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A Support System to Consult Remote another Doctor on Assessment and/or Medical Treatment Plan when a Doctor has a Patient not in His/Her Major

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***Abstract*—**Recently, majors of doctors are divided into terribly lots of detailed areas. However, it is actually not a rare case that a doctor has a patient who is not in his/her major. He/She must judge an assessment and make a medical treatment plan for this patient. According to our investigation, conventional approaches such as image diagnosis cooperation are insufficient. This paper proposes an 'Assessment / Medical Treatment Plan Consulting System'. We have implemented a pilot system based on our proposition. Its effectiveness is clarified by an evaluation.

***Keywords*—**Application, Computational Intelligence and Telecommunications, Medicine, and Intelligent Systems.

I. Introduction

RECENTLY, majors of doctors are divided into terribly lots of detailed areas. It is a common tendency in the world. However, it is actually not a rare case that a doctor has a patient who is not in his/her major. He/She must judge an assessment and make a medical treatment plan for this patient.

According to our investigation, conventional approaches such as image diagnosis cooperation system have the following three drawbacks:

Problem 1: Introduction of some additional hardware and/or software for a cooperation system is required in order to consult other doctor. It spends time and effort. Its initial cost is not low.

Problem 2: Even if a doctor introduces the above additional hardware and/or software, he/she cannot consult remote doctors who do not introduce them. Consulting range is restricted into the cooperation system.

Problem 3: Consulting is restricted to image diagnosis. It is preferable if any consulting concerning assessment and/or medical treatment plan is possible.

Hereafter, we abbreviate a doctor who hopes consultation to 'source doctor'. We also abbreviate another remote doctor who receives the consultation to 'destination doctor'.

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This paper proposes an 'Assessment / Medical Treatment Plan Consulting System'. It allows a source doctor who has a PC by which he/she can send and receive an E-mail and browse a homepage, to consult much more doctors than conventional. It has the following feature: it can easily switch the communication media depending upon a communication environment of a destination doctor. Concretely, if a destination doctor does not have the connection to the internet, proposed system supports a source doctor to consult via FAX or letter. The source doctor can consult not only another doctor connected via a network, but also a remote doctor who is not connected to the network, more easily than conventional.

This paper is organized as follows: In the next section, we overview the conventional works of image diagnosis cooperation. Section III proposes our solution. We design our system as a solution. Section IV develops a pilot system, and evaluates it by doctors in active. Finally, in Section V, we conclude our talk.

II. Conventional Works

We overview some conventional typical works as image diagnosis cooperation.

'Hikone Municipal Hospital' tries an image diagnosis cooperation using a commercial DBMS(DataBase Management System) 'FileMakerPro' and image browsing software 'Web Viewer'[1]. This example is insufficient in the following two points:

(i) consulting is restricted to image diagnosis
(ii)additional software such as 'FileMakerPro' and 'WebViewer' are required in each client PC for cooperation.

'Keiju Medical Center' tries another type of image diagnosis cooperation. Peripheral affiliated clinics are connected to this center using dedicated line, and they send some test images to the center. Assessment judged in the center is returned to the source doctor[2]. However, this example is insufficient in the following two points:

(i) consulting is restricted to image diagnosis in here, too
(ii)only affiliated clinic connected via dedicated line can consult. Cooperation is restricted and closed in the dedicated line.

In this way, conventional approaches include Problem1 to 3 described in Section I.

III. Solution

Now we propose our solution. We suppose that a source doctor in our solution has a PC by which he/she can send and receive an E-mail and browse a homepage.

A. Classification of the Communication Level

We classify the communication level of a destination doctor into the following three categories:

- 'Internet Category': connects to the internet
- 'FAX Category': does not connect to the internet, however, communicable via FAX
- 'Letter Category': does not connect to the internet, and not communicable via FAX.

We try to develop a system which allows a source doctor to consult even if a destination doctor belongs to the above any category.

