

Using Image Processing Technique for Supporting Healthcare Workers in Collaborative Works

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Abstract. Collaborative work is an activity done by more than one person to get a job done. For healthcare workers, several jobs are considered as collaborative work such as consulting or diagnosis. In this study, medical images were used as the objects manipulated by physicians at different locations. They could manipulate and provide comments or opinions to each other during collaborative sessions which included time proximity: at the same time or at different time. The system composed of application program for managing collaboration and image processing functions. Two case studies have been done on analysis of tumor and diabetic retinopathy. The first case dealt with real-time collaboration at different locations while the second case dealt with different time collaboration.

Keywords: Collaborative work · Medical image · Processing · Healthcare worker

1 Introduction

Collaboration is an act of someone working with other people on a joint project. In real life, there are two kinds of job achievement i.e. by doing it alone or having other people to help or participate with. Actually, using software to get a job done by more than one person may require an enhancement of tool or software that one person uses to do their job to a tool that support more than one person to do the job together. Decision making, for example, starts with having a decision support system (DSS) for one decision maker and later when there are situations that the decisions have to come from a group of people, the board or committee for example, a group decision support system (GDSS) is then introduced [1, 2].

In order to be able to collaborate for decision making, the number of people involved are not the only matter, the tool for supporting collaboration is also important as well. To set up a tool, there is also the proximity for time and space involved. For the time, it can be at the same time or different time while space can be in the same place or different place [2]. The combination of time and space that will be benefit from using software for collaboration are two cases. For the first case, users are in different location

and they use the system at the same time. This means that they have to set the schedule to use the system. The second case is the situation that users are in different locations and they use the system at different time. If this tool is used in healthcare unit such as hospital, the staff at different hospitals can have a floor for the diagnosis without any needs to travel.

When we focus on the use of computer applications in healthcare organization such as hospital, there are several examples including the information system that are based on healthcare information, decision support and quality assurance [3]. For healthcare, decision making is more complicated than others, so information and tools to support the decision must be accurate and easy to work with.

Nowadays, medical Imaging plays the key role in helping physicians diagnose and make decision to treat the patients. We can have the digital images of the patients from X-rays machine, Computed Tomography (CT) Scanner and MRI (Magnetic Resonance Imaging) machine. Interpreting those images may need some experts or someone with more experience to consult with, especially in an unusual case. With the advance in telecommunication network, transferring images from one location to others for discussion or consultation may not be a problem. It would be more useful if the image can be manipulated by healthcare workers at different sites in consulting session.

Since there are many types of images that are related to health information and the use of those images should be analyzed and discussed by more than one expert in the field for accurate result, there should be a tool to support real time collaborative work for problem solving, decision making or consulting in healthcare.

In this research we are interested in setting up a software program to help healthcare worker in one location to collaborate in real time with experts from other locations for decision making using information gathered from medical image processing. Users can use the program to analyze medical images acquired from CT scanner, MRI machine or any devices that provide digital image for specific purposes which would benefit in decision making and all the visual images can be shared amongst experts in real time.

2 Related Works

There are several papers on the use of computer for collaborative works in many areas such as in education [4–6], government services [7] and healthcare [3, 8, 9]. In education, collaborative learning is implemented in different ways [4, 6]. By using the internet, the community of learners could be constructed and applications were implemented to support distance learning especially web-based applications like chat rooms, blogs, wikis. For government service such as transportation, the use of computer in the collaborative works have been implemented as a training tool for transportation teams to practice on how they should response in emergency events [7]. The computer-based system provided the team with the drills for different situations with details like daily traffic situations and unusual situations. In healthcare, when computers were used in hospital units such as patient wards, laboratories, and departments,

computerized data were every where. Now, global computer network makes it possible to connect with external units such as patient residents and other hospitals [3, 9].

With the advance in technology, especially computer graphics, all the new scanning machine for healthcare have a digital output, making them easy to process. Right now there are many software tools which can speed up and enhance the operation of the analysis of medical image. Fifteen of these software programs were compared in several aspects such as function, system language, platform and etc. [10]. Some researchers emphasized on finding new algorithm that could be used in image processing such as image reconstruction, image enhancement, image smoothing and etc. [11] While other used parallel algorithm for tumor edge detection which could detect cancer tumor at early stage [12]. Methods and algorithm for detecting different categories of cancer such as breast, liver and brain tumor were also investigated [13]. The methods used were, a restively loaded bowtie antenna with genetic algorithm approach, FPGA (Field programmable Gate Array) - 3-D Ultrasound computer tomography with adapted matched filtering algorithm, in pentetreotide SPECT-A Collimator based on Monte Carlo simulation, and Cellular automata (CA) based segmentation method – MR (Magnetic Resonance) Images.

