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COCOLAB: Supporting Human Life in Ubiquitous Environment by Community Computing

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ABSTRACT

In recent years, the numerous studies have attempted to find and explore to support human life in the Ubiquitous environment. However, no definitive answer has been given to this question and research is still in its early stage. This paper proposes the ***Community Computing*** as one of solution to support human life for home environment by implementing seven different goal-oriented scenarios. Also, this paper describes normal home-like test-bed ***COCOLAB (Community Computing Lab***) of ***Center of Excellence for Ubiquitous Computing and Network (CUCN)*** and shows how community computing is implemented for each scenario such as defining goal or configuring devices. With successful results of implementation, it is the purpose of this paper to suggest the community computing is the one of the best solutions to support human life in Ubiquitous environment.

Keywords: Community Computing, Ubiquitous Life, Scenarios, Location Based Decision, and Test-Bed

1. INTRODUCTION

Since Mark Wiser introduced the basic concept of the Ubiquitous computing [1] the great attention has been shown to the question of implementing these new technologies. Essential to the notion of the Ubiquitous computing is to provide comfortable life to human and much scholarly work has been done on the topics of achieving this goal such as Aura [2], Pico [3], Gaia [4], or RCSM [5]. Notably, the COCONUT (**Co**mmunity **Co**mputing and **N**etworking for **U**biqui**T**ous Life) [6] project of CUCN is an obvious parallel to these projects. The main purpose of COCONUT project is to develop fundamental technologies for man-machine interaction and intelligent information processing for Ubiquitous autonomic computing services, and to implement real Ubiquitous environment based on context awareness. More over, the COCONUT project considers Ubiquitous computing not simply as “human can access computer anywhere, anytime” but as “the computers think more intelligently to provide better services without any perception of humans” To implement this concept in Ubiquitous environment, the CUCN focuses on ***Community Computing*** that will be covered later. Remarkably, the CUCN developed a COCOLAB test-bed to implement seven different scenarios those might happen at our normal life. However, the CUCN provides quite different approaches to resolve the goal of each scenario. The CUCN applies community computing to provide better services for human life. Many people are working on Ubiquitous environment and they also provide their own test-bed such as Ubiquitous Home [7], PAPI [8], Easy Living [9], Aware Home [10] and the COCOLAB is one of these kinds of test-bed. As a consequence, the central to this paper are two ideas: Suggesting scenarios of Ubiquitous life and solving these scenarios with our developed solutions which is community computing. This paper is organized as follows. Section 2 describes the concepts of community computing. Also, the main computing devices at COCOLAB are introduced at section 3. Section 4 describes the scenarios and way to resolve their goals by implementing community computing. Finally, the final comment is given at section 5.

2. COMMUNITY COMPUTING

In general, user application service areas a ‘community’ are interpreted as “a collection of people who are physically closed” or “a collection of people who have common interest” [24], [25], [26]. The COCONUT project uses this term to have a different meaning and defines a community as *a collection of devices and services that cooperates one another to achieve common goals* and the members are considered to have cooperative relationship among them. Therefore, a community will be comprised of

goals, members, and functions of the members. A member who is in one community and can also be a member of another community. One or more devices or services can be a member of multiple communities simultaneously. In summary, a community might be a subset of other communities and the services and devices might be shared by multiple communities depending on the goal of the community. Consequently, *community-based computing* has two viewpoints. First, a service or device is developed to collaborate or cooperate with other entities for a new service. Second, a new service can be developed simply by composing the pre-configured services and devices into a community. If a community is to be specified formally, it can be represented as a tuple of goal (*G*), a necessary condition (*C*), a member set (*M*), and a procedure (*P*). The presentation format has not been defined yet and we will discuss what will be presented in each field. First, ***G*** presents the goal of the community. One of main objectives of ubiquitous computing environment developers is to provide people with comfort, safety, and convenience. The main goal of community in ubiquitous computing environment also corresponds with that of developer. All of the communities try to achieve or approach to the ideal object in complex or various situations and conduct tasks for transferring from various situation to situation that is close to the ideal goal. The goals of a ubiquitous computing environment can be arranged in a hierarchically and the community that has a more general objective may include other communities which has a specific object. Second, E presents a situation and a triggering event that will activate the community. A situation can be considered as the prerequisite of the goal. A triggering event is an event that incurs the requirement of the goal at the given situation. A situation can not explain when the community should be activated. In addition, a triggering event can not define the exact situation that the community starts to act. Therefore, E contains the situation and the triggering event simultaneously. Third, M presents the specification or requirement of the member of the community. It does not specify the specific instance of the service or device. Instead, it defines the functional requirements of each member. Since a community can be a member of a community, a member can be a pointer to another community. According to the specified requirement, proper instance will be searched when the community is organized and activated. Last, P presents how members collaborate. The roles of the members can be defined or detailed procedure can be specified. A community has a life model and it is created when required. Its creation is referred to the creation of specification. The community is not active until it is activated by the triggering event in a given situation. After accomplishing its goal, it goes into inactive state. Whenever a triggering event occurs in a given situation, it is reactivated. The specification will be transformed without changing the goal and will evolve with the advancement of the goal. The community will decease when the specification is removed from the ubiquitous computing environment. The figure 1 shows how the community computing is implemented.

