A Proposal and Its Implementation of Agent System supporting the Quality of Senior Lives

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Abstract

Advances in information technology are changing the social environment, and have brought about the so-called information-oriented society. Particularly when we consider the elderly, a large gap is opening up between those who can use computers effectively to process information and those who cannot, causing an information barrier. If, we lower this barrier and take the active usage of information in the daily lives of the elderly as an integral part of their life-cycle, we will be able to provide this informationally handicapped group with new interests in life. This paper proposes a support system to encourage effective information exchanges between the elderly and their family, friends, acquaintances and care provider organizations to improve the quality of life.

1. Introduction

Advances in information technology are changing the social environment, and have brought about the so-called information-oriented society. Particularly when we consider the elderly, a large gap is opening up between those who can use computers effectively to process information and those who cannot. This is one of the factors that causes an information barrier [1)5)]. If, we lower this barrier and take the active usage of information in the daily lives of the elderly as an integral part of their life-cycle, we will be able to provide this informationally handicapped group with new interests in life. Currently, many of the systems intended for the elderly are aimed at reducing the burden placed upon people needing care, and those providing this care. Furthermore, there are few examples of research announcements being made for information technology intended to improve the lives of the elderly.

This paper proposes an information barrier free system intended for the elderly that employs human interface agent. This system provides functions such as those that enable the user to easily handle information with a PC, a system function that improves the quality of life, and a health-check function, through the assistance of an agent[3)4)]. Through the implementation of a prototype of this system, we were able to confirm the possibility of the effectiveness of this system.

2. Functions of the Barrier Free Systems

2.1 Overall Structure of the System

As shown in Fig. 1, this system is connected to the user, the user's family, friends, hospital, and helpers by means of networks. The agents are loaded into a PC at the user's home, located on several relay servers, and operate as a multi-agent system[2)]. The agent located within the user's PC, assists with the operation of the user's PC, conducts e-mail handling, acquires information regarding the user's health conditions, as well as providing the user with some pleasure and improving the quality of his or her life. The agent in the relay server houses the user's information data base, provides information that improves the quality of life for each user, provides an alarm function, manages the user's physical condition, and exchanges information with the user's hospital and helpers.

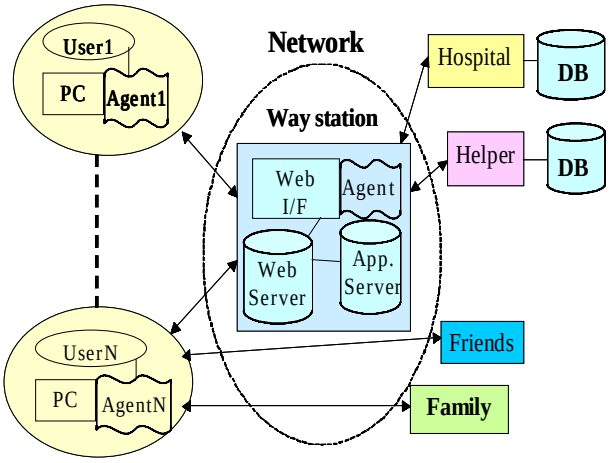


Fig 1. Overall Structure of the System

2.2 Providing PC Operation Interface easy to use

Current PCs are designed primarily for people who are familiar with how they operate. For the elderly user, these PCs are difficult to operate, due to their complexity and the various and diverse functions that they possess. As shown in Fig. 2, operation of this system is assisted by an agent that, through human interface technology, provides an easily understandable PC system.

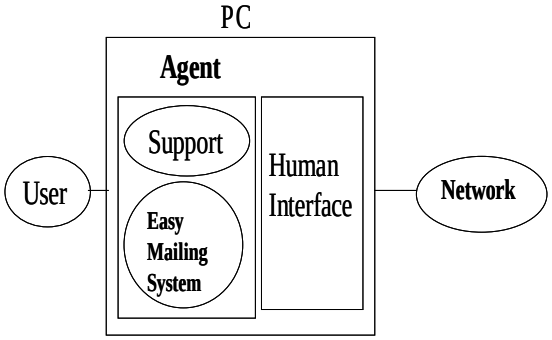


Fig2. Barrier -Free System

In order to simplify the procedure when the user is sending an e-mail transmission, the number of input headings has been reduced, and an easy-to-understand visual operation procedure is provided. In order to assist people who are not good at keyboard operations, a pull-down menu format has been adopted.

