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Medical Traffic Management Filtering For Mobile Healthcare System

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Abstract

The number of mobile devices and the amount of mobile traffic are increasing rapidly. The selection of an optimal set of serving mobile networks for multicast streams is a challenging problem. This paper presents traffic group management framework for mobile devices to reduce the transmission energy of medical data and to access firstly the data by doctors through wireless networks. With an increase in the usage of mobile devices, users have to continually store and transport data on their mobile devices. In order to have efficient transmission rate in mobile computing environment, medical traffic of mobile devices is classified. Analyzing mobile traffic is necessary to provide high quality mobile network services such as QoS management, traffic engineering, etc. In fact, several multi-flow applications consume a lot of mobile network resources. This paper proposes the framework for medical information using traffic group management filtering in hospital information system (HIS). It evaluates these existing HIS by combing with a newly proposed traffic grouping.

1. Introduction

There has been a dramatic growth in the usage of multiple applications in wireless personal communication. Most mobile devices are equipped with digital cameras; users can share their images, multiple data through wireless networks, including both Wi-Fi and cellular networks. Since wireless mobile devices are battery-operated, transmission energy should be conserved. The transmission energy of multiples information can be reduced by filtering or grouping them. However, it is important to ensure that the processing energy does not exceed the reduction in transmission energy. There are important issues for MobiHealth to tackle:

- **Quality of service :** Network related issues: hand-over, interruption/delays in transmission, data loss bandwidth problems, etc.
- **Social acceptance :** Health risks (cell phone usage), economic issues, ethical issues.
- **Legal issues :** Accreditation of the devices and applications, Protection of health related data, Privacy, security and encryption of data, and Medical responsibilities / liability

The wireless bandwidth plays an important role in the selection of the network parameters. At high bandwidths, data can be transmitted with lower energy consumption; saving energy becomes dominant. At low bandwidths, the transmission energy is higher and can be reduced by better filtering techniques.

Although the capacity of current technologies continues to grow, the requirements for data storage and transmission bandwidth grow as well [1]. Some of the popular methods include white and black listing, digital signature, postage control, address management, collaborative and content-based filtering.

The advancements in mobile technologies and mobile computing power have caused an increase in the popularity of mobile devices. With this increase, usage of mobile devices has been broadening through industries such as Healthcare, Insurance and Field Services [5]. To keep up with all the data that needs to be stored on a mobile device or transferred quickly across a network as a real-time data transfer, there needs to be a way to efficiently users classification and filtering the important medical data without losing the information in hospital information system (HIS)[6].

2. Hospital Information System

Today, Technology advances and the proliferating health care applications indicate that mobile computing will find a secure place in both inpatient and outpatient care. It is not too early for organizations to investigate the benefits it can offer and how it would fit in with current information systems, workflow, and care practices [7].

Mobile computing is not a single technology but a combination of three components (handheld computing device, connecting technology and a centralized information system), each with different performance considerations, costs and risks. Successful implementation of mobile computing requires employing all of these components in the way that best suits the work and environment of the end users.

The major benefits of mobile computing – connection care givers to clinical data and applications anywhere and anytime- is increasingly attractive in a health care environment where physicians work longer hours and see more patients. They are looking for a more efficient means to enter and retrieve data.

As shown in Figure 1 mobile computing has three components:

1. Handheld, mobile computing device
2. Connecting technology that allows information to pass back and forth between the site's information system and the handheld device and back
3. Centralized information system.

Here is how mobile computing works:

- The user enters or accesses data (such as vital information, image, clinical notes or medication orders) using the application on the handheld computing device.

- Using one of several connecting technologies, Nurses or Outpatient transmit the new data from the handheld to the site's information system where system files are updated and the new data are accessible to other system users such as ultrasound department, heart department, and emergency department described in Figure 1.

The process works the same way starting from the other direction. For example, physician may want to have access to all new laboratory results for today's clinic patients. This information is stored in the site's information system and now needs to be transmitted to the handheld device. Again, the connecting technology delivers the data to the handheld and the doctors or nurses or outpatients can roam around, accessing or updating the appropriate information from the handheld device.

The process is similar to the way a worker's desktop PC accesses the organization's application, except that the user's device is not physically connected to the organization's systems. The communication between the user's device and the site's information systems uses different methods for transferring and synchronizing data, some involving the use of radio frequency (RF) technology. Examples of the current uses of wireless Internet include accessing short emails, quick look-up capabilities (stocks, weather, flights, directions, movies, and restaurants), retail transactions and alert messaging in health care. Wireless Internet has not been widely used in health care at this point.

The other avenue of development is use of mobile computing as an extension of a hospital information system (HIS) or practice management system, with the mobile device providing both HIS access and specific functionality. The application descriptions are focused on mobile computing functionality, but the paper high light uses as both management-function and extensions of HIS solutions.

Information is periodically downloaded from the hospital information system (HIS) to the handheld device and then uploaded from device to the HIS. Data syncing is not a wireless data transfer method because data are transferred from the mobile computing device to the site's information system through a docking (or syncing) cradle wired to the LAN [7].

