their home.

Patient outcomes and cost were compared when home health care was delivered by telemedicine or by traditional means for patients receiving skilled nursing care at home. A randomized controlled trial was established using three groups. The first group, control group C, received traditional skilled nursing care at home. The second group, video intervention group V, received traditional skilled nursing care at home and virtual visits using video conferencing technology—WebRTC. The third group, monitoring intervention group M, received traditional skilled nursing care at home, virtual visits using video conferencing technology, and physiologic monitoring for their underlying chronic condition. To improve clinical outcomes at lower cost for home health care [26–30], demonstrated that virtual visits between a skilled home health care nurse and chronically ill patients at home can improve patient outcome at lower cost than traditionally skilled face-to-face home health care visits.

Telemedicine is the process of delivering service and exchanging information related to health care issues across distance. Telemedicine is all about a procedure or system where patients get help from doctors at home. Interaction between the patient and the doctor through different media like audio, video, video call, image and information exchanging by web, mobile and internet technology is also a mean of telemedicine. In the paper [31–33], they present a telemedicine model which is developed in the context of Bangladesh. They have designed the system by taking feedback from people of every profession of Bangladesh. As the poor people are the main sufferer of health-related issues, they have mostly emphasized on the poor thoughts and feedback.

Since the development of information technology, telemedicine has been increasingly important in various medical activities. However, telemedicine application for deep brain stimulation (DBS) has not been sufficiently perceived by the public. In this study, they first made a primary exploration to identify the DBS telehealth requirements. According to their questionnaires, 31 participants (22 patients, 9 neurosurgeons) reported an urgent remote adjustment demand. Teleprogram combined with video communication was a preferred communication pattern. Based on the requirements discovery, [8,33–35] proposed an appropriate interaction mode for DBS remote follow-up. System details were illustrated. Four clinical cases were done in China to test the functionality of the remote monitoring system. The results show the interaction mode is feasible and efficient for DBS postoperative follow-up.

2.3 Scheduling and load balancing in telehealth system

Current trends in both computer networks and home automation domains tend to bring the communications and the interactions between humans and machines to a new paradigm. Every appliance would get the ability to connect with each other's and anybody, from any locations, thus paving the way to increasingly smarter tasks and numerous possibilities. Indeed, demand-response scheme on one hand with the WebRTC framework on the other hand are both promising tools for enhancing every aspect of our daily lives in a greener way. In the paper [36–39], authors introduce a new energy control network as an appliance scheduling algorithm, which relies on WebRTC and virtual appliances to flatten the aggregated energy load curve without compromising user comfort.

With the growing number of commodity devices capable of producing continuous video and audio data streams, the resulting overall data volumes raise challenges with respect to the infrastructure used to process and store them. The future availability of services to automatically aggregate, analyze or relate streams from different sources is desirable. Components of a possible architecture for a large-scale and real-time video processing system were outlined in [40–43]. Furthermore, they introduce the Nephele Livescale Toolkit, which can be used to build real-time video/audio processing data flows for the scalable, data-parallel execution engine Nephele. They also demonstrate the Livescale Toolkit using a data flow that groups and ranks live video streams by geographic origin and video quality in real-time and redistributes them to subscribed clients.

Finally, research in [44–48] shows that telehealth refers to the use of telecommunication technology to remove time and distance barriers in the delivery of health care services. Telehealth can help nurses provide education and counseling, social support, disease monitoring, and disease management reminders to cardiovascular patients in their homes. As a result, patients gain more flexibility in scheduling health care visits, have easier and more convenient access to health care, may have fewer time-demanding clinic visits, receive care in a location that does not require the burden of transportation,

