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User Intention-Awareness System for Goal-oriented Context-Awareness Service

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Abstract

As the technology developed, the system is being developed as the structure that is adapted to the intelligent environment. Therefore, the existing situation information system couldn't provide satisfactory service to the user as it provides service only by the information which it received from the sensor. This paper analyzed the problems of the existing user intention awareness system and suggested user intention awareness system to provide a stable and efficient service that fits to the intention of the user compensating this. This paper has collected the behavior data based on the scenario of the sequential behavior course of the user that occurs at breakfast time in the kitchen which is the home domain environment that is closely related to our lives. This scenario course also showed the flow that the goal intentional user intention awareness system acted that it suggested, and showed the sequential course processing the user behavior data by tables and charts.

Key Words : Intelligent home, Intention modeling, Behavior prediction, Behavior analysis

1. Introduction

Now, our lives are becoming a ubiquitous computing environment that can access and communicate to the network any time, anywhere [4]. Due to this, it is concentrating how to correspond efficiently and intelligently to the individual situation reinforcing the computing/networking function and intelligent judging function within the ubiquitous computing environment. Therefore, specific technologies such as individual sensor, service and network technology are developing continuously. So, the situation awareness system that perceives the situation of the user by the computer itself is embossed as a necessary factor in recent ubiquitous computing environment. The situation awareness system [5] provides appropriate service to the user through interpretation, inference process and perceives the situation through the collection and combination of sensor information from the surrounding environment. Also, the situation awareness is an important factor to provide efficient service to the user by the system through inference and comparison of the goals of the user and the understanding of situation information, not just the simple awareness of the situation information. So, the situation awareness system can provide the service while adapting to the used situations and changes and has important feature than it can utilize the computer resources and services maximally through the detection and sensing of the user environment.

As the technology developed, the system is being developed as the structure that is adapted to the intelligent environment. Therefore, the existing situation information system couldn't provide satisfactory service to the user as it provides service only by the information which it received from the sensor. To solve this problem, the study of the system that fits to the intention of many users is proceeding as of. Here, the user intention awareness system can be defined as predicting the user's next behavior by recognizing the dispositions of the user that is repeated at a specific space automatically. This kind of user intention awareness is playing an important role in many applications. For example, it is playing a central function in web service search, communication between men and computer and mutual communication between men and robot. So, the intelligent system can have the ability to understand the intention of the user from simple demands and behaviors to this user intention awareness basis, and it can compose more efficient and environmental adaptive system through this.

Already in many papers and projects, the study of the method that serves while grasping the intentions through the prediction of user's behavior has been processed, and it has been achieved by the forms that provide service through the experiment using behavior data. Also, the robot or software agent has executed the behavior which corresponds from the predefined rules and grasped the intention of the user from the simple commands and key words. By this, there is a problem to grasp the intention of the user by simple rule. Because, to define the behavior for each domain previously generates systematical limit, and there may be cases they don't process the already defined rules and other behaviors.

This paper analyzed the problems of the existing user intention awareness system and suggested user intention awareness system to provide a stable and efficient service that

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fits to the intention of the user compensating this. The existing systems (Easy Living, Smart Home, Intelligent Room, Adaptive House, etc.)[7] predicted a user's intention using information inputted only from the sensor. To investigate a user's intention more easily and accurately compared to the existing systems, this study predicted a user's intention by classifying the inputted data from the sensor according to each time, using the k-means clustering method.

It approached while aiming at the point that the suggested system has the goal intentional disposition to the vague intention of the user. The reason is that if the user has some intention, it may be included to the behavior according to that, and that behavior is one expression to achieve the purpose. People have their own habits, but the habit occurs irregularly and their habits change often. Also, when they move to another place [6], the change in movement is included in the habit. Our goal intentional user intention awareness sys-tem provides motional predictive sequence while using the machine learning technique, and it composed a system by 6 modules and 1 History DB to process the behavior information of the user which changes dynamically time after time. These modules collect the unprocessed data that can be obtained from sensor or RFID, and can change into the processed data for more efficient process at the user intention awareness system.