At the first time using this system, the character size that is easiest for each user to read and other parameters are set up. A character size option tool is presented to the user, and they choose the character size that is easiest to read.

2.3 Information Support Intended to Improve the Quality of Seniors' Lives

As humans become older, they often sense that they are no longer connected to society, and feel isolated. To help remove this sense of isolation, this system provides a means for the user to communicate with others. When using this system for the first time, user information such as hobbies, family information, normal body temperature, and regular blood pressure is input into the database by the system support person. The agent uses this information to improve the user's quality of life by providing information and assistance.

(1) Providing E-Mail Partners

The e-mail addresses of acquaintances, friends, family members and volunteers are recorded in the database for each user as initial user information. The user utilizes the e-mail addresses to exchange messages with their e-mail partners. Furthermore, when the user has made a request, or decides that the user has not sent or received a message for a long period of time, the agent will present the user with e-mail partners that they can contact. The agent keeps track of the number of e-mail transmissions sent by the user and utilizes this information to understand the user's lifestyle.

When users join new social groups, they may exchange more messages with more e-mail partners. As a result, in parallel with an increase in the user's activities, and the number of e-mail partners, the assistance that the system provides in sending and receiving e-mail transmissions changes to some extent. At times like this, the agent will ask the user questions about their hobbies and their relationships with friends, in order to grasp the changes that are occurring. The questions that arrive from the agent are easy to answer, and the user can select ones they answer from a list of options. Through this process, it will be possible to introduce the suitable conversation partner for the particular situation.

(2) Supporting Contact With the Family

When registering user information on the system, information on the user's family is also recorded. Based upon this, while the agents send information to the user, they place themselves between the family and the user, and transport family information to the user. For example, the agent provides the user with information such as what their

grandchildren currently enjoy, the television programs that they watch, and what type of games they play. However, family members' hobbies will probably change over time. The agent sends the user's family a series of questions by e-mail to obtain information. If this system provides a means of increasing the number of times that the users contact their families, it may strengthen their sense of family bonds, and give them more topics of conversation.

(3)Giving Advice on Hobbies

The agents grasp what the user's hobbies are, and they use this information to tell users about related events and the URLs of other groups involved with this hobby. The agent will examine information registered when the user first used the system, how the user utilizes the system, etc., to identify ways of presenting information to the user, give advice, and introduce social groups. Based upon the results of this investigation, they will use the best methods to obtain information from the user and to introduce groups to the user. By applying the information, the users receive advice that relates to their hobbies. When the agent is introducing a new group to the user, the agent asks the user various questions, and selects the best groups. Through this, it is possible to provide the user with suggestions for how they can enjoy their free time.

Agents can increase the number of opportunities that a user has to communicate with other users. In order to do this, each user's agent exchanges information with other agents. The example, when the user wants to join new clubs, Agents get user's wishes. Then Agents chase up friends who will join to the same club. Furthermore, user information registered when the user used the system for the first time is likely to alter as the user's hobbies and the associated groups change. These changes are added to the information that was initially collected, and this information is used to support the user.

(4) Providing Lifestyle Information

Also, for the aged who tend not to be aware of changes in society, this system is intended to provide the user with lifestyle information, so as to enable them to grasp the present situation of society. Also, in order to remove the sense of isolation from society, news and similar information are sent to the user on a daily basis.

2.4 Checks on Physical Condition

When users feel anxious about their physical condition, this system provides a physical condition checking function.

(1) The user inputs information such as their tem-
perature, changes in their blood pressure, pulse information directly onto the PC screen. While the input information is transmitted to the user's hospital and helpers, this data is stored in a special database that has been set up for each user. While administering the physical condition check, the agent provides the user with appropriate advice. When the results of the checks are abnormal, the Health Check Agent contacts the Hospital Help Agent, and while the Health Check Agent and the Hospital Help Agent are working together, they support the hospital and the user.