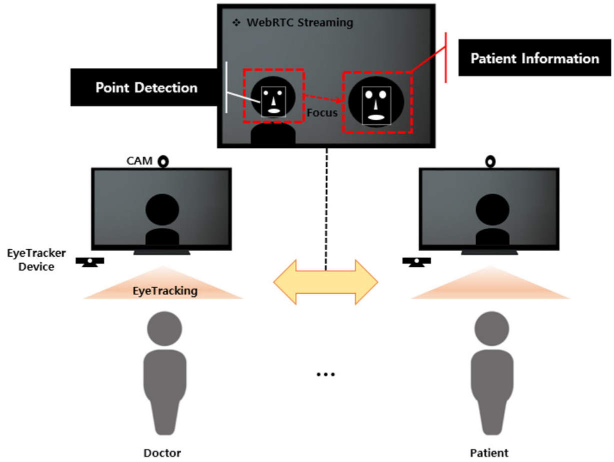


Fig. 1 Overall system architecture

and in an environment that is less threatening than a clinic or emergency department. Cardiovascular health care may be enhanced through diverse telehealth applications, including sensor technology and wearable monitoring systems, internet-based peripheral monitoring devices, videophones, interactive voice response systems, and nanotechnology. Although telehealth enhances care, legal, human, and environmental factors need to be considered before implementing a telehealth program. Additionally, more evidence that is obtained through large multicenter-controlled trials about the potential benefits and cost-effectiveness of telecardiovascular health is needed.

3 Overall system design and construction

In this section, we describe the overall system architecture that we propose to equalize the big streaming data. Figure 1 shows the structure of the entire system. Basically, there are two persons, doctor and patient in the telehealth care system. The doctor and patient send and receive voice and video with each other in both directions through the WebRTC. Assume that the EyeTracker Device tracks the eyes of each user. EyeTracker Device checks users focus state whether concentrate to the part of the user's region, to zoom out the region into a desired size of picture which can help doctors to know the detail of their region of interested. Close-up pictures of the last segment region show the area information of the analyzed patients with big data. This studied also improve the performance of the existing WebRTC streaming network.

Section 3.1 describes and explains its domain detection method for WebRTC structure, Sect. 3.2 shows the method to improve the performance of an existing network through Load Balancing and Scheduling WebRTC. Section 3.3 in this study explains how to take advantage of the BigData.

3.1 Face recognition using WebRTC

WebRTC sends and receives real-time voice and video in both directions without installing any plug-ins for Web Browser. Figure 2 shows the structure of WebRTC in this study. WebRTC is divided into Browser, App Engine, and Web Server. When a user is connected via a Browser, signaling will produce or create the connection to the Web Server. Signaling is the process for establishing user's connection, opening and closing a communication control message, to send and receive codec, bandwidth, IP address, etc. WebRTC API provides the MediaStream, RTCPeerConnection, RTCDataChannel. MediaStream is a function for synchronizing the video, the media stream gets the sound from the user's Cam and Mic, RTCPeerConnection encrypts, and manages the bandwidth, those WebRTC components manage stably the user's voice and the video data. Finally, the RTCDataChannel in WebRTC transfers data quickly and directly with the underlying network P2P connection between users possibly.

Figure 3 shows a flow chart for a connection between users in WebRTC process. The PeerConnection will check after passing the course signaling. If the check is successful, the user is connected directly to the data but, if it fails, the server will rely on users TURN to receive data.

We use the face tracker API for the detection of patient area. Figure 4 shows a state that patient face is detected using Face Tracker API which was implemented in

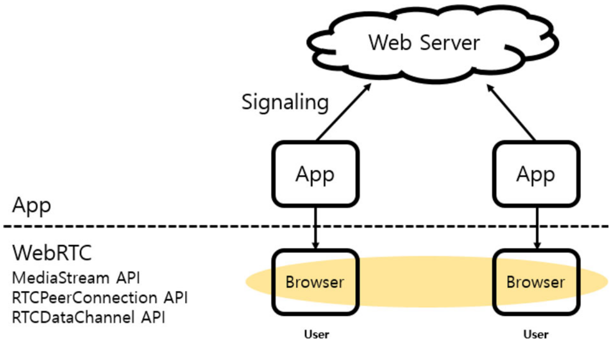
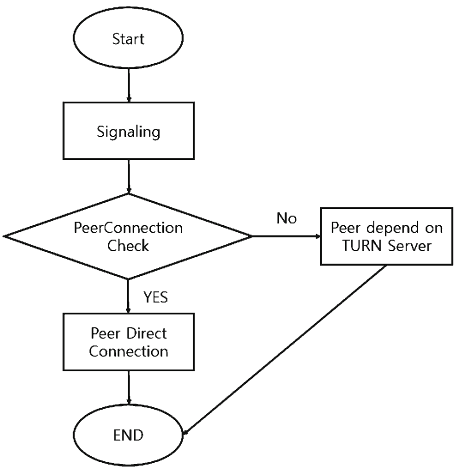


