Smart-Furoshiki: A Context Accumulation Device from Everyday Daily Objects

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ABSTRACT

Recently, there is lots research for tangible objects which enables to support users everyday's life. However, due to the high price of each sensor-attached devices themselves, we hesitate to attach such devices to any kinds of cheaper objects. To give an actual example, documents using at a weekly meeting is not worth to attach sensor-embedded devices which costs more 20$. Even worth, batteries of sensor-embedded devices should despoil the earth environment to no small extent. Therefore, the low-priced system to support users' daily life without battery is needed. We will propose a novel hardware platform using cheap RFID tags which can attach on any everyday items. We have design and implemented two size of RFID system which has flexible multiple area antennas to support accumulation of users' context. This paper describes details of Smart-Furoshiki and its applications.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous; D.2.11 [**Software Engineering**]: Metrics—*Data abstraction*

General Terms

RFID

Keywords

RFID, Muiltple Detection, Everyday Items, Context Accumulation

1. INTRODUCTION

Recently many of researchers have proposed ubiquitous systems to support everyday users' environments, especially rooms and offices. These system are embedded computers and sensors to support human activities [6]. However, to setup all of devices is difficult for users who are unfamiliar with computing technology. To make matters worse, it takes much cost to appropriate objects' positions in this kinds of environments. Most of research has ignored such a economical cost and users maintainability.

Figure 1: Furoshiki: traditional Japanese wrapping cloth

We have been creating non-export DIY ubiquitous system, for example smart furniture [3, 11, 4]. However, these objects are still too large and heavy for users to set up any environments. These systems needed lots of sensor buttery. Our reaseach goal is to develop a technology which enables non-expert users to create smart objects in easy way without node battery. Each RFID tags are less than 1$ and they are easy to attach any kinds of objects even the object is made of metals.

We propose a novel system called Smart-Furoshiki which is a sensorized cloth for supporting office and home activities. "Furoshiki" is a type of traditional Japanese wrapping cloth that can were frequently used to transport clothes, gifts, or other goods.(see Figure 1)As Furoshiki is so flexible and simple. Therefore it can use lots of porpose. For example it can wrap any type of shapes from bottles to box. Also It can cover on the important things, or spread under cloth.

Smart-Furoshiki has passive flexbile RFID annntenas and a tiny RFID reader and can be used universally such as a tablecloth, a tapestry and a cover. We user passive type

of RFID not to use battery. Users can easily use Smart-Furoshiki without configuring computers, sensors and networks inside each Smart-Furoshiki.

2. SYSTEM ARCHITECTURE

In this section, we describe the system architecture of Smart-Furoshiki. We have develop two type of Smart-Furoshiki, large size and mobile size.

2.1 Desktop-Size Furoshiki

Desktop-size version is created for the purpose of to use in a office and home environment. This type can detect not only RF-IDs of everyday objects but also the existence area ID. By using these two type of ID, the system can detects the context information. An example scenario is that a user ' s car key and her/his wallet are always put nearside on the Smart-Furoshiki.

Hardware of Desk-top Size Furoshiki

Figure 2 and leftside show the architecture of Smart-Furoshiki. Smart-Furoshiki has 8 RFID antennas and 8 tags. RFID reader uses 8 antennas on timesharing system due to avoid the radio wave collisions between antennas. The reader is special model Takaya TR3-D002C-8 which has 8 antenna channels. Each antenna is made by conductive fabric[10] for the purpose of bending it flexibly as shown in Figure2. The material of fabric antenna has special film of metal. It has a thickness of 0.125mm. The density is 72g per m^2. According to the tag size, the reading distance is from 0cm to 18cm.