3 Use of Medical Image Processing in Collaborative Works

Medical images are usually used for radiographic technique in diagnosis, clinical studies and treatment planning, so it is quite important to life and death situation. Today with the advance in the field of computerized image processing and digital equipment, all the medical imaging system such as X-Ray, Computer Tomography (CT), Magnetic Resonance Imaging (MRI) and etc. provide the output in a digital form, making them easy for transferring and interpreting. When interpreting the data, sometimes the physicians rely more on their experiences than the output from the machine. The decision may come from one physician or from a group of physicians which means that they might prefer to get some help or opinions from others. For example, two dimensional images from the imaging devices may look unclear or may have some suspicious points to be considered, if there are some collaboration process before progressing into the next step of processing, the decision may be more reliable. Figure 1 shows the flow chart of the process.

3.1 Experimental Setup

In order to test the concept that collaboration in healthcare for real time decision making using medical image processing can be done for users who are in different places, we have developed the software applications to support the work flow shown in Fig. 1. This software was installed in a server which acted like a host for the system where users could join in and behaved like clients.

In real life situation, MRI digital images from local hospital can be diagnosed by the physicians at the hospital or with the help of experts or other physicians at that

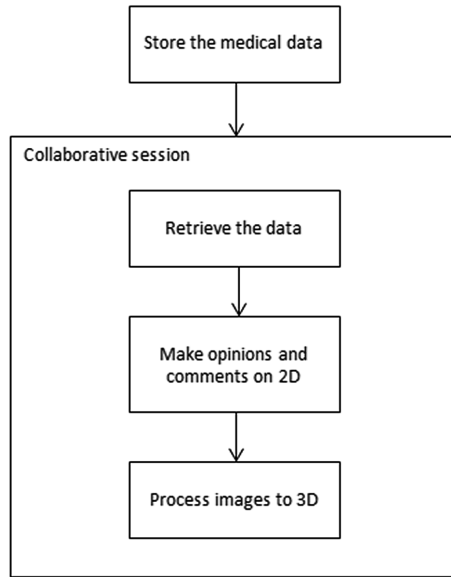


Fig. 1. Flow chart of the collaborative session

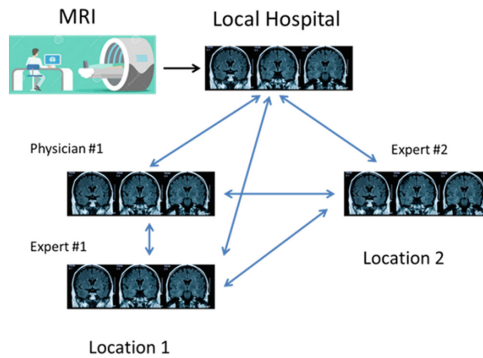


Fig. 2. Flow of medical image to and from experts

hospital or experts somewhere else. If the decision did not need real time analysis, then each person can get the image by mail or by other means. If the decision must be in real time, video conferences may help. In the case that images need to be manipulated by someone or everyone before making any decisions, then we have to create a new application to support these activities. Figure 2 shows how each person interacts with the image.

The hardware requirements for this setup were one standard server attached to local

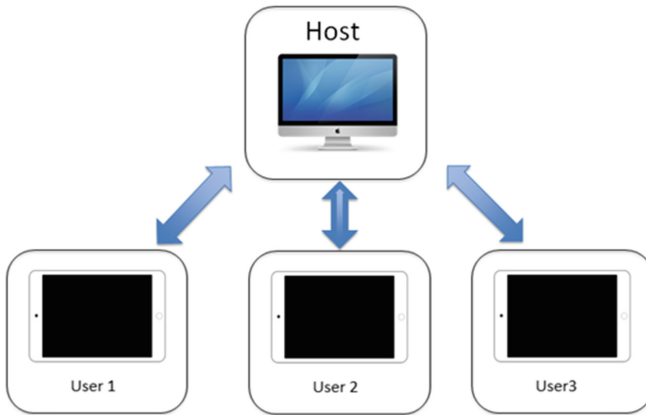


Fig. 3. System setup for collaboration

area network and few clients which could be tablets or laptop computers. The only condition was that all of them must be in the same network. The system flowchart is shown in Fig. 3.