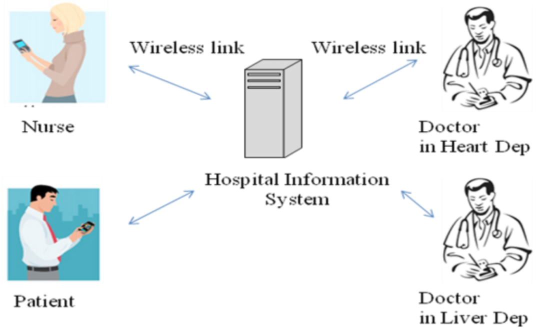

Figure 1: HIS Overview

3. System Architecture

The system considers a network selection problem for multicast groups of mobile clients that operate in a heterogeneous wireless access network environment. We present a solution to this problem with an optimal allocation of mobile users to multicast groups when multiple mobile networks are available for operation as in Figure 2. It shows a high level overview of three major stakeolders: the sender, the broker, and the recipient. The senders are nurses or patients. The receivers are Departments such as heart, stomach, etc in Hospital. The broker (owned by the mobile operator) sends challenge query to check whether the sender's disease type is correct or not. If it is correct or sure, redirect to the doctors in the departments. Otherwise, reply to the users to check their disease type. It also groups the patients and multicasts the data to the doctors.

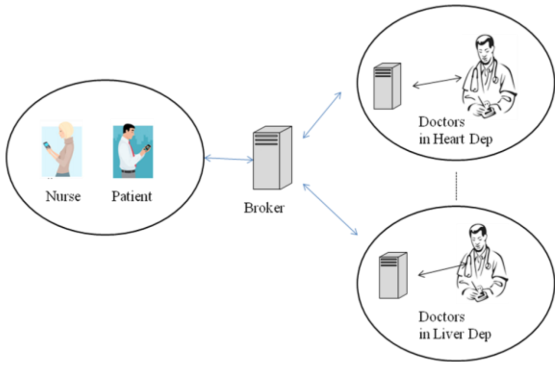

Figure 2: Multicast group filtering architecture

Medical mobile messages make it harder for one to apply such approaches directly in mobile networks and analyze the results . Also, there are is a challenging task since a mobile traffic contains text, images, video, type of deseases and phone number, etc is relatively bigger in size and contains less structured fields compared to an email. Therefore, medical traffic is filtered by applying content-based filtering methods to HIS to control bandwidth usage.

Fig. 3 The broker responds answers to the senders against the known correct value. If the values match, the traffic is classified as disease type, for exemple, heart, liver, etc. The broker full responsibility of running our framework for the following reason: to reduce the traffic usage by filtering mobile traffic at the earliest possible stage; that is, before forwarding them to the recipient.

In this paper, we propose a traffic filtering framework based on combination of HIS and demonstrate that Its combined approach can be more effective and efficient in handling medical information. Firstly, it classifies outpatient's urgent data or nurse's data with high accuracy. And then, using the content-based filtering approach, urgent medical traffic is filtered to decrease transmission energy and grouped the data to reduce the number of user subject to access the data.

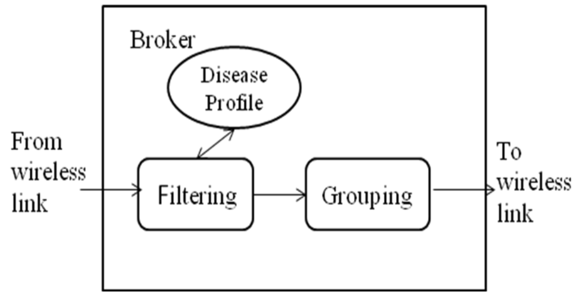

Figure 3: Broker function in HIS

4. Content based filtering

The information filtering approach is based on the information retrieval (IR) domain and employs many of the same techniques. One aspect by which information filtering differs from IR is with respect to the uses' interests. While in IR the users poses ad-hoc queries, in information filtering the users have profiles which represent their long-term interests, and the filtering system tries to provide to each user relevant items on a long-term basis. As said, the user profiles, as well as the item profiles, may consist of sets of terms. Based on some measure of similarity between the respective profiles, the filtering system selects and rank-orders the relevant items and provides them to the user [2].

Content-based filtering techniques recommend items for the user's consumption based on correlations between the content of the items and the user's preferences. Content-Based Filtering (CBF) helps users to find out the most valuable information and analyzes the item content representations to make recommendations. A major advantage of content-based filtering is that users can get insight into the motivation why items are considered relevant to them, because the content of each item is known from its representation. Content-based filters are less affected by problems of collaborative filtering systems such as early rater problem, sparsity problem, and gray sheep: if a new item is added to the repository, it cannot be recommended to a user by a collaborative filter before enough users read/rated it. Moreover, if the number of users is small relatively to the volume of items in the repository, there is a risk of the ratings coverage becoming very sparse, thinning the collection of recommendable items. For a user whose tastes are unusual compared to the rest of the population, the system will not be able to locate users who are particularly similar, leading to poor recommendations.