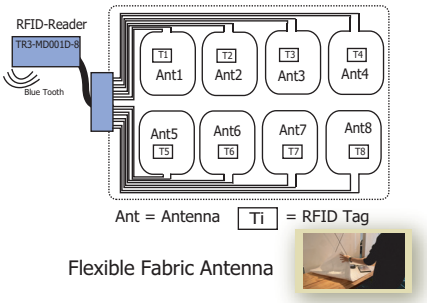

Figure 2: Architecture of the Smart-Furoshiki and Flexible Fabric Antenna

The 13.56 MHz tags are stitched into the Furoshiki at the center of each antenna. Every antenna is unified as the cable to the 8 port RFID reader. The Smart-Furoshiki is separated in to 8 areas, which is cove Furoshikie range of RFID antenna. To simplify the explanation, we user Ant_1-Ant_8 as the name of antennas and T_1-T_8 as RFID tags. T_i is placed at the center of Ant_1 and always detected by Ant_i.

Figure 3 right side shows the middleware screen shot of Smart-Furoshiki. Smart-Furosiki can read multiple objects ID in multiple areas unlike other RFID system. The middleware has also has application repository and multicast data transition architecture to support applications developers.

Mechanism of Sape Recognition

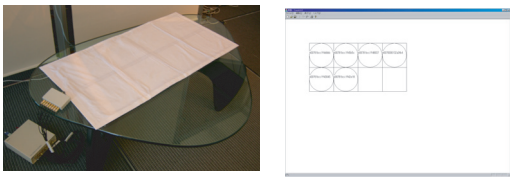

Figure 3: Exterior of Smart-Furoshiki

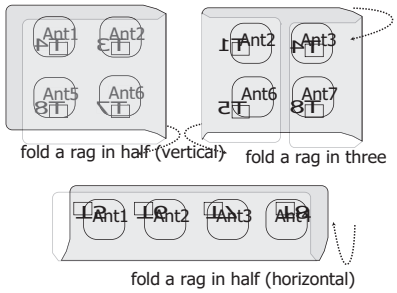

Figure 4: Mechanism of Self Shape Recognition

When Ant_1 detects T_4, the shape of Smart-Furoshiki is folded in to half as Figure 4. When Ant_2 detects T_1 and Ant_3 detects T_4 simultaneously, the shape of Smart-Furoshiki is folded in to three. In the same way, the detection T_2 from Ant_1 means that the shape is folding into half horizontally. In the case that there are more than 2 Smart-Furoshikis, We can estimate physical overlapping of Furoshikis by reading the neighbor's tags. Thus, the Smart-Furoshiki can detects tags' ID, detected area on it, and physical shape of Furoshiki.

2.2 Mobile-Size Furoshiki

Users carry too many kinds of everyday objects including books, papers, cell phone, magazines, DVDs, wallet, and music player. Users have a wish to manage such objects. Furthermore, they have a desire both to reduce things left behind and not to lose something important work related on the something on the bags.

All the electric devices, such as bluetooth communication module, RFID reader, and antenna much condenser circuits, and battery, are accumulate into a small electric box(see Figure 6).

To satisfy these needs, we have designed and implemented a new type of Smart-Furosihki as our future work.

Hardware

Figure 5 show the use case of Mobile-Size Furoshiki. This type of Furoshiki can put everyday objects inside and can carry it anyplace. The system can recognize the users' belongings, a thing left behind and the duration time to bring. System can gather these users context even if users are outside of office.

3. APPLICATIONS

To assume the usage in office environment, We have 3 applications based on the affordance of Smart-Furoshiki, laying, covering, and hanging.

