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Implementation of Medical Image DB Access Agent for Ubiquitous Medicine

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요 약

과학시술의 발달로 유비쿼터스 환경에서 원격의료가 가능하게 하였다. 유비쿼터스 환경에서 원격의료를 위해서는 센서기술과 DBMS(Data Base Management System), 서버, 멀티미디어 정보통신망 등이 혼합된 원격의료정보시스템을 구축하여야 한다. 원격의료정보시스템은 분산형 데이터 베이스인 텍스트, 비디오, 오디오 등으로 구성되고, 이를 유비쿼터스 환경에서 액세스하여야 한다. 본 논문에서는 원격의료를 위해 원격지에 분산되어 있는 멀티미디어 형태의 데이터베이스를 원격지에서 빠르게 접속하여 검색할 수 있는 검색 에이전트를 설계하고 구현하며 성능을 평가하였다.

▸ Keyword : Ubiquitous, Telemedicine, ATM, Agent

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Ⅰ. Introduction

Technical development makes telemedicine in ubiquitous environment possible1). Telemedicine in ubiquitous environment can diagnose patients by arranging of patients' history, sharing information between medical agencies, and joining the participation of related specialists and medical agencies in diagnosis through super-speed information network based on sensor technology and dispersive databases such as text, video, audio, etc. 2,3) In addition, it makes mutual supports of medical information and techniques easy through telemedicine conference, but the support of unestablished medical items and general diagnosis of specialists in the related area should be possible. System configuration for this can be accomplished by building dispersive system connecting each hospital with

ATM network. From the side of hospital services, when patient is transferred to

the secondary medical agency from the primary one, diagnosis results by the primary medical agency are transmitted to the secondary agency with the primary medical opinions and voice information through super-speed information network based on ATM network. For these, we designed and implemented remote connection functions for DBMS which accepts ATM network services as it is but does not support ATM network service when commercial DBMS is used for making database.

Ⅱ. Materials & Methods

2.1 Medical Image DBMS for Telemedicine Information System

For the data composed of multimedia of mass storage like medical image database, high-speed access should be required with no lowering of speed by increase of data quantity and DBMS supporting the various modes of data. The DBMS Currently used includes relational DBMS, object-oriented DBMS, and object-relational DBMS. These DBMSs are not suitable to support functions of telemedicine information system. Therefore, in this study, we suggest a methodology of making them without exclusive DBMS and making a rapid correspondence without the change of system required from the use of exclusive DBMS. In this study, we uses ORDBMS Illustra as telemedicine image DBMS. 4)

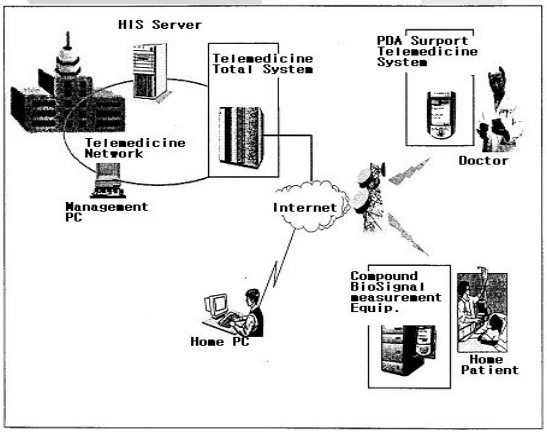


Fig. 1 Configuration Diagram of Telemedicine Information System

2.2 Teleconnecting Implementation Environment

Three DBMS servers equipped with LINUX and three DBMS servers were used for implementation of telemedicine information system. Network equipments were connected by installing ForeRunner SBA-200 Adaptor at Fore ASX-200 ATM switch to 3 servers and ForeRunnerLE PCI Bus PC Adaptor installed at 2 Pentium PCs with UTP.