B. Introduction of Database Connected to the Internet

It is preferable if a source doctor does not need to remember which category a destination doctor belongs to. In order to realize such a system, we store the information of doctors and medical facilities into databases connected to the internet. The schema design of this database is as follows:

- 'Doctor' table stores each doctor information by the attributes 'Doctor Code', 'Medical Facility Code', 'Name', 'E-mail Address', 'diagnosis department', and 'Position'. 'Doctor Code' is the primary key of this table.
- 'Medical Facility' table stores its information by the attributes 'Medical Facility Code', 'Name', 'Postcode', 'Address', and 'FAX Code'. 'Medical Facility Code' is the primary key of this table. This means 'Medical Facility Code' in the 'Doctor' table is a foreign key. It plays a role to connect these two tables.

We locate our Web server and database one in independent position from any doctors and medical facilities. This brings us that proposed system can be used the whole menu on any client PC which has an E-mail software and a Web browser.

C. Consultation Algorithm

The algorithm of consultation is as follows:

Step 1: A source doctor inputs the information for consultation, including information of a patient in the past and test images, on Web browser via FORM.

Step 2: The system receives them.

Step 3: The procedure is branched from here (Fig. 1):

'Case 1 (Internet Category)': If E-mail address of the destination doctor is stored in the 'Doctor' table:

The system sends the submitted information for consulting to the destination doctor in the form of an E-mail. The source doctor's information is also sent in the message of this E-mail. We display the E-mail address of the source doctor with 'mail-to' tag, and make the destination doctor possible to start typing the corresponding reply with one click.

'Case 2 (FAX Category)': If E-mail address of the destination doctor is null in the 'Doctor' table, and his/her medical facility's 'FAX Code' is stored:

The system produces a Web page including

(i) the information for consulting, and

(ii) FAX cover sheet filled the source and destination data.

It is produced from the submitted information and the information of both source doctor and destination one. Source doctor can print this Web page using 'Print' menu of the Web browser, and can easily send as a FAX to the destination doctor.

'Case 3 (Letter Category)': If E-mail address of the destination doctor is null in the 'Doctor' table, and his/her medical facility's 'FAX Code' is also null:

The system produces a Web page including

(i) the information for consulting

(ii) cover letter filled the source and destination data, and

(iii) destination label for a letter.

It is produced from the submitted information and the information of both source doctor and destination one. Source doctor can print this Web page using 'Print' menu of the Web browser, and can easily send as a letter to the destination doctor.

We make the database be always possible to be updated. In here, 'update' has broader meaning and includes 'insertion', 'deletion', and 'update' of narrower meaning. Let a doctor has no E-mail address. If he/she is specified as a destination doctor, above 'Case 2 (FAX Category)' or 'Case 3 (Letter Category)' is selected. However, if the E-mail address of him/her is newly inserted, after that, above 'Case 1 (Internet Category)' is selected for consulting. Similar mechanisms are applied on deletion or update. Source doctors don't have to know any change in the environment on the destination doctor.

IV. Pilot System and Evaluation

A. Pilot System (Fig. 2)

We have implemented our pilot system at the following environment:

- Programming language: 'Active Perl 5.6.1'
- DBMS: 'Microsoft Access 2002'
- Web server: IIS5.1
- Cooperation between Web server and database server: CGI[3].
- Means for security: SSL[4]

Note that we treat many patient's data. Means for security is indispensable.

We have implemented all the menus corresponding to the proposition in Section III. A source doctor can login the pilot system from the user authentication menu. He/She inputs the information for consultation including test images and clicks the submit button. Depending upon the environment of a destination doctor, appropriate communication media is selected and necessary operation is guided. He/She does not need to remember the communication media appropriate to the destination doctor.