3.2 Software Development

For healthcare collaboration in which real time decision making on medical image is required, the software should support the users to work on the same image at the same time. For example, all three users would like to discuss about the tumor on the same image, they can mark on the tumor, paint them with different color and etc. Few properties of the software are as following:

- Basic functions for image processing such as image enhancement, edge detection, segmentation an etc.
- 2D image from medical imaging devices can be stored and retrieved to display on each users screen.
- Manipulation on each screen can be done and image on each screen can be saved as individual or can be accumulated to new image under assigned condition.
- Information related to the same image that has been evaluated can be analyzed and can be used to formed 3D image.
- 3D image that has been created can be transformed i.e. rotate, translate, enlarge and etc.
- Manipulated Image by different techniques or different users can be compared.

The user interfaced and menu for the program are shown in Fig. 4.

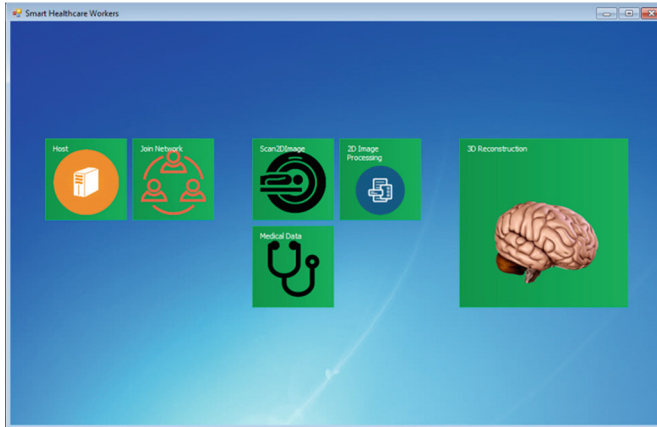


Fig. 4. User interface and menu for the collaborative software.

4 Case Study 1: Collaborative in Brain Cancer Diagnostics Using Image from CT Scan

Usually, visualization of human tumor can be done by analyzing the cross sectional image of the human body from CT scanner in the suspicious area. CT is the abbreviation for computed tomography or computerized tomography that will provide the cross-sectional images of human body. Analyzing the tumor for its shape or whether it is cancer tumor or not sometimes need more than one physician opinion. Figure 5 shows the conceptual framework of collaborate physicians analyzing the CT image of a brain cancer patient.

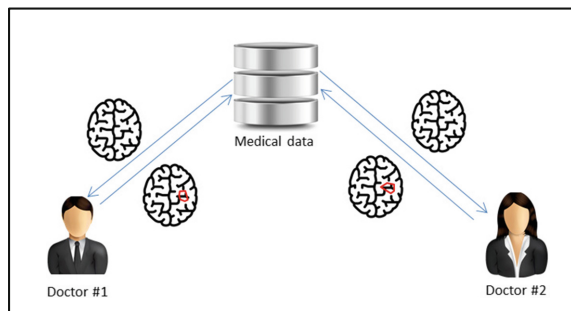


Fig. 5. Conceptual framework for physicians collaboration

In order to prove whether collaboration can be applied to the image processing analysis, we have set up the experiment using modified image from CT scanner and then stored in our program. We proposed that two users (physicians or experts) helping each other to estimate the size and shape of the tumor. With the help of the software

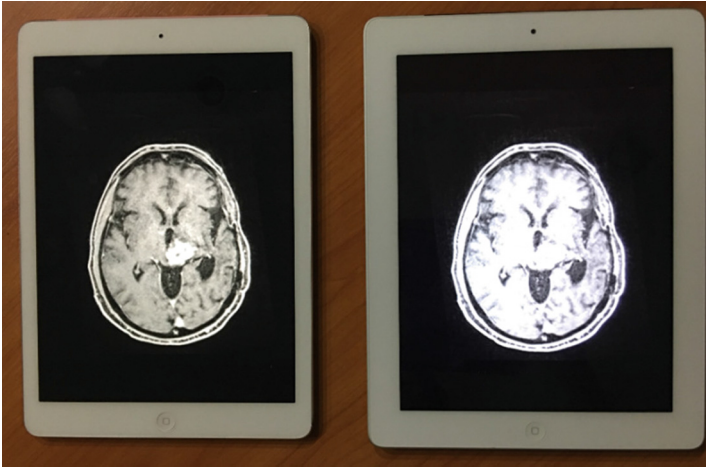


Fig. 6. Image from CT scanner showing the suspicious part to be identified

functions, the image has been enhanced and the shape of 2D tumor cells could be seen easily on each user's iPads in Fig. 6.