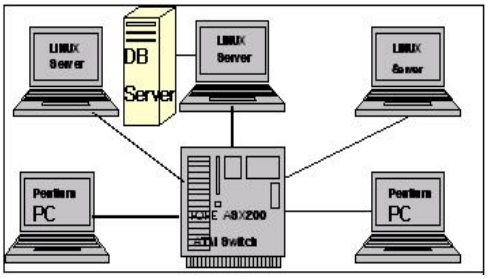


Fig. 2 Hardware Configuration Diagram

2.3 Teleconnection Design Using ATM API

Implementation of remote retrieval function using a commercial DBMS-provided API has the structure like (Fig. 3). The structure is DBMS-dependent type and accompanies some restrictions in building system. First, all hospitals installing telemedicine information system must use the same DBMS or re-connection of telemedicine information system compatible with DBMS they use. Second, in case that API cannot support ATM network (Native ATM), TCP/IP characteristics should be followed in transmitting medical image of mass storage. Third, the above first and second problems will recur an replacing DBMS in the future. To solve these restrictions, implementation of remote retrieval function of independent structure in DBMS is required. In this study, we designed remote retrieval agent to keep independence of DBMS and to accommodate ATM network.

It incorporates teleconnection function by using commercial DBMS API in layered agent as shown in (Fig. 4) to make it function IPC (Inter Process Communication) and designs protocols related to connection between agent and retrieval service program to be used at ATM network and data transmission. 5,6)

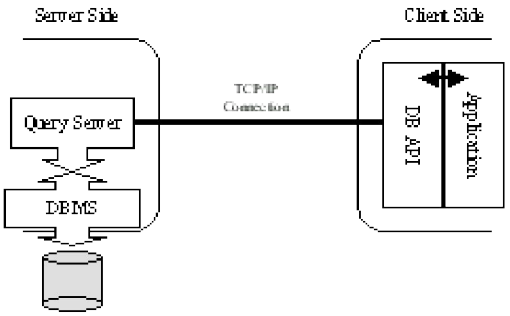


Fig. 3 Retrieval Function Structure Using DBMS-provided Library

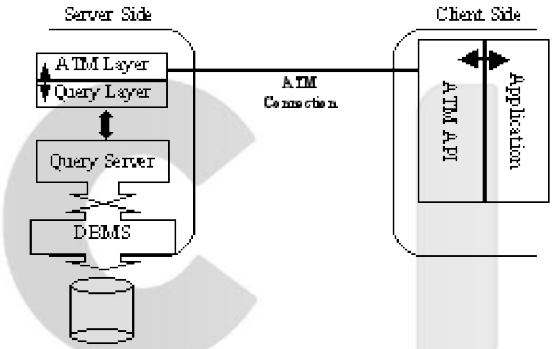


Fig. 4 Retrieval Function Structure by Agent

Agent is composed of control agent and service agent, and (Fig. 4) exhibits structure of service agent responsible for data transmission. Control agent performs the function of initial connection and management. Query layer is designed to correspond to multiple DBMSs with replacement of query layer without change of remote control service program for the independence of DBMS. For ATM network service, multiconnection service is supported with transmission layer by using AAL5. 7,8)

2.4 Implementation of Teleconnection Agent

Since control agent cannot perform direct access to database, it is designed to mode without query layer as shown in (Fig. 5).Coordinator layer retrieves empty slot of CCD layer and confirms service function as requested by remote retrieval service program through ATM network. As the empty slot is confirmed, it recognizes service as accessible and performs connection procedure. If there is no empty slot, inaccessibility of service is notified in remote retrieval service program. CCD layer is data structure storing information which was required for connection management, and consists of service state field for confirming service, SAP number field keeping service access point number of service agent, and service address field storing computer ATM address with the operation of remote retrieval service program. Multiparty process by CCD layer is implemented by assigning empty slot in order requiring connection.