(2) It is possible for the user's doctors, nurses, and helpers to check this temperature, blood pressure, pulse information on a weekly or monthly basis.

3. System Configuration and Implementation

3.1 System Configuration

The authors have constructed the agent system on a three-layer structure composed of clients, a web server, application server, and a database server. The reason for using the three-layered structure is that this organization can cope with an increase in the number of users, and by having each agent posted on and operating on the application server, it is possible to reduce the burden imposed upon the web server. The configuration of the system prototype that has been set up in our laboratory and its connections to the agents are shown in Fig. 3.

First of all, when the user turns on their PC, the web browser starts up automatically and the top page for this system appears on their screen. When various types of information are accessed through the top page, this information passes through the browser and is transmitted to the web server and the application server. Agents operate on the application server. The agent that meets the user's request answers the request.

When the user makes a request for sending an e-mail message, health check or other means, this information passes through the web browser, and is sent to the web server. The Operating Helping Agent, which corresponds to each user, operates on the

application server.

Although various agents act upon the user's requests, usually they act upon the Operation Helping Agent's decisions. The Life Enhancing Agent operates when the user's request involves improving their quality of life (see (a) of Fig. 3). When the user requests a health check-up, the Health Check Agent becomes involved (see (b) of Fig3). The Alarm Agent does not act according to user's requests, but always operates on the application server, and operates when particular conditions on the server arise. The Hospital Help Agent operates when doctors and nurses at the user's hospital utilize this system. The Helper Agent operates when helpers use this system. The Operation Helping Agent, Life Enhancing Agent, and Health Check Agent access all of the user databases, store this data, and contact the users. Furthermore, the Hospital Help Agent and Helper Help Agent access the user database in order to obtain relevant information, such as the user's current state of health (see from (a) to (e) in Fig. 3).

This system's structural environment consists of a Windows 2000 OS, Apache 1.3 web server, JRun3.0 Application Server, and makes use of an Oracle8i database.

This system has been developed using Java. Most of what appears on the user's screen has been developed using JSP(Java Server Pages), and process control of this system has been developed using Servlet.

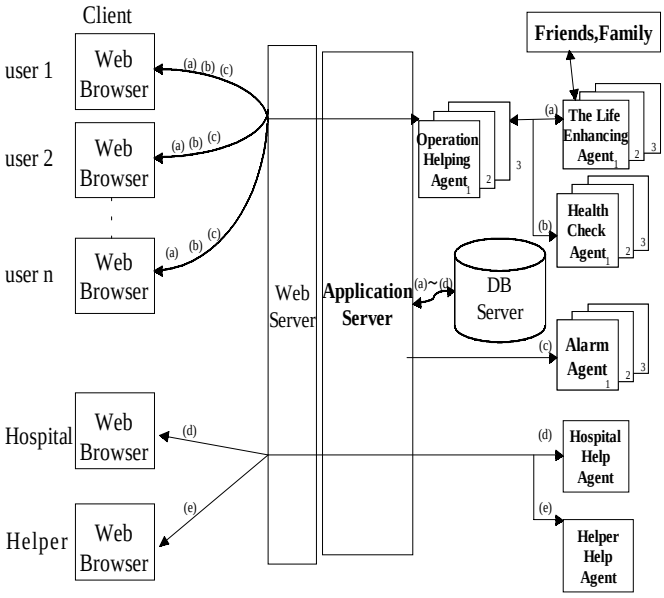


Fig.3 System Organization

3.2 Implementation of Agents

3.2.1 Operation Helping Agent

Changing the window that appears on the screen of the user's PC and using other functions can be quite a burden for the users. Therefore, the system has been designed so that the user can use all of the functions with a single screen. When user sets up the PC, she or he will see the screen shown in Fig.4 at the first. This system does not need to set up any soft ware by user.