In real life, the machine can only differentiate the objects under conditions that we have created, so there is a room for skill physician to make different opinions. In this case, these two experts may identify the boundary of the tumor differently and the shape may be different from the machine proposed. Figure 7 shows how the two physicians identified the boundary of the tumor differently.

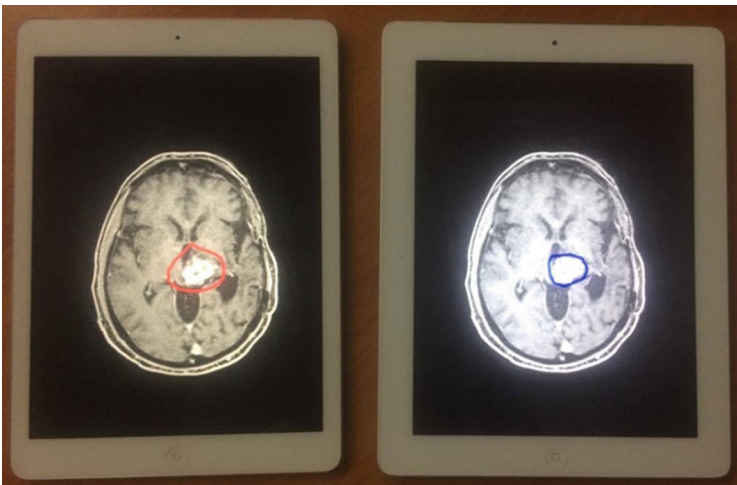


Fig. 7. Two physicians identify the boundary of the tumor differently

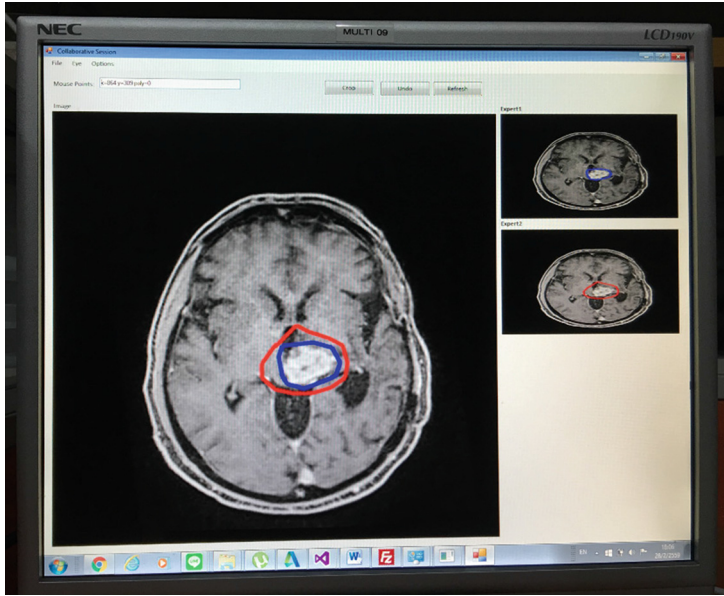


Fig. 8. Accumulation of two images from two experts

By accumulating all the new boundaries of the tumor from 2D CT layers images (Fig. 8), the program could put them together and construct them into a 3D image as shown in Fig. 9.