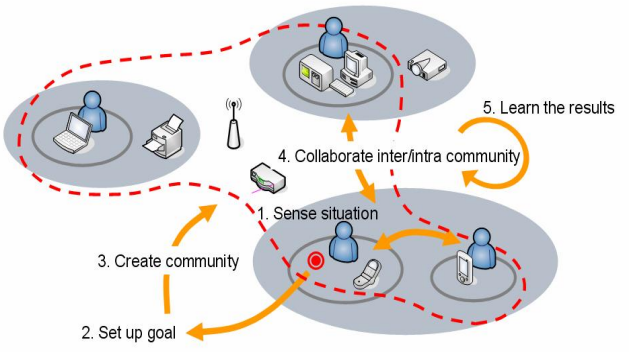

Figure 1 : Implementation of Community Computing

According to this figure, the initial step of community computing is that the required context or information is collected by sensors. After sensing the information, the appropriate device sets up the service goal to provide. Base on the found service goal, the proper devices are configured and make a community. These devices are called community members and collaborate each other to achieve the found service goal at second step. The main issue of community computing is how to define the service goal and configure community members efficiently.

3. THE BASIC DEVICES IN COCOLAB

To support the best services to human in given situation, there are many devices work together according to community computing concept. However, there are common or main devices which control other devices or provide basic information for overall situation. First of all, the sensor network should be deployed to provide basic information to make correct situation. Many people are working on this field [11], [12], [13], [14] and also the wireless sensor network is already implemented for home or commercial market.

The CUCN are also developing the sensor network and deploys simplified version of that by utilizing RFID at COCOLAB.

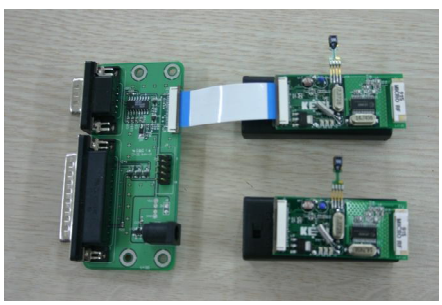

Figure 2 : RFID Reader and Mobile Node

Figure 2 shows the deployed RF reader and mobile node at COCOLAB. After sensing the location of humans by this sensor network at COCOLAB, the collected information is

transferred to the main server. This device is called ***Situation Manger (SM)*** at COCONUT project. The Situation Manager utilizes the collected data from deployed sensor network to define current situation of humans. The implemented scenarios of COCOLAB are mostly based on the current location. After defining the situation, the Situation Manager notices the information to ***COCOM*** that stands for Community Computing Manager. The COCOM configures the computing devices and home appliances to provide the found services. Currently, the COCOM is static that only works for some pre-defined scenarios. This will be improved to be more intelligence so provides services in dynamic environment. There is another main computing resource to support COCOLAB.

The COCONUT project developed ***uT-Adaptor System*** to transfer any data in this system. Any device in this project should send and receive data through this middleware by using XML-based interface language. Finally, the Digital Appliance Server ***(DAS)*** is deployed to manipulate home appliance systems. When the COCOM configures the devices with given situation, it controls the home appliance systems through DAS such as on or off the light. Since the DAS has to manipulate the appliances it contains all of the information of the systems in COCOLAB. Figure 3 describes the how these devices are connected and working together to resolve the goal, in this case, opening door.

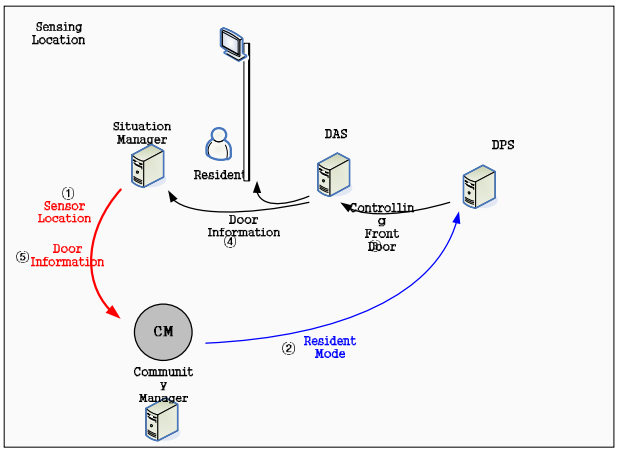

Figure 3 : Returning Home Community

In addition to these devices**,** the CUCN developed Community Viewer to monitor which devices are participating in specific community at real time. By utilizing this viewer, the users can figure out current situation of community and how the community is configured. This viewer shows all the devices at COCOLAB testbed and only active devices are highlighted and connected each other to show the community members for each community. The figure 4 shows the community viewer for sleep scenarios that will be covered at next section.