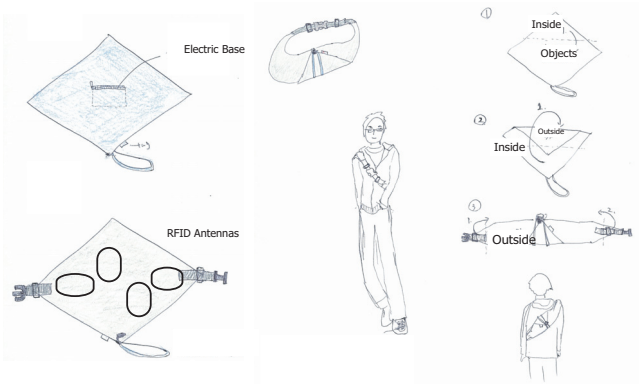

Figure 5: Use Case of Mobile Size Furoshiki

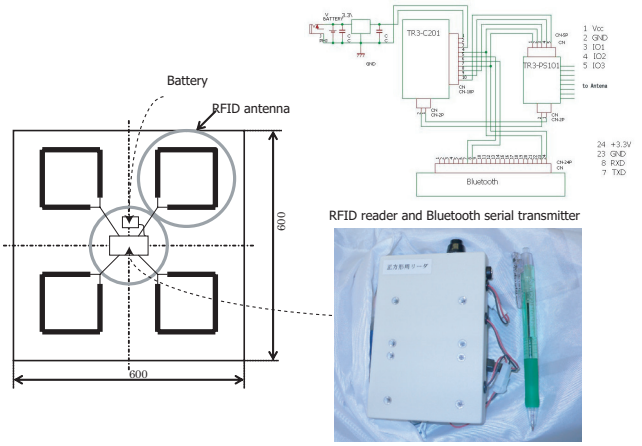

Figure 6: Carry type of Smart-Furoshiki

3.1 Supporting Collaborative Works by Laying Smart-Furoshiki on A Desk

Currently, the number of documents and data which are treated in cyber space is increasing. However, cyber desktop management systems can not recognize objects on a physical desktop area, correctly. (ex. Books, DVD jackets, pens, papers, lights, electrical appliances ,room sensors) On the other hand, physical objects can not recognize either cyber object which used by same person. This Smart-Furoshiki is a novel hardware and desktop management system which can handle both cyber and physical objects.

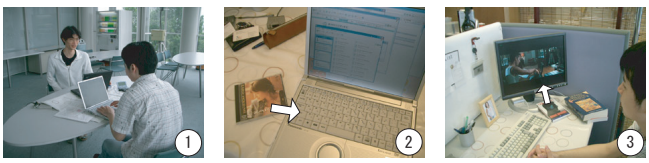

Figure 7: Supporting Collaborative Works by Laying Smart-Furoshiki on A Desk

The users can lay Smart-Furoshiki on a desk. The Smart-Furoshiki supports cooperation between objects on it. Objects on Smart-Furoshiki are identified by RF-ID. Figure 7 shows it. When computers are brought close, those computers share directories each other. When the users edit the same file on those computers, the changes are immediately updated on the editors each other (1). Also Smart-Furoshiki supports cooperation between computers and objects. For example, the users place a music CD near a computer, and the music data in CD is copied to the computer (2). Besides, Smart-Furoshiki supports cooperation between objects. The users can see the movies on the display putting the movie DVD near the display (3).

3.2 Managing Objects Covered with Smart-Furoshiki

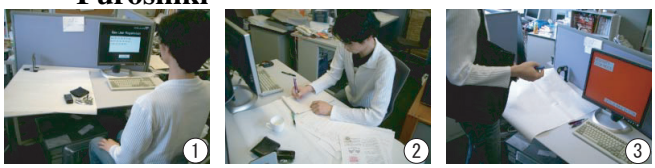

Figure 8: Managing objects Covered with Smart-Furoshiki

Users can manage the users' objects covered with Smart-Furoshiki. The scenario is showed in Figure 8. First, the user attaches an RF-ID tag to the user's objects and registers it to Smart-Furoshiki (1). When the user puts the user's object that is registered before, the user is authenticated and login the PC on the desk. The authenticated user can work on the desk like 3-1 scenario (2). When the user leaves the desk, by covering the objects with Smart-Furoshiki the user visually hide them and log off the PC (3). When the user wants to uncover the objects hidden by Smart-Furoshiki, the user must put the user's object. If a user that is not authenticated put off Smart-Furoshiki, the Furoshiki informs the home security system of the theft. Also, Smart-Furoshiki reminds a user of the object left behind on it. For example, when a user always brings the user's cell phone, watch and wallet together Smart-Furoshiki remembers this practice. When the user left the watch behind although the user brought cell phone and wallet Smart-Furoshiki warns the user.