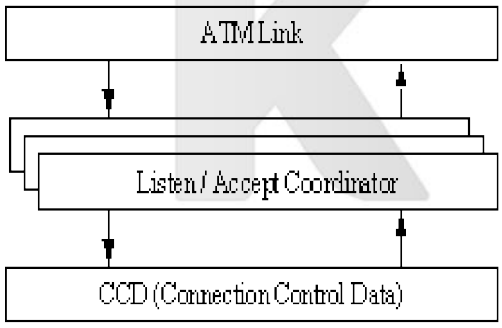


Fig. 5 Control Agent Structure

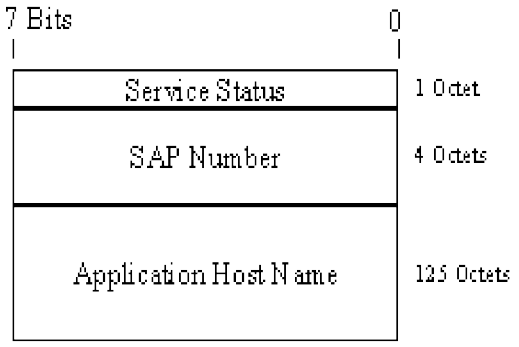
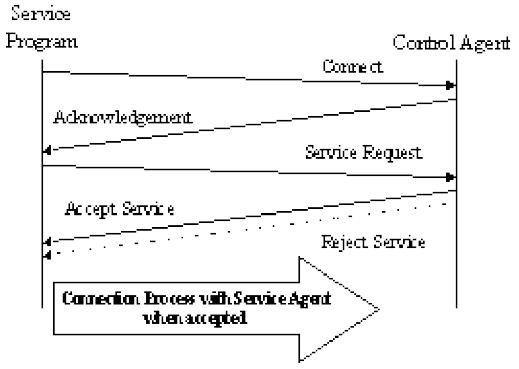
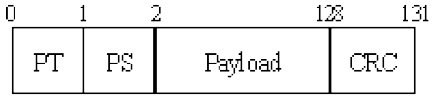


Fig. 6 Connection Control Data Structure

ATM link layer of agent uses SVC (Switched Virtual Connection) for connection establishment, performs connection oriented service of AAL5, and plays a role of passing packet arrived from teleconnection service program to Listen/Accept Coordinator. Initial connection process is completed by transmitting results of Listen/Accept Coordinator to teleconnection service program. (Fig. 7) is (a) initial connection process and (b) transmission packet structure. Packet type field indicates whether transmitted packet is connection request, accept or reject, and payload size indicates the size of data recorded on Payload Field. Service program and data of agent are recorded on Payload Field and service program host name is recorded when requested and SAP number of service agent when accepted. Null data are recorded when rejected. CRC field is not used for initial connection establishment as reserved field for error check at application layer.



(a) Initial Connection Process



PT : Packet Type (Request, Accept, Reject)
PS : Payload Size (Real loaded size)

(b) Packet Structure

Fig. 7 Initial Connection Process and Packet Structure

Service agent performs one-to-one correspondence with teleconnection service program. Service agent activated by control agent constructs Basic Query Connection only at the beginning and does not construct medical image channel for minimizing waste of bandwidth.(Fig. 8) shows service agent structure. Basic query connection layer plays a role of retrieving and controlling telemedicine information database, and performs text mode data process. Query proxy performs the functions of extracting SQL syntax required for database retrieval from packet transmitted by remote retrieval service program and transmitting it to query server. Result proxy performs the result process from query performance, and is also responsible for settling SQL syntax error and server error, as well as for combining Query results.

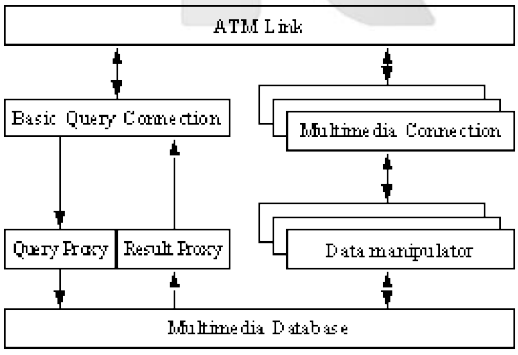


Fig. 8 Service Agent Structure

Connection establishment by data types is designed to set QoS suitable to characteristics of each media with thread. 9)