Also, this kind of processed data interact with the History DB, and come to infer small intentional behavior to the user behavior information through Bayesian inference and learning algorithm of the Micro Inference. And the Macro Inference based on the Micro intentional behavior comes to provide transparent service to the user by inferring and learning what kind of bigger action the user will behave through HMM inference algorithm. This paper has collected the behavior data based on the scenario of the sequential behavior course of the user that occurs at breakfast time in the kitchen which is the home domain environment that is closely related to our lives. This scenario course also showed the flow that the goal intentional user intention awareness system acted that it suggested, and showed the sequential course processing the user behavior data by tables and charts. The system we will suggest in the future can provide needy service to the user at appropriate time through intention inference by the core technology for intelligent home embodiment, and it can develop to the infrastructure technology while the optimal service can be provided according to the situations such as intelligent home embodiment, public institutes and hospitals.

The rest of the paper is organized as follows. Section 2 briefly reviews the user behavior prediction theory, adaptive system used in this paper. Section 3 proposes a user intention awareness framework approach. Finally, we conclude this paper with a discussion of the current limitations of the approach and provide future directions for this research in Section 4.

2. Related Work

2.1 User Behavior Prediction Theory

In this paper, we look into the studies about the user's behavior analysis at the existing situation awareness system. The behavior records are used at the modeling to predict the activeness and next behavior of the user, too. Many situation awareness applications and studies used the behavior records to do adaptive behavior of the system [2]. This kind of application can infer the interests and purposes and the behavior records of the user through analysis. It has explained the cases of the user's behavior analysis that has been used hitherto. Studies have been progressed with the goals of the methods for the user's behavior prediction in many papers and projects already. The places to predict behaviors were study rooms, conference rooms, home domain environment, which are limited spaces [7]. By this, they were achieved by the forms of providing services through the experiments using simple behavior data. For the behavior prediction technique, Bayesian Network and Markov model and nerve net were mainly used. The next briefly describes the role of each algorithm. Algorithm plays the role of transmitting the context information which has been worked on, and Bayesian network aims at the embodiment of the network that best fits to the training collection of the data according to the given evaluation scale. By this, it is appropriate to the model that fits to the time through the optimal result and comparison from the status prediction method. The Markov model [1] is used in generating the model that predicts the future movement of the user, and this is because the Markov model has the feature that expresses the change in pattern according to the flow of time. For example, as we explain, the weather prediction decides tomorrow's weather based on the facts of the past weather. System is achieved by the process as follow. It comes to express the status that can occur at the given situation through the setting of statistical model about weather prediction, and is achieved of the system at which succession occurs by new status with continuous time of regular interval.

The nerve net is composed of many units that have simple processing factors of the nerve unit expression at a parallel system. The biggest feature of nerve net is that it has the ability that can learn based on the cases (director learning).

2.2 Adaptive System in Environment

Previous research has been done using real-life experimental environments, such as the Enabling Environment, Aware Home, and Neural Network House [8]. Among these researches comparable to ours, the Neural Network project is subtle adaptive system in the house. Some examples of what the system can or eventually will do include: predicting when the occupants will return home and determining when to start heating the house so that a comfortable temperature is reached

by the time the occupants arrive; detecting statistical patterns of water usage, such that hot water is seldom if ever used in the middle of the day on weekdays[3], allowing the water heater to shut off at those times; inferring where the occupant is and in what activities the occupant is engaged perhaps he is reading at the kitchen table and controlling lighting patterns and intensities accordingly, even anticipating which rooms are about to be entered and turning on the lights before the room becomes occupied.

However, the temporal prediction approach assumes that changes in the environmental factors follow some predictable temporal patterns. Although possibly valid in some environments, this assumption may not apply to many others. All sensor observations are associated with the timestamps when the readings are made; object's location change along the time; the containment relationships change along the time, and all related transactions are also associated with time.

3. The Proposed Approach

We have approached aiming at the point that the vague intention of the user has goal intentional disposition. The reason is when the user behaved something, that behavior implies the intention of the goal, and it is an expression to achieve the purpose. For example, we can predict the behavior information of the user through the behavior the user works and history information at the home domain environment. But, people have the habit that is repeated in everyday life but that habit occurs irregularly and has the motive that sometimes change. To grasp this habit of the user and to infer right behavior, we must be able to process the user behavior accurately that changes dynamically according to the time. So, the system by 6 modules and 1 History DB for the goal intentional user intention awareness system that this paper has suggested provides dynamic prediction sequence using machine running technique to process the user's behavior information for efficient service.