Fig. 2 WebRTC system architecture

Fig. 3 Peer connection flow



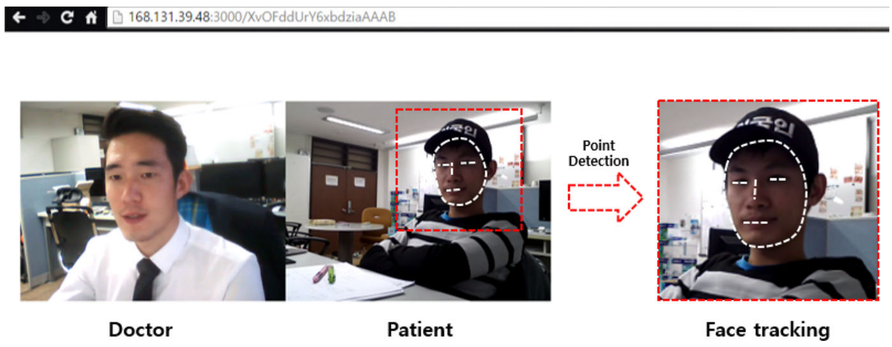


Fig. 4 WebRTC simulation and face tracking

the browser along with webRTC. The highlighting portion of specific area determines through the matrix of pixels in Eq. (1) and face tracker API. Also face, eyes, nose and mouth can be emphasized in the areas corresponding to what doctor wants to see. Through the video doctor can highlight the patient's faces as well as can find in the details of eyes, nose, mouth, etc. As a result, the doctor can examine the patient more closely.

$$\begin{bmatrix} A_{11} & \cdots & A_{1J} \\ \vdots & \ddots & \vdots \\ A_{I1} & \cdots & A_{IJ} \end{bmatrix} \tag{1}$$

3.2 Load balancing and scheduling network for improved performance

Load balancing across multiple servers to reduce the server's overloaded by distributing the load to other users. We studied how to load balance with the *Session_Weight* of the user PC and the role of each server to enhance the performance of the existing P2P network WebRTC. The user sends and receives data via the P2P system with many users using WebRTC. In the sending and receiving data process User-PC has a session with other users for exchanging traffic packages. Assuming that, S_{total} represents the total number associated with the session User-PC using the present WebRTC, T_{total} represents the total traffic. Dividing the total traffic by the total number of User-PC, we will have an average T_{avg} within the network. We seek *Session_Weight[i]* multiplied by the number of sessions S_i and the T_{avg} connected to each User-PC.

$$S_{\text{total}} = \sum_{i=1}^{n} S_i \tag{2}$$

$$T_{\text{total}} = \sum_{i=1}^{n} T_i \tag{3}$$

$$T_{\text{avg}} = \frac{T_{\text{total}}}{n} \tag{4}$$

$$Session\_Weight\,[i] = \sum_{i=1}^{n} S_i \times T_{\text{avg}} \tag{5}$$

In Algorithm 1, the weight assigned for each User-PC *Session_Weight [i]* is shown with a method for efficient dispersing.

Algorithm 1 Session and Weight Load Balancing Algorithm

```
for Num = 1 to Server_Number do
  Session_Weight[Num] = Server_Number_Session_weight
end for
for Num = 1 to Server_Number do
  temp = Session_Weight[Num]
  j = Num-1
  while (j > 0 && Session_Weight[j] > temp)
    Session [j+1] = Session_Weight[j]
    j=j-1
  end while
  Session_ Weight[j+1] = temp
end for
for Num = 1 to Server_Number do
  Session_Weight[Num] = Num
end for
```

Implementation process for the Session and Weight Load Balancing Algorithm:

1. Stores *Session_Weight[i]* of each User-PC.
2. *Session_Weight[i]* are sorted in ascending order using a temp variable.
3. *Session_Weight[i]* are sorted in the order in which they shall be given a number.

Algorithm 1 shows the process of reducing the overload of the server where traffic is concentrated in one place. The following Algorithm 2 shows a Round Robin Scheduling Algorithm which uses season weight for transmitting user data efficiently.