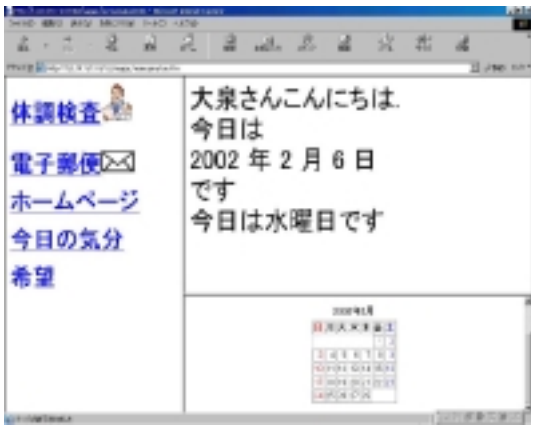
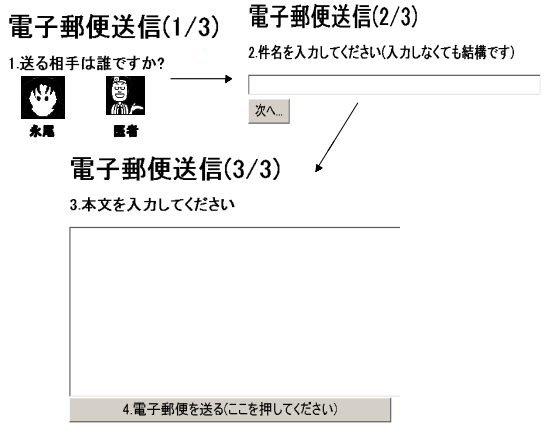


Fig.4 The Screen for the user at the first

Fig. 5 presents an example of Operation Helping Agent's e-mail screen.



E-Mail Transmission (1/3)

1.Who do you wish to send a message to?

E-Mail Transmission (2/3)

2.Please enter message name (A message can be sent without a name attached)

E-Mail Transmission (3/3)

3.Please enter your message.

4.Please press here when you wish to send your message.

Fig.5 E-mail Transmission Flow

Icons representing persons to whom the user want to send e-mail messages appear on the screen, and the user chooses from among them. In order to simplify the sending of e-mail messages, a conversational (Wizard) format is employed, and as long as the user uses the system as instructed, they can send messages. The number of messages sent is counted, and the function used to transmit the user's mail keeps a record of messages sent.

3.2.2 Life Enhancing Agent

An outline of the Life Enhancing Agent's job is presented in Fig. 6.

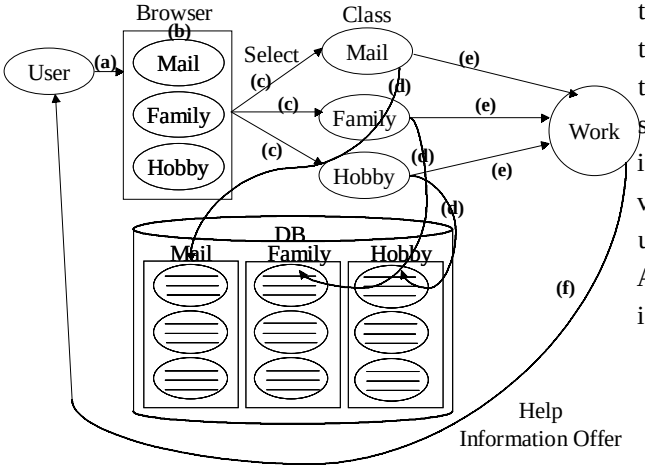


Fig.6 Life Enhancing Agent

First of all, the user accesses to the browser (see (a) of Fig. 5). The user chooses from among the options whether they wish to send an e-mail message on the browser, communicate with their family, or do something that involves their hobbies (see (b) in Fig. 5).These headings correspond to structural classes that the agent has set-up, and the proper database can be accessed through these classes. The information located in the database can be obtained by the class(see (d) of Fig. 5). The information that has been obtained from the database has a priority ranking, and data is extracted from each class depending upon its importance. Based upon the information that has been taken from the database, each class is required to meet the request made by the user (see (e) of Fig. 5). The agent sends the information that corresponds to the user's request through the browser (see (f) of Fig. 5).

Introducing users to social groups is one of the Life Enhancing Agent's duties, and this task is done using TAF [2] structure. Agents assist users with their hobby friend searching through this function.