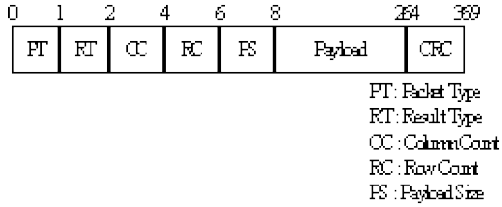


Fig. 9 Data Transmission Packet Structure

PT in packet structure of (Fig. 9) indicates serial data when the length of data to be transmitted is larger than the size of payload, and RT field indicates whether transmitted data is result value or error information. RC and CC record row and column of retrieved data records, respectively. PS field records the size of data recorded on Payload field. CRC is the function of 32 bits error detection to perform error retrieval at application layer for reliability of transmitted medical information. Stage of connection establishment of service agent is divided into Basic Query Connection and medical image data channel configuration, as shown in (Fig. 10). Remote retrieval service program should be released for the reuse of slot assigned through connection clear procedure with control agent at the point of ending work.

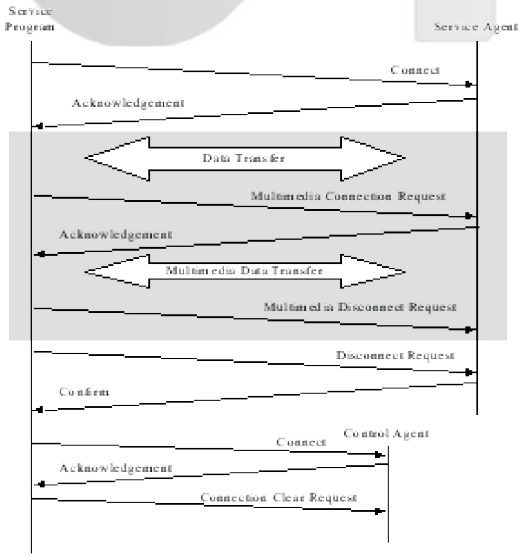


Fig. 10 Service Agent Protocol Structure

III. Experiment & Results

Implementation of teleconnection by agent has advantages, such as DBMS independence and possibility of accommodating ATM network service, but it accompanies overhead from connection establishment. Accordingly, gains and overhead resulted from application of ATM network service are measured to make performance evaluation. Overhead from the use of agent includes QoS establishment delay in initial connection, activation time of service agent, and delay of basic query connection configuration and of medical image channel configuration.

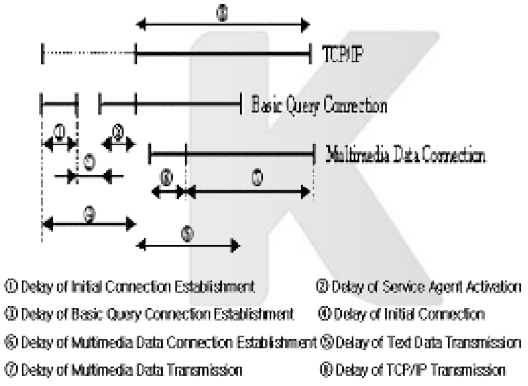
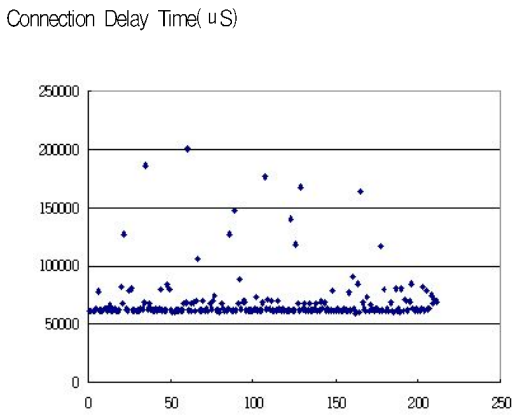