Algorithm 2 Session and Weight Round Robin Scheduling Algorithm

```
for Num = 1 to Server_Number do
  Session_Weight[Num] = Server_Number_Session_Weight
end for
for Num = 1 to Server_Number do
  temp = Session_Weight[Num]
  j = Num-1
  while (j > 0 && Session_Weight[j] > temp)
    Session [j+1] = Session_Weight[j]
    j=j-1
  end while
  Session_Weight[j+1] = temp
end for
for Num = 1 to Server_Number do
Total_Session_Weight += Session_Weight[Num]
end for
```

Implementation process for the Session and Weight Round Robin Scheduling Algorithm:

1. Stores *Session_Weight[i]* of each User-PC.
2. *Session_Weight[i]* are sorted in ascending order using a temp variable.
3. *Total_Session_Weight* is obtained through the sum of the aligned *Session_Weight [i]*.

$$PM\_Traffic = \frac{Toral\_Session\_Weight}{Server\_Number} \times \text{F}ixed\ Time\ Slice\ Length \tag{6}$$

$$Total\_PM\_Traffic = \sum_{i=1}^{n} PM\_Traffic_i \tag{7}$$

PM_Traffic of the formula (6) is the amount of data transmitted individually according to the weight of the User-PC. *Total_PM_Traffic* shows the sum of the transmitted *PM_Traffic*.

3.3 Patient information provision method using big data

In the modern life, we are more concerned about our health. Thus, many service providers are improving their quality services. They are not only concentrating on each individual, they also concentrate on the relationship between the one who related to their patients. Each individual has their own record in service provider aiming to predict or diagnose a disease; many wearable devices were used for patients' convenience, but also can get data daily in the case of dangerous disease such as cardiovascular, respiratory diseases; or the analyzing of hereditary for next generation. Thus, the data of those records become big for processing.

In the Fig. 5 shows that data are collected from user with various kinds by Service provider. The service itself contains a complex system for storing, securing and analyzing those big data from thousands of users. The data are mining and giving a clinical decision to health care professional. Finally, the personalized health care is provided appropriately for users.

In the database, it stores lots of data which gets from each part of the human body. It also stores the details of prescription, diseases which patients have taken in their life.

All information of each part about our body is saved separately in each database table. In Fig. 6 is shown an example of our body part such as Head, Chin, Breast, Knee, and Foot. But in the real, the system may be more complex due to the specification of the system health care. For example, a specialist can take care of your disease if he knows the details about your illness.

4 Experiment result using load balancing and scheduling

In this Sect. 4, we experiment the performance of existing WebRTC Network Load Balancing and Scheduling through experiments and analysis.

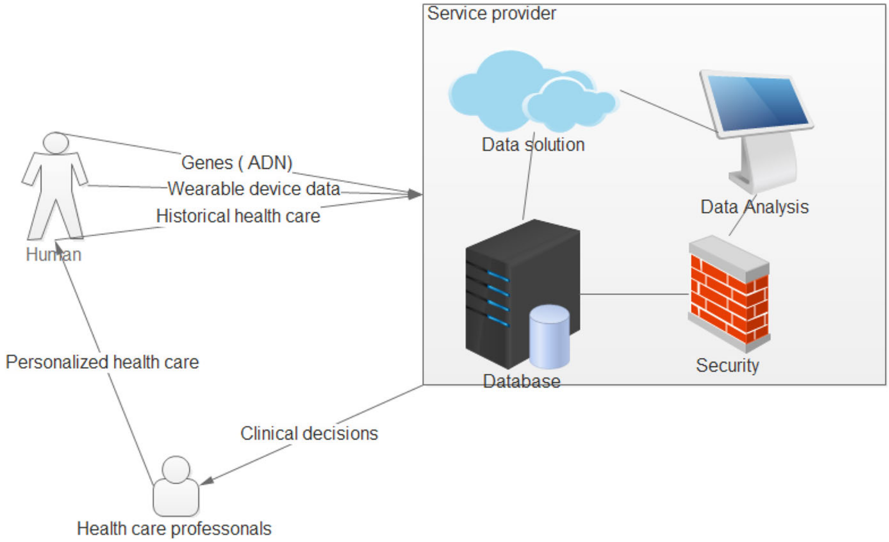
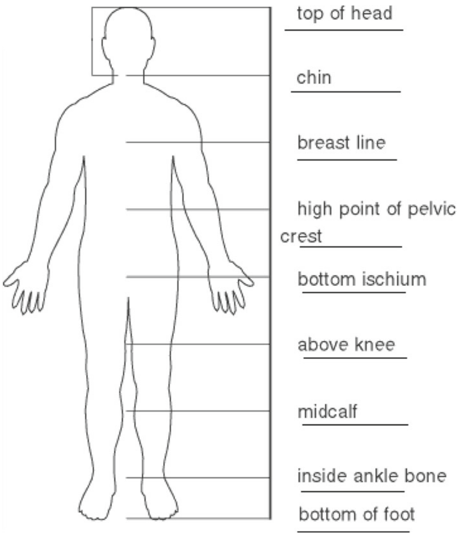