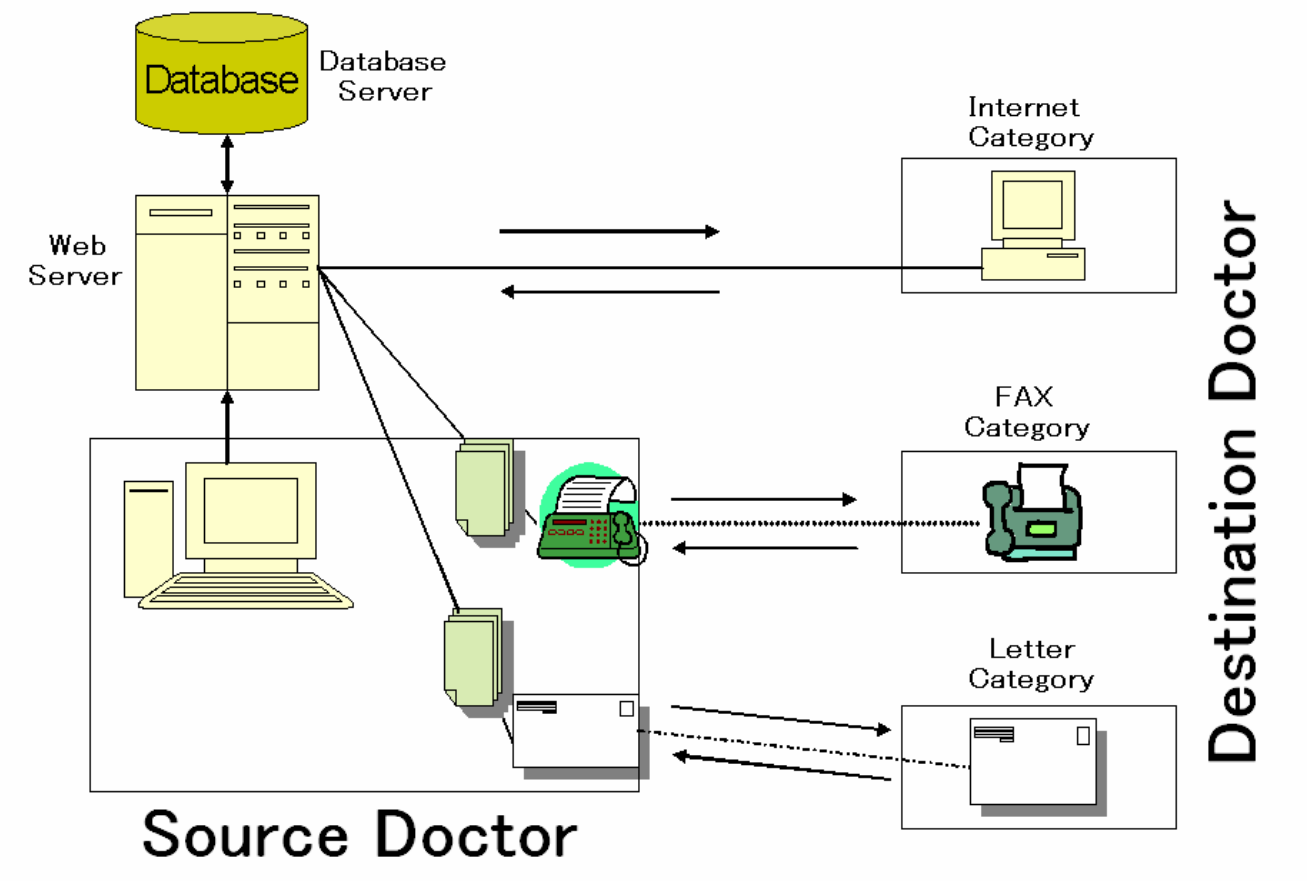

Fig. 1 Design of our system

B. *Evaluation*

We hear the evaluation of our pilot system from thirty-three doctors in active:

- We need no additional hardware and/or software. It is very preferable.
- A source doctor can consult without hesitation, because a destination doctor can determine when he/she replies it by himself/herself.
- We need much shorter time and much little load for consulting than conventional.

They almost evaluate our system to be useful.

The following two comments are concerning the enhancement of our system:

- It is preferable if a destination doctor can download the information of consultation as an 'Excel' file.
- Not a few doctors open an E-mail software at low frequency. Therefore, the system should send the same E-mail message to the Hospital/Clinic Office, too. It can be used for alarm from an office staff.