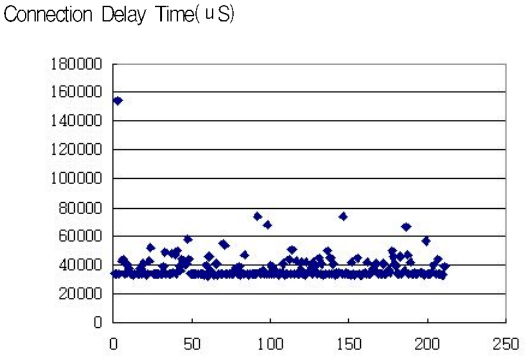
Fig. 11 Delay Time of Connection Establishment

(Fig. 11) shows, delay time schematically when DBMS API and agent are used, respectively. When TCP/IP (DBMS providing API) are used, there is no overload required for connection establishment. Therefore, transmission delay is the greatest factor in TCP/IP. In connection using agent, delay occurs due to QoS establishment in connection establishment, but initial connection delay has no influence on real data transmission since it is a delay at the point of activating remote connection service program, as shown in (Fig. 11).

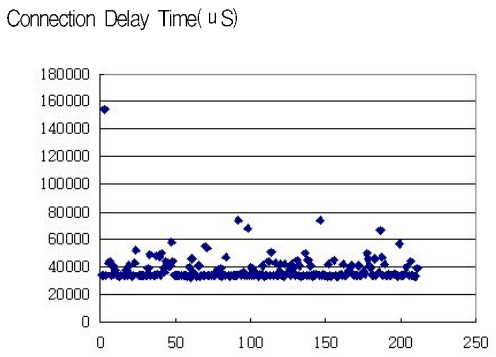


(Fig. 12) Initial Connection Delay Time of Agent

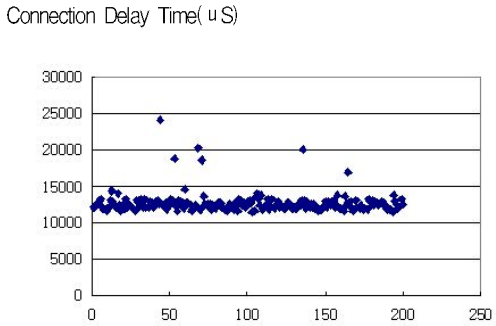
(Fig. 12) is the measurement result of initial connection delay time. Transmission of character information has no problem in transmission with relatively lower bandwidth, compared to medical image information. Concrete delay from transmitting character information in telemedicine information system occurred by combination of database retrieval time and retrieval results.



(a) Basic Query Connection Delay Time



(a) Basic Query Connection Delay Time0



(b) Character Information Transmission Time

(Fig. 13) Character Data Transmission Time

(Fig. 13) shows the Basic Query Connection configuration and character transmission time measured in service agent, and giving almost uniform distribution of transmission time. When the average bandwidth of transmission channel was set to 20 Mbps, the real transmission rate was measured with about 17 Mbps. We concluded that the degree of dispersion is dependent on the change of CPU load in transmitting mass storage data. Use of agent requires computer having better capacity because the whole time depends on processing time of hardware unless hardware handles transmitted data in a high speed. For instance, packet design of this study used CRC 32 for error check, but transmission rate in transmitting data was lowered to 1/3 compared to when CRC32 was removed. It means that CPU rate for CRC32 operation cannot reach transmission rate.

IV. Considerations

In this study we suggested methods that medical image DBMS agent is applicable to ATM network in telemedicine information system for ubiquitous medicine. It obtains the following conclusions:

1. Implementation of teleconnection functions using agent is composed of independent structure of DBMS.
2. Independent teleconnection function can be applied to various DBMSs actively.
3. Currently applicable ATM network at PACS has restriction of Fore SPANS ATM API.
4. These restrictions can be eliminated with use of XTI or ATM API.

Future tasks are to design and implement transmission to PDA through wireless network.

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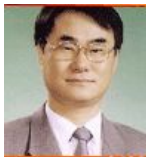

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