Fig. 5 Data collection

Fig. 6 Dividing data from human body



First load balancing is set so as to generate traffic of 1.024 bps on average from three users. Then, Load Balancing is set more than 3072 bps for each user, thus, the traffic from these users can handle if the rate of traffic generation should be set to 10 kbps, and the traffic generation time is set from 10.0 to 1000.0 s.

Figure 7a shows a single user in the three users can see if a large amount of traffic is generated. Blue Line has been generating more traffic than the Red Line and the Green Line. Figure 7b shows the transfer data to receive the user's Delay Time. The Red Line and the Green Line Delay Time are reduced, meanwhile Blue Line is increased.

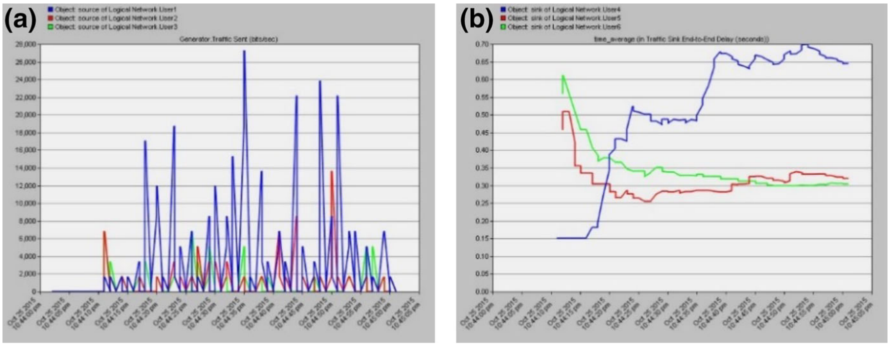


Fig. 7 Existing WebRTC network, **a** the traffic received (bits/s), **b** the end-to-end delay (s)

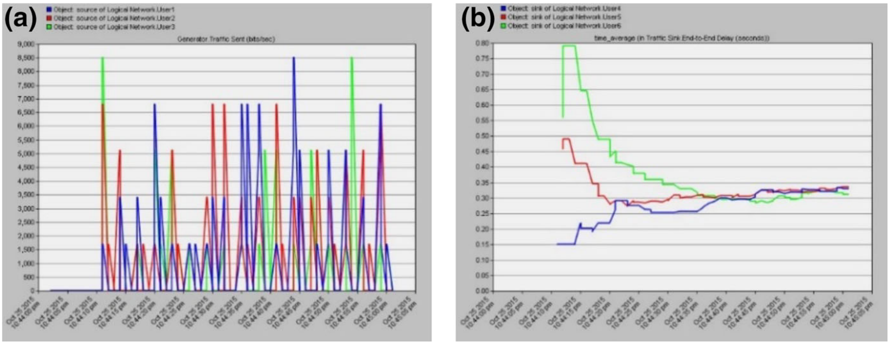


Fig. 8 The proposed load balancing methods, **a** the traffic received (bits/s), **b** end-to-end delay (s)

Figure 8 shows the proposed Load Balancing method that we have described in the Load Balancing Algorithm Sect. 3.2. (a) It shows an even traffic is generated. Figure 7a is concentrated on a server at one time, Fig. 8a shows the distribution of three servers. Also shown in Fig. 8b shows that the Delay Time constant also decreases.