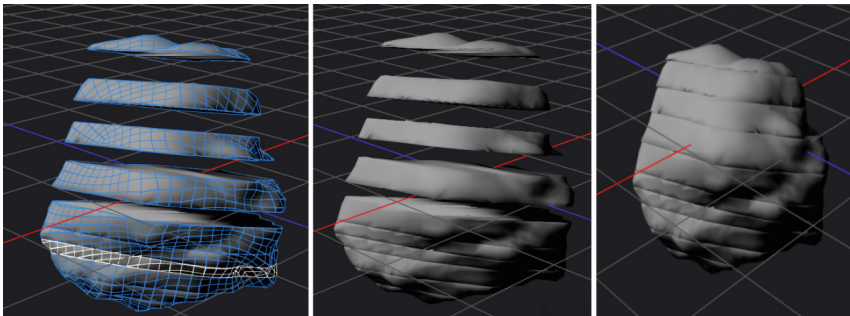


Fig. 9. Using 3D construction function, 3D tumor cell can be constructed

5 Case Study 2: Detection of Diabetic Retinopathy

Diabetic retinopathy is the leading cause of new blindness in diabetic patients. The exact mechanism by which diabetes causes retinopathy remains unclear, but if it is detected in early stage, treatment can be provided to save the vision. In the initial stages

of diabetic retinopathy, red dots caused by the breakdown of blood vessels appears in the superficial retinal layers of the patients. If these dots or hemorrhages can be detected and identified using image processing and collaborative technique, then treatment can be provided. Figure 10 shows the initial sign of the symptom compares to the normal one.

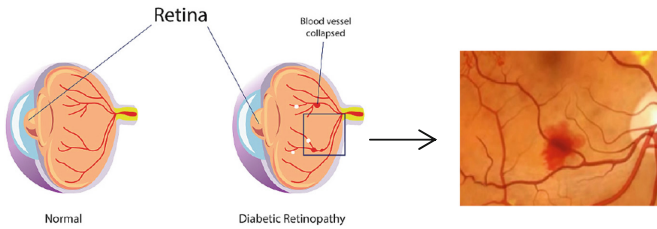


Fig. 10. Diabetic retinopathy compare to the normal one (Color figure online)

Since the dot is very small at the early stage, identifying them is very difficult. Using the software to process the image and then by consulting with experts using collaborative function, the diagnostic result should be more accurate than by one judgment.

Figure 11 shows the retina images before and after processing in which we could see the dots and blobs clearly and experts can identify them whether the patients has Diabetic Retinopathy or not.

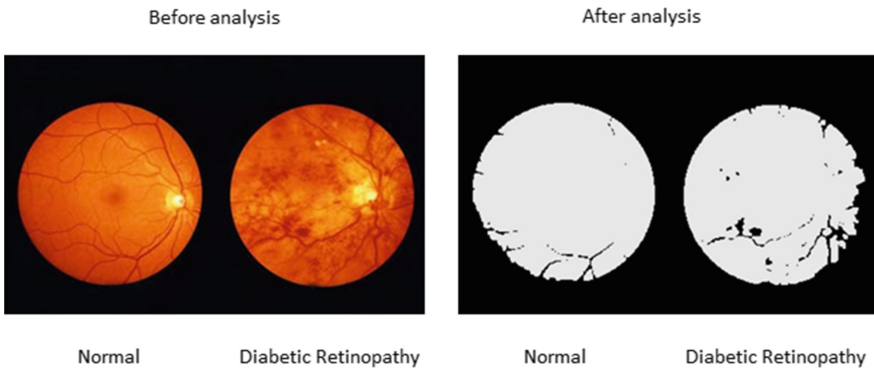


Fig. 11. The retina images before and after processing

6 Result and Discussion

In the first case study, by implementing our system to help identifying the location and shape of the tumor, each user (medical doctor or expert) could identify the parts that they considered as tumor. The system would collect all the information that each user

provided such as the boundaries of the tumor, the remarks and etc. and then put them together to form the results, which in this case was the shape of the tumor. This kind of collaboration will help the workers in identifying uncertain areas and providing more accurate result. In the second case study, users could manipulate retinal images and processed them so that all the red dots caused by the breakdown of blood vessels could be identified. Depending on the image processing method each user used, the results from each user may be different. Since the system also had functions for comparing the results, so the final correction could be made after all users read the results from others and an agreement was made.

The differences between these two cases was that, the first one made real time collaboration from users who were at different locations while the second one, the collaboration was done in different locations and at different times.

7 Conclusion

Even though, there are some software for collaborative decision-making available in the market, but they are mostly designed for business purposes. With the software tools that support both collaborations through network and having functions for image processing, healthcare work could be processed in real time with results more accurate than from the judgment of only one expert. In this paper, we have tried to show that real time collaboration in group support systems for medical purposes by using data analyzed using image processing is possible. More detail works should be done which to people in healthcare businesses to work more effectively.

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