3.3 Wall Type Task Schedular using Smart-Furoshiki

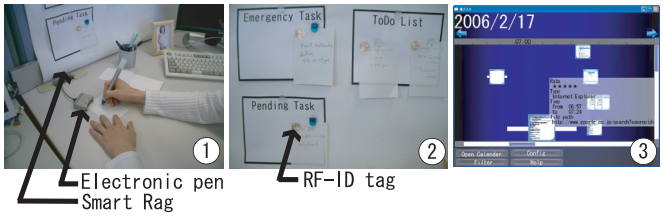

Figure 9: 1:Writing memo pad 2:Pinned tasks 3:Timeline viwer

The third example is the application to manage users' tasks. The scenario is shown in Figure 5. Smart-Furoshiki hangs

on a wall. The wall is separated into some areas. The area means the priority of tasks, such as "Emergency task" and "Pending task". First, a user writes a memo pad about the user's task with an electronic pen that is able to convert handwriting to digital data [7], and pins that memo pad to Smart-Furoshiki (1). The application registers a task content written on this memo pad as pinned areas' meaning (2). Furthermore, when a user removes the pin, the application deletes the pinned task. The pinned tasks are shared in the group, and also the user can check the tasks wherever the user can connect the network. Finally, these task histories are referenced on a PC by Timeline viewer (3). Users can see the task histories, and retrieve before tasks easily.

4. RELATED WORK

There is a research that aims to realize a smart carpet that identifies things on it[2]. However the size is too large to be used as a tablecloth or a tapestry like Smart-Furoshiki. bYOB developed at MIT media Lab is a smart bag with embedded sensors [5]. bYOB is built in antenna of RF reader. Our Smart-Furoshiki is made from a conductive textile and can work as the antenna itself. Therefore Smart-Furoshiki is thinner and cheaper than that of bYOB. Other research [1] [9] are also using sensorized fabrics. The aim of these research is to obtain biometrics information at wearable environment. Our research target, on the other hand, is for collaborative work at office environment.. Electronic Tablecloth made from E-broidery [8] is an electronic conductive textile can read an RF-ID tag. However the usage of it is limited to tablecloth. Smart-Furoshiki has more flexibility.

5. CONCLUSION

We have developed a furoshiki type smart material called "Smart-Furoshiki" that allows inexperienced users to create smart work surroundings. We proved two type of Furoshiki. Large size Smart-Furoshiki can detect objects ID and place using 8 RFID antennas which are made from flexible fabric. Smart-Furoshiki can recognize the changing its own shape autonomously through combination of detecting RFID tags and antennas. Moreover, Smart-Furoshiki's flexibility allows to turn fold this into any shape. Using this features, Smart-Furoshiki can be based on a lots of applications. To show the utilization of Smart-Furoshiki for the various purposes at office environment, we implemented demonstrations based on three scenarios. First one is the collaboration between mobile PCs on the laying Smart-Furoshiki At the second demo by using Smart-Furoshiki for covering objects, users can keep privacy in easy way. As the third demo Smart-Furoshiki, hanged on a wall, helps tasks management between cyber and physical memo papers. Secondly, to accumulate context information even when users outside environment, we provide mobile-seize Smart-Furoshiki. Mobile-size has 4 RFID antennas, chargeable battery, tiny RFID readers, and Bluetooth communication module. By using two type of Smart-Furoshiki, ubiquitous applications can accumulate users' context easily and contentiously.

6. ACKNOWLEDGMENTS

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