Despite these strengths, content-based filters alone can prove ineffective. Unlike humans, it has difficulty in distinguishing between high-quality and low quality information that is on the same topic. And, as the number of item grows, the number of items in the same content-based category increases, futher decreasing the effectiveness of content-based approaches.

Many current content-based systems build the user's profile and items' profile. A user profile contains information about user's tastes, preferences and needs which can be elicited from users' questionnaires or learned from their transactional behavior over time, while an item profile contains a set of attributes of items. Then, the system calculates the similarity of user profile and each profile of all the items and recommends items may satisfy user need or tastes [3]. Combining the feature of items and the user interest model, the utility function is usually defined as:

$$U(c, s) = \text{score}(\text{ContentBaseProfile}(c), \text{Content}(s))$$

To generate keywords, for each user the system remove stop words and then perform word stemming. To compute the degree of match between the user's keywords and the keywords in the disease type profile, the system uses the overlap coefficient given formula:

$$M = 2|D \wedge Q| / \min(|D|, |Q|)$$

Where D is the set of keywords extracted from the user's disease type and Q is the set of keywords in the disease type profile. The coefficient, M, is not influenced by the sizes of D and Q, which is desirable as the number of user's explicit keywords could be much larger than the keywords in the disease type keyword list or much smaller than the keywords in the disease type keyword list [4].

Finally, the system sorts items by the utility values and recommend other items to that user which have a high degree of similarity to the disease type profile. Our content-based filtering algorithms match user's disease type keywords to keywords in the disease type profile. If the result is match, the broker classifies the patients into groups according to the disease type for doctors in the hospital information system to save medical traffic bandwidth usage. Otherwise, the broker gives feedback to the users such as nurses or patients to be sure their disease type.

5. Broker based filtering

The system considers end-to-end approach for bandwidth allocation based mobile traffic type from mobile clients. Broker based framework for bandwidth allocation assumes the availability of two types at servers and clients: mobile clients – broker and broker-servers. The mobile users send medical data as shown in figure.4 to broker to check and filter the data according to Disease Type in the medical data from mobile patients. Moreover, he can upload medical images or video in the mobile data he can register to get patient ID in the HIS. The users can get reply messages by their ID from servers. And then, the broker groups the filtering similar patients in the same queue with FIFO style and reserves bandwidth allocation of several mobile traffics to associated Department in Hospital. The broker is used for filtering, grouping and reserving bandwidth allocation based on surplus bandwidth available on the server link. Initially, each queue is allocated minimum static bandwidth and then allocated the bandwidth within the requested range. It also tries to keep aggregated bandwidth below the each server link bandwidth.

Consider N servers, K queues, C_s = capacity of each server, s link, C_r = capacity of rth queue link, $bandwidth_{ij}$ = bandwidth of jth queue, where i={1,2,..,N}, j={1,2,...,K}[8].

$$\Sigma_{i=1}^{N} \ \Sigma_{j=1}^{K} bw_{ij} \leq C_s$$

$$\Sigma_{j=1}^{K} bw_{ij} \leq C_r$$

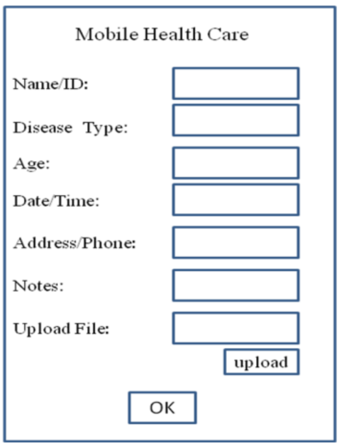

Figure 4: Mobile client function for HIS

Algorithm: Broker Function

1. Initial allocation by broker for accepted mobile data.
2. The broker senses bw profiles from each server to collects statistics of all connections.
3. The broker filters mobile traffic by using Content-based filtering.
If (Disease Type from user== Disease Type in Disease Profile)
Sends the mobile data to jth queue for grouping
If (bw_{ij} <= C_s && bw_{ij} <= C_r)
Sends the mobile data associated department server
Else
set bw profiles to each server with new allocations by using bw without taffic
Else
Response to the mobile user to check Disease Type
4. Stop.

Conclusions

The paper presents traffic group management framework to save transmission energy through wireless networks and to tackle important issues for MobiHealth such as network related issues: hand-over, interruption/delays in transmission, data loss bandwidth problems, etc. In this paper, it measured and analyzed the characteristics of mobile traffic in HIS network. This could be direct indicator towards faster accessing for doctors and faster traffic transmission rate. This scheme has generally superior performance in medical traffic to reduce the transmission energy space for real time transmission and decrease users to access medical data in Information system. Other benefits have been identified in recent mobile computing implementations in the areas of improved workflow, decreased manual tasks, shorter patient and clinician wait times, and better clinical documentation.

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