3.2.3 System functions operating through TAFs.

(1)TAF Operational and Functional Architecture

TAF [3] (Training system for Agent Framework) devised by Mr. Kinoshita and staff is an agent framework intended to plan and bring about an agent structure. Based upon the basic agent structure (architecture) determined by the TAF, this system provides information possessed by agents, agent programming language detailing the rules for this knowledge as well as agent transmissions. Also, when agents are operating on this system, duties performed are stored in the system's repository, where they are managed. This information can be extracted when agents wish to view it. The agent coordinator, through making use of TAF, can configure various agent systems. Agent architecture provided by the TAF is shown in Fig. 7.

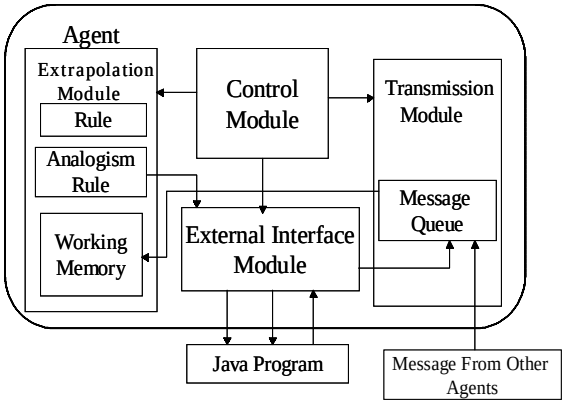


Fig.7 Agent Architecture of TAF

The transmission module, extrapolation module, control module, and external interface module are the four functional modules forming the structure used by agents operating under TAF. Operations conducted by agents operating under TAF are regulated by rules, which are stored in the extrapolation module's exclusive production system (TAF-PS) rule base. Furthermore, dynamic decisions made when the agents are operating on the system are based upon miscellaneous information stored in the working memory.

(2)An Example of the Life Enhancing Agent's Duty

This system uses TAF to enable agents to exchange messages with each other. In this case,

let's consider the exchange of messages between User A, User B, Agent A, and Agent B, where the exchange of messages presented in Fig.8 are executed through the program shown in Fig.9 and the screen shown in Fig.9. (1) User B would like to be involved in a social group. (2) User B informs Agent B of the first, second, and third choice of social groups that he or she would like to join. (3) Agent A asks user A what his or her interests are and ascertains the first, second, and third preferences. (4) Agent B sends a message to agent A.(① in Fig.8),AgentB accepts that.(② in Fig.8) (5) Agent A and Agent B compare each of the users' preferences.(③ in Fig.8) (6) At this time, User A's and User B's first, second, and third preferences do not match. (7) Since User B expressed a desire for a friend, User A is given priority, because they were invited by User B. Thus, Agent A and Agent B give preference to user A's wishes. (8) Agent A and Agent B compare each of the users' preferences. (9) Agent A and Agent B choose one group. (10) Agent A sends User A a confirmation message describing the particulars of the decision.(④ in Fig.8) (11) User A sends a message of consent to Agent A. (⑤ in Fig.8) and then AgentA sends a message to AgentB.(⑥ in Fig.8)(12) Agent B sends a message of decision to User B(⑦ ⑥in Fig.8).