3.1 User Intention Awareness Framework

The framework to grasp the intention of the user that changes according to the time is composed of 6 modules. To explain each module, it is as follows. First, behavior data acquisition is collected while observing user's behavior through video camera, cam, and CCTV. Second, context extraction selects data to express situation among the raw data that are not processed and are provided by data acquisition module. Also, it groups or categorizes the context related to the user. Third, the situation expression module plays a role processing the context information according to the framework for the user behavior inference and learning at the user intention framework. Fourth, data matching plays a role to take charge of insertion, deletion and correction of the data through the comparative analysis with the existing data while gearing with the history DB. Fifth, micro inference sets user's sequence applying the Bayesian technique of many small behaviors that can distinguish the intention of the user through history DB and intercompatibility. At last, the macro inference is the module that used HMM (Hidden Markov Model) to infer the intention of the user that can do bigger behavior through the intentional information which is generated from the micro inference module.

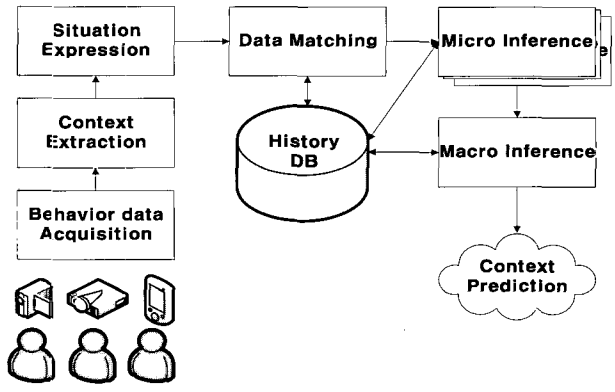

Fig. 1. User Intention Awareness Framework

3.2 The Operation Flow

Figure 2 is the overall flow chart of the user intention awareness system that pro-vides customized service inferring and learning the situation information that fits to the user's intention of the situation information that is not processed which enters from each sensor or RFID to video camera, cam or CCTV. For example, the behavior data acquisition from RFID or the sensor that collects and forwards the general information from the surrounding environment forwards context extraction module while collecting situation information is not processed. Next, it forwards the data to the situation expression module while extracting only the needed data to the inference and learning from the user intention awareness system of the received situation information from the data achievement module. And the situation expression module which got this extracted information comes to forward that processed data to data matching module after processing it into the context information that fits to the data matching module. In the phase of data matching module, the history DB and mutual data are being exchanged mutually with the periodical interval, and when new situation data information is received, it comes to play the role of inserting, deleting and correcting the received situation information while comparing it with history DB and existing data.

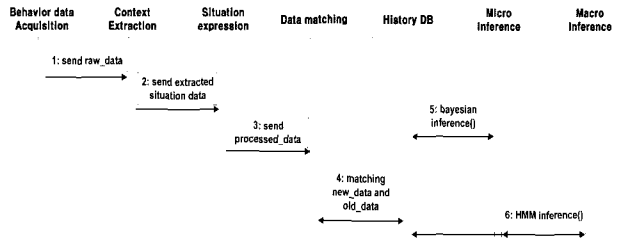

Fig. 2. The structure of the proposed user intention awareness system

Also, when the user intention behavior information is received, micro interface module that interacts with the history DB plays the role that infers micro inference behavior to fit to the user behavior information applying Bayesian inference and learning algorithm for which behavior will the user do while discerning the behavior information according to the sequence of time as the user's intentional behavior information is received. At last, the macro inference plays the role of predicting the intentional behavior information to provide transparent service to the user while inferring and learning what kind of bigger behavior will the user do through HMM inference algorithm receiving micro intentional behavior information that is inferred in micro inference.

3.3 Scenario

3.3.1 Scenario Environment

This paper collected the behavior data based on the scenario of the sequential behavior courses that the user could do at the breakfast time in the kitchen which is a specific domain environment that is closely related to our lives. First, to compose the scenario, the utensils and food in the kitchen are set limitedly. We collected context information that we have used to make food for a week at the kitchen domain experimental environment. Also, that information controlled more efficient situation information dividing it by a large category at the History DB. That category was classified into 6- refrigerator, sink, dish shelf, gas stove, rice cooker and dresser. This information collected and analyzed data using video camera, sensor and RFID, and through this, we described the situation information expression which is processed and is grasped of the regularity of the behavior the user acts while cooking.