The following Experiments show the analyzed proposed Scheduling. The average user's server for Scheduling of traffic shall be set to 1.024 bps. In addition, the data processing speed ensures that the generated traffic is properly delivered to the destination if it is set to 3072 bps. Traffic generation time is set from 10.0 to 1000.0 s.

In Fig. 9, we use the conventional way of the Round Robin Scheduling. It shows a picture with equal data in a time sharing manner in the Round Robin. The Scheduler allows the processing of data sent equally from the three user-servers. It also shows the Queuing Delay time, and Timeshares are treated equally and in a manner so it gets less influence from other servers.

Figure 10 shows the appearance of the proposed method which applied Session_Weight_Round Robin Scheduling. (a) The graph of the Blue Line and Red Line has higher *Session_Weight* than *Session_Weight* of Green line, thus data transmit to the user is affected by the season. In addition, at the picture (b) the approach of Round Robin is applied in the Scheduler without affecting the time delay, which is shown

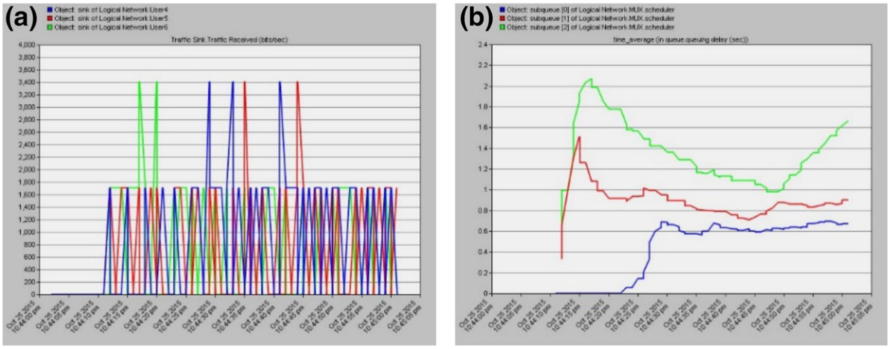


Fig. 9 Round Robin scheduling conventional method, **a** shows traffic received (bits/s), **b** a queuing delay (s)

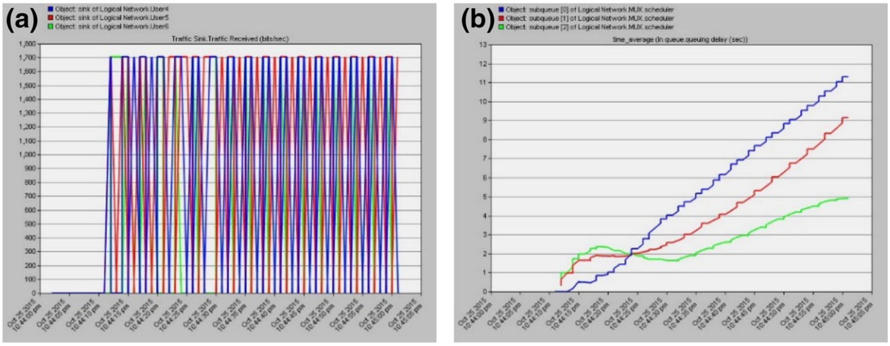


Fig. 10 Proposed Session_Weight_Round Robin scheduling method, **a** shows traffic received (bits/s), **b** a queuing delay (s)

in Blue Line, Red Line and Green Line. As a result, the user can receive data in an efficient and reliable manner.

5 Conclusion

In this paper, we have presented Session_Weight load balancing and scheduling to improve performance of telehealth care service based on WebRTC. When the existing WebRTC network system is overloaded on the server by big streaming video, the user is hard to gain a good service. Our session weight load balancing and scheduling methodologies provide the best possible streaming service to users of the telehealth care service based on WebRTC.

Using the proposed methodology, we have evaluated the network performance. We have shown that existing WebRTC network applied to session weight load balancing and scheduling has proven its superiority in most of the cases. We also improved the performance of the existing WebRTC network through our methodology. Therefore, users can take advantage of the reliable and efficient telehealth care service based on

WebRTC. Finally, the results from the experiment section in this research demonstrated the superiority of the method.

In the future, we will research if the operational focus of the telehealth care system has actually linked to the human eye through the EyeTracker Device.