Figure 4 : Community viewer for sleep scenario

4. IMPLEMENTATION OF COCOLAB

The COCONUT project implements four scenarios of home situation and three scenarios of office situation. Each scenario has its specific goal and the purpose of this implementation is to provide the solution for the goal by utilizing community computing. Figure 5 shows each room of COCOLAB. This section describes the scenarios and shows why the community computing is the best solution.

Figure 5 : COCOLAB Testbed

4.1 Returning Home

Description: The resident is approaching to the front door.
Goal: Figuring out the identification of human and prompt human to leave a message or open the door.
Solution: The RFID reader reads the mobile node that attached to the human object and sends the node's ID to the situation manager. If the ID is pre-registered as the one of residents on the server the situation manager defines the current situation as "opening a door" This is the goal of this situation and sends the information to the COCOM. When the COCOM receives this goal it configures the devices and appliance as community members to resolve the goal. The COCOM sends commands to the DAS to control each device for opening the door. The figure 3 shows how this process is accomplished.
Community Members: door phone, sliding door.

4.2 Home Community

Description: The resident sits down on the sofa and enjoys media. While he is watching TV, he moves to the restroom and comeback to the living room.
Goal: Providing the best environment for enjoying media and seamless service depends on the human's location.
Solution: The SM notices that the resident is entering at living room and the DAS opens the curtain and turn on the light. When the resident sits down at the sofa the lights on the TV side and the TV turns on. The program on TV is on depends on the resident's preference such as sports, news or movie. While he is watching the TV the residents are moving to the restroom. Since the SM figures out that the location of residents has been changed the TV on living turn off and the program keeps playing at restroom through magic mirror at restroom. While he is watching TV at restroom there is incoming call. Since the server already knows where he is, the phone in the restroom rings. When he comes back to the living room while he is talking through phone at restroom the resident can talk through the phone at living room without any manipulation of phone. The SM just redirects the incoming call to the phone in living room. Also the he can still watch the TV at living room after talking. While he is on line the volume of TV is
Community Members: TV, lights, phone, magic mirror, curtain.

4.3 Care Network Community

Description: the resident's father has problem with his heart and get appropriate help from related people
Goal: Proving the health care services to a patient
Solution: While he is watching a movie his father has a problem with his heart. The cardiac sensor on his body senses this problem and sends the information to the father's PDA. The PDA alerts the father's first son about this situation but he rejects to come to his father due to some reason. The father's PDA figures out that the first son can't come to. Finally, the emergent message is sent to the second son's device which is the PDP TV. He checks the emergent message and figures out what's going on for his father. After figuring out his father's problem, he leaves to help him out.
Community Members: PDAs, Cardiac sensors, TV.

4.4 Sleep Community

Description: The resident goes to the bed room and wants to get sleep
Goal: Providing best environment for sleep situation.
Solution: When he goes into the bed room the light turns on and the curtain opens. He is lying on the bed to get some rest. The application predicts his intention based on his location and movement. This probability based situation aware application is called SSR which stands for Smart Sleep Recognizer. The current version of SSR only considers the time, location, and movement. When he stays in bed without any movement the probability of sleep should increase. By utilizing the Bayesian network, the SSR infers that with higher probability the subject wants to get sleep. The SSR sends this situation to the server and the proper reaction occurs to provide the best service to him. When he moves out of bed the SSR notices that he is trying to get up. In this case, the server understands this situation and gives proper services for helping him up.
Community Members: lights, fan, air condition, curtain

4.5 Conference Community

Description: The resident receives emergence message from his company and needs to set up the emergence meeting.
Goal: Providing meeting environment at work place.
Solution: When he receives the emergence message from company he simply push the button on his PDA to setup the meeting. The Office Agent (OA) checks the members who should participate in this meeting and their schedule or location. The OA figures out the place and time for the meeting depends on the found information. Finally, the OA sends out this information to all of the members.
Community Members: OA, PDAs.

4.6 Network Community

Description: The resident registers his materials for a meeting and the materials are transferred to the PC on the meeting room. All the devices are prepared for the meeting.
Goal: Providing best environment for meeting.
Solution: When the resident is entering meeting room the lights turn on and the present slides those are transferred before are displayed through projector. Also, the slides are printed automatically. When the late member arrives his notebook can participate in this meeting and shares the information by implementing ad-hoc network. The members in meeting room receive the slides automatically and share the information.
Community Members: Projector, PC, Notebook, PDA.

4.7 Office Community

Description: At the middle of meeting, one of the members returns to his office and needs information on the meeting.
Goal: Providing seamless service for the meeting.
Solution: The COCOM notice that the member returns to his office. Since is figure out the location of the member the COCOM transfers the all the information on notebook at meeting room to PC at his office so he can continue to work on the job.
Community Members: Notebook, PC.

5. CONCLUSION

The CUCN defines the community computing as *"An autonomic collaboration model for Ubiquitous fusion*

service in Ubiquitous computing Environment" With given scenarios we show you how well this concept is suitable for resolving problem to support human life in Ubiquitous environment. Currently, it is just static community computing and will be improved to be dynamic community computing for near future to support efficient service to human.

7. ACKNOWLEDGEMENT

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