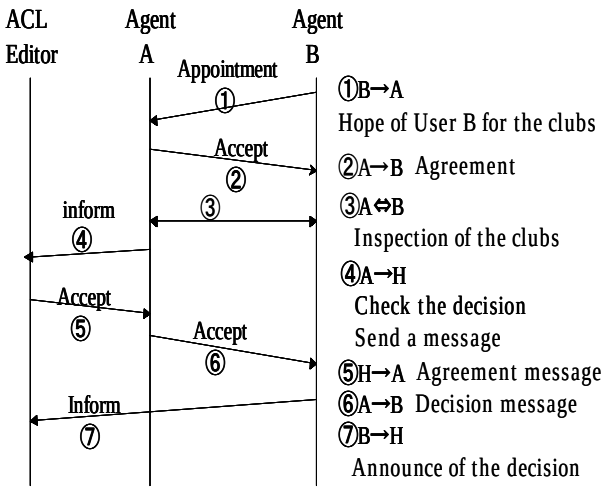


Fig.8 Construction of Message Communication

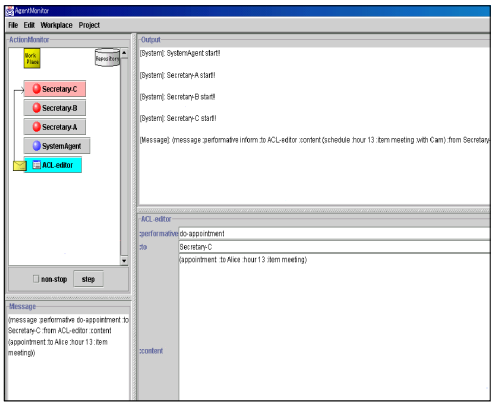


Fig.9 Example of Life Enhancing Agent (Search of Circle company)

```
(agent Syumi-1
  (property
    (create :author "kazuya" :date "01/22/2002"))
  (initial_facts
    (priority :first Bob :second Carn)
      // Secretary-1 の場合、(priority :first Bob :second
Carn)
      // Secretary-2 の場合、(priority :first Carn :second
Alice)
      // Secretary-3 の場合、(priority :first Alice :second
Bob)
    (secretary :name Alice :agent Syumi-1)
    (secretary :name Bob :agent Syumi-2)
  )
  (knowledge
    (rule add-hobby /*データ入力 */
      (message :performative add-hobby :from ?agent
               :content (hobby-list :rank ?r :hobby ?h))
= ?msg
        -->
        (remove ?msg)
        (make (hobby-list :rank ?r :hobby ?h))
    )
    (rule accept-hobby /* データ受け取り */
      (message :performative accept-hobby :to ?agt
               :content(hobby-list :rank ?r :hobby ?h))
= ?msg
      (secretary :name ?name :agent ?agent)
      -->
      (remove ?msg)
      (make (hobby-list :rank ?r :hobby ?h))
      (send :performative accept :to ?agent :content
(accept :rank ?r :hobby ?h))
    )
    (rule check-hobby1 /*データ照合 1*/
      (message :performative request-information
               :from ?from :content (hobby-list :rank
1 :hobby ?h)) = ?msg
  -->
      (make (join :from ?agent :hishobby ?h1))
      (make (join :from ?agent :hishobby ?h2))
      (make (join :from ?agent :hishobby ?h3))
      (make (check :c c))
      (remove ?msg)
    )
  /* 優先度1とのチェック マッチしたらユーザに決定項目
を連絡*/
    (rule check1
                    ⋮
```

Fig.10 Part of Programing of the Search of Circle company

3.2.2 Health Check Agent

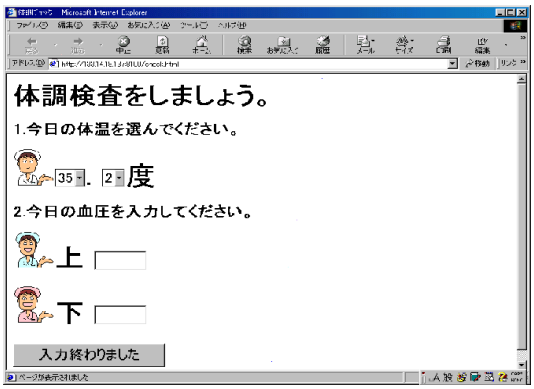
Fig.11 shows an example of knowledge information that has been used by the Health Check Agent. The knowledge information used in diagnosis is stored as a XML document, and management of this information is conducted through an “if-then” production rule. In this figure, <condition age> indicates the user's age, <condition pressu> shows the systolic readings, and <condition presd> indicates the diastolic readings. The health check and advice that is output to the user are based upon the user's age, and their systolic and diastolic readings.