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References

1. Bauch N (2015) 9 Bodies in the cloud: a geography of electronic health data. Regulating the cloud: policy for computing infrastructure, p 257
2. Dubey H, Yang J, Constant N, Amiri AM, Yang Q, Makodiya K (2015) Fog Data: enhancing telehealth big data through fog computing. Proc ASE BigData SocialInf 2015:14
3. Mockus A (2014) Engineering big data solutions. In: Proceedings of the on future of software engineering, pp 85–99
4. Coakley M, Crocetti G, Dressner P, Kellum W, Lamin T (2015) Transforming telemedicine through big data analytics. arXiv preprint arXiv:1505.06967
5. Ranjan R, Georgakopoulos D, Wang L (2015) A note on software tools and technologies for delivering smart media-optimized big data applications in the cloud. Computing 1–5
6. Kuusik A, Reilent E, Loobas I, Parve M (2011) Software architecture for modern telehealth care systems. Adv Inf Sci Serv Sci 3(2)
7. Stamm BH (1998) Clinical applications of telehealth in mental health care. Prof Psych Res Pract 29(6):536
8. Priyanka K, Kulennavar N (2014) A survey on Big Data analytics in health care. Int J Comput SciI Inf Technol 5(4):5865–5868
9. Noel HC, Vogel DC, Erdos JJ, Cornwall D, Levin F (2004) Home telehealth reduces healthcare costs. Telemed J E-Health 10(2):170–183
10. Hersh WR (2014) Healthcare data analytics. Health informatics: practical guide for healthcare
11. Paez DG, Aparicio F, de Buenaga M, Ascanio JR (2014) Big data and IoT for chronic patients monitoring. In: Ubiquitous computing and ambient intelligence. Personalisation and user adapted services, pp 416–423
12. Belle A, Thiagarajan R, Soroushmehr SM, Navidi F, Beard DA, Najarian K (2015) Big data analytics in healthcare. BioMed Res Int
13. McGregor C (2013) Wearable monitors on babies: big data saving little people. In: 2013 IEEE International Symposium on Technology and Society (ISTAS), Toronto, ON. IEEE. doi:10.1109/ISTAS.2013.6613120
14. Keh H-C, Hui L, Chou K-Y, Cheng Y-C, Yu P-Y, Huang N-C (2014) Big data generation: application of mobile healthcare. In: Trends and applications in knowledge discovery and data mining, pp 735–743
15. Li SJ, Te He W, Wang XB, Shi T (2015) Collaborative filtering algorithm for recommendation system of improvement based on big data environment. Appl Mech Mater 736:189–195
16. McAfee A, Brynjolfsson E, Davenport TH, Patil DJ, Barton D (2012) Big data. The management revolution. Harvard Bus Rev 90(10):61–67
17. Onyejekwe ER (2014) Big data in health informatics architecture. In: 2014 IEEE/ACM international conference on advances in social networks analysis and mining (ASONAM), pp 728–736
18. Payakachat N, Tilford JM, Ungar WJ (2015) National database for autism research (NDAR): big data opportunities for health services research and health technology assessment. PharmacoEconomics 1–12
19. Doswell JT (2015) Artificial intelligent psychological counselors for home accessible mental telehealth. In: 142nd APHA annual meeting and exposition APHA
20. Jang-Jaccard J, Nepal S, Celler B, Yan B (2014) WebRTC-based video conferencing service for telehealth. Computing 1–25
21. Barnett TE, Chumbler NR, Bruce Vogel W, Beyth RJ, Haijing Qin, Rita Kobb (2006) The effectiveness of a care coordination home telehealth program for veterans with diabetes mellitus: a 2-year follow-up. Am J Manag Care 12(8):467