Soon we have added these two menus. These are also evaluated to be useful.

V. Conclusion and Future Research Directions

In this paper, we have designed and developed a Web database system which supports a source doctor to consult a destination doctor on assessment and/or medical treatment plan when a patient is not in the source doctor's major. It can reduce all of Problem 1 to 3 described in Section I. Our pilot system is evaluated to be useful by doctors in active.

By the use of our system, a source doctor can consult much more doctors at lower load than conventional. This will contribute to the improvement of medical quality. For a destination doctor, it will also be preferable because he/she has more chances to meet many cases of diseases.

As future research directions, we are planning: (i) enhancement of the functionality on reply menu, (ii) evaluation of our pilot system through actual use, and (iii) modification of the system to become more easy to use.

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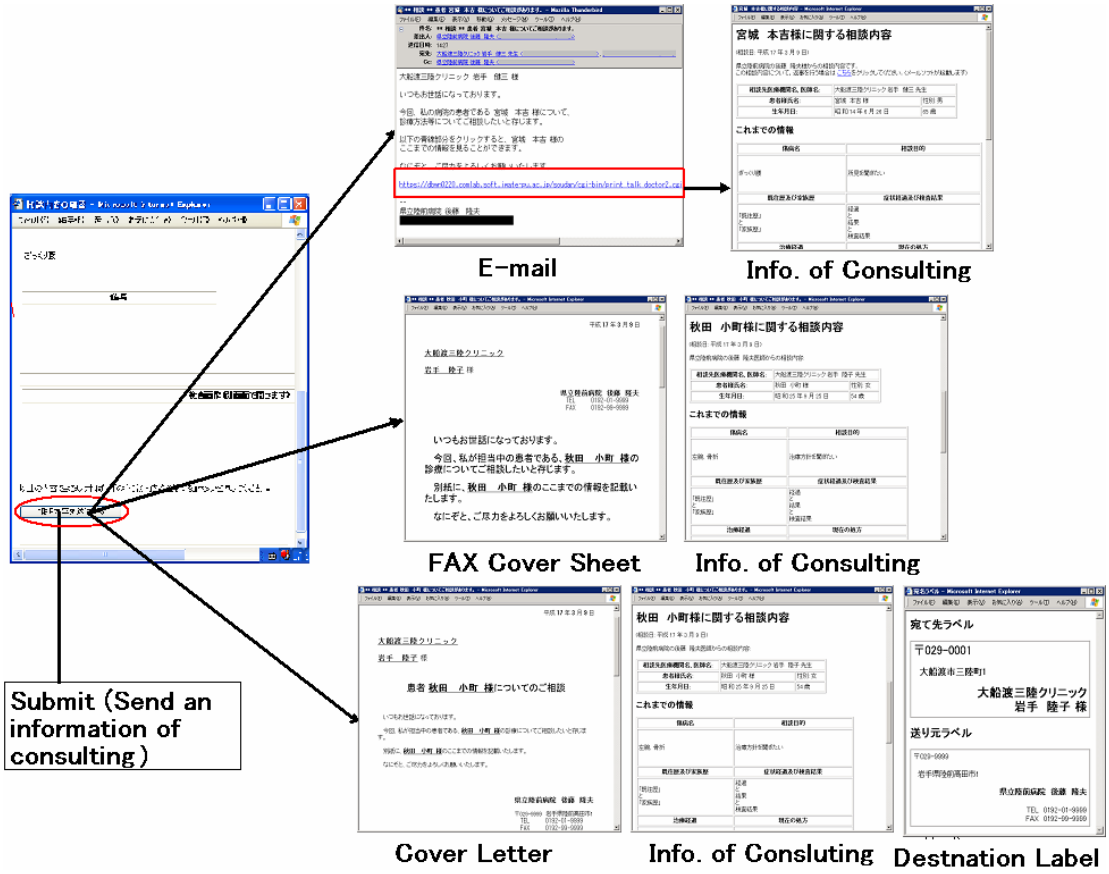

Fig. 2 Pilot system