The Health Check Agent's health check screen is shown in Fig. 12.

```
<?xml version="1.0" encoding="SHIFT_JIS" ?>
<conditionList>
 <condition age="60">
  <condition pressd="80">
   <condition pressu="110">血圧の上と下の開がないですね。気をつけてください。</condition>
   <condition pressu="120">正常血圧です</condition>
   <condition pressu="130">正常血圧です</condition>
   <condition pressu="140">正常血圧です</condition>
   <condition pressu="150">少し高めの血圧です。生活を見直してください</condition>
   <condition pressu="160">高血圧です。気をつけてください</condition>
   <condition pressu="170">高血圧です。気をつけてください</condition>
   <condition pressu="180">高血圧です。気をつけてください。</condition>
   <condition pressu="190">だいぶ血圧が高いです。医師に連絡します</condition>
   <condition pressu="200">だいぶ血圧が高いです。医師に連絡します</condition>
  </condition>
  <condition pressd="85">
   <condition pressu="110">血圧の上と下の開がないですね。気をつけてください</condition>
   <condition pressu="120">正常血圧です</condition>
   <condition pressu="130">正常血圧です</condition>
```

.

Fig 11. Part of Knowledge of Health Check Agent



1. Please select today's temperature.
2. Please input today's blood pressure.
   Systolic reading
   diastolic reading

Fig.12 Browser of Health Check

4. Evaluations and Considerations

Regarding the results of this prototype system's operation, evaluations and considerations have been based upon system functions and configurations.

4.1 System Functions

(1) PC Operational Support

At the present stage, the prototype system is being operated with pseudo users representing regular users. The pseudo users are given guidance on issues such as selecting character size, guidance on the menu, and what they should do next. Although major problems with this system have not been detected through these operations with pseudo users, when considering the older age of the actual people who will be using this system, we assume that spoken guidance on how to operate this system is essential.

(2) Information Assistance for the Life Enhancing Agents

(i)Providing E-Mail Partners

Currently, when the user is selecting to whom they will send a message, the e-mail partner is shown as an icon. This system uses agents on TAF to find out friends joing a new club with the user. Through that, the number of friends and the e-mails partners increases, it is necessary for the more numerous e-mail partners to appear promptly to the user, and the new addresses need to be registered in the system. Currently, we are investigating how to input new addresses during times when they cannot be promptly registered in the system.

(ii)Maintaining Contact With the User's Family

Issue that must be handled in the future include: what type of the user's family information should the agent transmit to the users; how can the agent grasp information such as contact with the family that is connected to helping improve the user's quality of life.

(iii)Giving Hobby Related Advice

As the user's activities in groups increases, it is likely that their preferences will change. In this case, the means to identify such changes has become an issue that needs to be addressed. Currently, user information is registered when the user begins using the system. Based on this information, the agent presents URLs that are related to the user's hobbies, but it is likely that they quickly tire

of them. We are currently considering how agents can connect the information they have obtained with advice that is linked to the user's new hobbies.

Searching the clubs with agents, user inputs the clubs in the first to third choice. On the agent monitor of TAF shown for users, users are force to input especially data like agent's name and details of movement.

Therefore this system makes user lost on using. Then this system needs to input only the names of clubs. As the result, the labor hour of user are lighten up.

(3) Checking Physical Condition

In the system's present state, the users measure their blood pressure and temperature, and personally enter this information into the computer. However, if this system is not simplified to the point where all a user has to do to measure important information, such as a touch pad and thus automatically transmit the information, this process will probably cause considerable distress when real-world users use it.

4.2 System Configuration

(1) Enrichment of the Agent's Knowledge

User information is registered in this system when the user uses it for the first time. Afterwards, the agent asks the user various questions on a regular basis to obtain the most recent information. In order to utilize these information for the user support, it is necessary for the agent's knowledge to be enriched.

(2)Strengthening the Multi-Agent System

Presently, multiple agents are only working together when users are looking for a social group to join. Although the current situation is one where agents are directly sending messages to each other, if a domain is set-up where multiple agents have common indirect access to this exchange of messages, they will be able to provide even more information to users. This system would use a combination of direct transmissions sent between agents, as well indirect transmissions.

5. Conclusion

In this paper, a proposal for an information-barrier-free support system intended to improve the quality of life for the elderly is being made. This system has a three-layer web-computing configuration that uses agents operating within its framework , and is primarily intended to enhance the lives of its users with TAF. Through this structure, we have proposed an information application system targeting the elderly, which makes use of agents. Furthermore, this system has been evaluated through the use of pseudo users. We have discovered areas where this system may possibly be used to enhance the lives of its users. From this time on, I would like to evaluate how this system works with actual elderly users, as well as their families, and the people in their lives.

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