22. Wilson LS, Stevenson DR, Cregan P (2010) Telehealth on advanced networks. Telemed e-Health 16(1):69–79
23. Pickard KT, Swan M (2014) Big desire to share big health data: a shift in consumer attitudes toward personal health information. In: 2014 AAAI Spring Symposium Series
24. Mukherjee A, Pal A, Misra P (2012) Data analytics in ubiquitous sensor-based health information systems. In: Next generation mobile applications, services and technologies (NGMAST), 2012 6th international conference on, pp 193–198
25. Nelson R, Staggers N (2013) Health informatics: An interprofessional approach. Elsevier Health Sciences, USA
26. Finkelstein SM, Speedie SM, Potthoff S (2006) Home telehealth improves clinical outcomes at lower cost for home healthcare. Telemed J e-Health 12(2):128–136
27. Nickelson DW (1998) Telehealth and the evolving health care system: strategic opportunities for professional psychology. Prof Psychol Res Pract 29(6):527
28. Brownstein JS, Freifeld CC, Madoff LC (2009) Digital disease detection harnessing the Web for public health surveillance. N Engl J Med 360(21):2153–2157
29. Vuononvirta T et al (2011) The compatibility of telehealth with health-care delivery. J Telemed Telecare 17(4):190–194
30. Darkins A, Ryan P, Kobb R, Foster L, Edmonson E, Wakefield B, Lancaster AE (2008) Care Coordination/Home Telehealth: the systematic implementation of health informatics, home telehealth, and disease management to support the care of veteran patients with chronic conditions. Telemed e-Health 14(10):1118–1126
31. Yasir R, Nibir SI, Chadni ZA, Ahmed N (2015) Telemedicine system for financially unstable people of Bangladesh. J Modern Sci Technol 3(1)
32. Gagnon M-P, Duplantie J, Fortin J-P, Landry R (2006) Implementing telehealth to support medical practice in rural/remote regions: what are the conditions for success 1(1):18
33. Granda JC, Nuno P, Suarez FJ, Garcia DF (2015) Overlay network based on WebRTC for interactive multimedia communications. In: Computer, information and telecommunication systems (CITS), 2015 international conference on, pp 1–5
34. Chen Y, Hao H, Chen H, Li L (2015) The study on a telemedicine interaction mode for Deep Brain Stimulation postoperative follow-up. In: Engineering in medicine and biology society (EMBC), 2015 37th annual international conference of the IEEE, pp 186–189
35. Keen J, Calinescu R, Paige R, Rooksby J (2013) Big data+ politics= open data: the case of health care data in England. Policy Internet 5(2):228–243
36. Thieffry J, Yamamoto S, Okamoto S, Yamanaka N. A virtual P2P energy management network based on direct-load control for the smart-grids
37. Kornak J (2016) System requirements for delivery of telemedicine services. In: Telemanagement of inflammatory bowel disease, pp 117–151
38. Ly SM (2015) Improving HIV-AIDS treatment and adherence through telemedicine
39. DelliFraine JL, Dansky KH (2008) Home-based telehealth: a review and meta-analysis. J Telemed Telecare 14(2):62–66
40. Lohrmann B, Kao O (2013) The Nephele livescale toolkit: real-time video stream processing at scale. In: Proc. of the 20th international packet video workshop-posters track, IEEE, San Jose
41. Chan DS, Callahan CW, Sheets SJ, Moreno CN, Malone Francis J (2003) An Internet-based store-and-forward video home telehealth system for improving asthma outcomes in children. Am J Health Syst Pharm 60(19):1976–1981
42. Hensel BK, Demiris G, Courtney KL (2006) Defining obtrusiveness in home telehealth technologies. J Am Med Inf Assoc 13(4):428–431
43. Polisena J, Tran K, Cimon K, Hutton B, McGill S, Palmer K, Scott RE (2010) Home telehealth for chronic obstructive pulmonary disease: a systematic review and meta-analysis. J Telemed Telecare 16(3):120–127
44. Nancy T (2007) Telehealth as a tool for enhancing care for patients with cardiovascular disease. J Cardiovasc Nurs 22(1):25–31
45. Ochian A, Suciu G, Fratu O, Voicu C, Suciu V (2014) An overview of cloud middleware services for interconnection of healthcare platforms. In: Communications (COMM), 2014 10th international conference on, pp 1–4
46. Al-Majeed SS, Al-Mejibli IS, Karam J (2015) Home telehealth by Internet of Things (IoT). In: Electrical and computer engineering (CCECE), 2015 IEEE 28th Canadian conference on, pp 609–613

47. Ding X, Ren H, Gan Y (2013) Method and apparatus of WebRTC media control. U.S. Patent Application 14/137,322
48. Holmberg H-C (2015) Web real-time data transport: WebRTC data channels