3.3.2 Situation Information in Kitchen

- *Refrigerator*: kimchi, fish-cake, beef, rice-cake, egg, spaghetti, strawberry jam, tomato ketchup
- *Sink*: chopping board, knife
- *Sideboard*: scissors, plate, scoop, cup, kettle, spoon, earthen bowl, pot, frying pan
- *Gas oven*: gas oven
- *Rice-cooker*: container for boiled rice
- *Cabinet:* bread, coffee, instant noodle, rice, spaghetti

Table 1 expressed the behavior of kimchi parched rice that the user made on the first day by the table among the user's behavior information that was observed for 1 week. This behavior table information is inserted, deleted and updated through History DB and intercompatibility. The experiment time was from 8AM to 9AM and the measuring time is different according to the kind of food, but was observed for about 30 minutes. It discerned the behavior of cooking kimchi parched rice by 8 behaviors of the ones that change according to the time for the dynamic situation inference. The behavior 1 expresses the behavior moving to the refrigerator, taking out the kimchi barrel and gripping the knife and chopping board from the disk shelf. Behavior 2 expresses the behavior of chopping kimchi and washing the knife and chopping board from the sink based on the behaviors of behavior 1. Behavior 3 takes out the fry pan and rice scoop from the dish shelf and parches kimchi turning on the gas stove, and behavior 4 expresses the behavior gripping the rice scoop and scooping up the rice. Like this, each user's behavior (opening the refrigerator door, gripping the knife, chopping board and rice scoop) can be sensed through the sensor or RFID, and this information is inputted to the user intention awareness system through behavior data acquisition module.

Table 1. User behavior of making the kimchi parched rice

Parameters	Context Name	Context Name	Context Name	Context Name	Context Name
Behavior 1	chopping board	refrigerator	kimchi	refrigerator	chopping board
Behavior 2	knife	faucet	chopping board	knife	
Behavior 3	dish				
Behavior 4	faucet	dishcloth	faucet	sink	
Behavior 5	tissue	frying pan	olive oil	gas range	
Behavior 6	chopping board	kimchi	spoon		
Behavior 7	rice-cooker	spatula	frying pan		
Behavior 8	account book	sesame	frying pan	dish	

3.3.3 Prediction of User Behavior Information

This paper showed the user's behavior information observed during a week at the kitchen domain and the pattern of the user's behavior that can be predicted in the future through this. As we see in the figure, the inference chart shows the information that we can collect directly from the sensor and RFID, and based on that information, it is divided into the Bayesian and the user intentional parts that can be inferred through HMM algorithm. These user intentional parts are divided into micro inference part and macro inference part, and this kind of information cannot be directly collected from the sensor, so we come to learn/infer while applying inference algorithm. So, in this scenario environment, the user can infer which food he/she will cook with the collected kitchen situation information from the sensor like figure 3. So, it configures the environment for the user to cook more comfortable and efficient cuisines by predicting the food that the user is to cook.

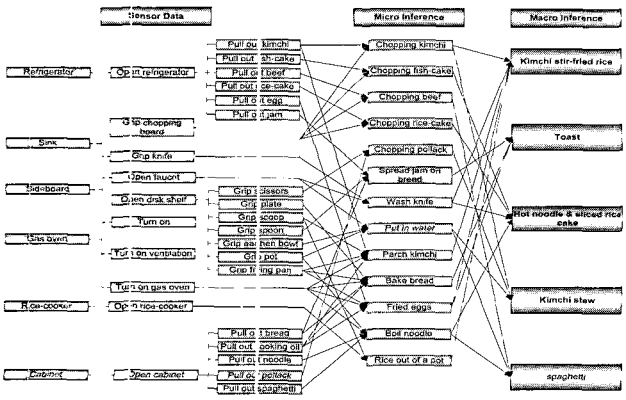

Fig. 3. Prediction of User Behavior Information

4. Conclusion & Future Work

The user intention awareness system this paper suggested analyzes the user's intention accurately at the ubiquitous environment, and it is the system to provide more stable and efficient service. We focused on that the user's intention has goal intentional disposition, and to infer right behavior and grasp the behavior of the user, the dynamic change according to the time can process the behavior of the user accurately. So, the goal intentional user intention awareness system that is suggested at this paper provides dynamic prediction sequence using machine running technique, and it composed the system by 6 modules and 1 History DB for us to process the behavior information of the user for efficient service. It provides more convenient environment to the user by predicting the behavior that the user is to do through the learning and inference of the information that is not processed and is collected from the sensor. In the future, we may embody it to be an efficient system also in the wide u-city range while researching and developing more expanded system. Also, we are to research and develop the system that is flexible to achieve compatibility also at this type of system and OS environment.

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