Visualization for Activity Information Sharing System Using Self-Organizing Map

Yuichi HATTORI and Sozo INOUE
Kyushu Institute of Technology,
1-1 Sensui-cho, Tobata-ku, Kitakyushu,
Fukuoka, Japan.
Email: eidwinds@gmail.com, sozo@mns.kyutech.ac.jp

Go HIRAKAWA
Network Application Engineering Laboratories Ltd,
1-4-4-6, Hakata-eki-mae, Hakata-ku, Fukuoka,
Fukuoka, Japan.
Email: hirakawa@nalab.jp

Abstract—In this paper, we introduce a visualization method for activity information sharing system using Self-Organizing Map and the activity information sharing system “ALKAN2”, which aims at gathering activity information for activity analysis. ALKAN2 gathers users’ activity using sensor data and movie data. Moreover, ALKAN2 prepares display environment for users. A user mimics activities of other users, and a user sends the mimicked data to the server. As a result, the mimicked data can be objectively evaluated. In this paper, we explain visualization for sensor data of ALKAN2.

Keywords—visualization; activity information; smartphone;

I. INTRODUCTION

If human activity can be objectively measured, we can expect various applications. For example, in the realm of health care, lifestyle can be quantified and can be used for prevention of lifestyle related diseases. In the agriculture, farmers can improve efficiency by automatically obtaining their own activity record. Although the measurement of activity has been difficult so far, the spread of smartphones equipped with three axis accelerometers are making it possible.

In this research, we aim at developing an activity recognition method. However, activity recognition needs a lot of sensor data of from a lot of users. Moreover, a lot of users gathers various sensor data is difficult. A user gets tired by collecting data. Therefore, we need to give users motivation.

We developed activity information sharing system “ALKAN2”. ALKAN2 can collect various activity information, because user can create activity list. For example, a list for healthcare, that for exercised, that for agriculture, and that for dance. ALKAN2 uses movie data. As a result, user can mimic other user’s activity while watching their movie data. Moreover, scoring uses the degree of similarity for mimicked data can be done. Therefore, other users can check their features, and users motivation improves by the activity is evaluated. Moreover, users can be expected to do a lot of activities. Therefore, the service provider can efficiently collect the data of the same activity. ALKAN2 overview is shown in Fig. 1.

This study describes a visualization method using Self-Organizing Map (SOM)[14] for collected activity data from ALKAN2.

Visualization of collected data is important because user understands features of collected data. User can understand features of data by visualizing numeric information. We used SOM to achieve visualization of collected data. SOM is a neural network of unsupervised learning, and can project multidimensional data to two dimensions. We tried the solution of the following solutions:

“activities which are similar each other can be easily captured.” “the feature of activities are clarified.” “The visualization results are understandable by beginners.”

As a result, we were possible to confirm users’ feature.

This paper is organized as follows. Related work is described in Section 2. Activity information sharing system is described in Section 3. Visualization is described in Section 4. Section 5 gives the summary and discussion for future work.

II. RELATED WORK

We aim at developing the activity recognition method. Activity recognition needs supervised data. A lot of activity information is needed for activity recognition.

There is large scale activity information gathering system “ALKAN” as system that collects a lot of activity information[1][2]. ALKAN can gather a lot of activity information using mobile devices and a server. However, ALKAN is the one only for the data collection. The user doesn’t have the advantage of collection. Moreover, the
activity list is fixed. Therefore, if activity not registered to the system, activity information can’t gather. activity information of can’t gather.

In the literature, a lot of work has tried to recognize activities with sensor devices. Chambers et.al.[4] tried to distinguish activity and movement of arm using two sensors on the arm. Laerhoven and Cakmakci.[9] tried to distinguish activities, postures, and riding bicycle, using two sensors at waist. However, these works experiment for only one user. They don’t do for varieties of people like this paper.

Lee and Mase[7] recognizes the types and the strength of movement with eight users using several sensors at waist and thighs. Mantyjarvi et. el.[8] uses 6 sensors on the waist, and recognized activities and postures with six users. Laerhoven and Cakmakci.[9] attaches 2 sensors on the back thigh, and 7 activities, postures, and bycicles are recognized with 10 users. Herren et. el.[5] uses 2 sensors on the back and on feet, and recognizes angles and walking speed with 20 users. However, these study aquire activity data in semi-artificial environments, and the users moved by the instruction. It has not been obtained from actual daily life.

As researches which aim at activity recognition in daily life, the following work are presented. Uiterwaal et. el.[10] used two sensors at waist and one sensor at thigh, and measured movements and postures in working environments. Kern et. el.[6] used 36 sensors at each joint, and measured movements, typing, chair, handshake and writing on a blackboard. However, these two researches used only one user. Therefore, more evaluation on the user generality are required.

Bao and Intille[11] discusses how to learn activity recognition from annotation data of users. They explained the procedures and examples of each activities in advance to users, and eliminated the variance of annotation. Upon which, they collected the data of 5 sensors on the body, and obtained 84% of accuracy. They also addressed 2 sensors on upper and lower body each keeps accuracy well as 5 sensors.

Our work also uses parts of the same feature vectors as Bao and Intille[11], but our work use single sensor, and we focus on the system to enable gathering activity data.

Berchtold et. el.[13] propose an activity recognition service with mobile phones and achieve 97% accuracy at best for 20 subjects. While our system is similar to this work, our system focuses on gathering open data for activities with accurate labels with low stress. Moreover, our work shows the result of gathering massive data.

Kawaguchi et. el.[12] proposed a promotion to gather open activity data from multiple laboratories, and has 6,700 accelerometer data from 540 subjects in total. While their work is not a system proposal, our approach is to provide a platform system to gather activity data anytime and anywhere.

III. ACTIVITY INFORMATION SHARING SYSTEM

A. System Overview

The ALKAN2 system consists of smartphone application and activity information sharing server. A user uses the smartphone application and sends sensor data and user information to the activity information sharing server. Moreover, the user uses a web browser on a client computer and sends movie data to the activity information sharing server.

B. Contents

We called sensor a combination of data and movie data “content”. Another user can watch contents after a user registers content to server. Contents view is shown in Fig. 2. Moreover, one content can have several sensor data and several movie data, for a case when user uses two cameras and when user uses several sensors.

C. User Roles

ALKAN2 has 3 user roles: provider, mimicker, and viewer. Moreover, all users can switch to all roles.

1) Provider: Provider is a user who registers a content first. Firstly, a provider gathers sensor data and movie data with smartphone application and video camera. Secondly, these data are uploaded to the activity information sharing server. Finally, the provider registers content. Moreover, the provider’s content is evaluated from viewer in 3).

2) Mimicker: Mimicker is a user who mimics contents. A mimicker uses the smartphone application and a video camera. If the user gathers sensor data only, it is ok. The degree of similarity with provider’s data is calculated by the mimicker. Mimicker’s content can be evaluated from viewer in 3).

3) Viewer: Viewer is a user who watch contents. A viewer can watch contents with a web browser on a client computer. Moreover, viewer can evaluate registered contents.
D. Smartphone Application

The smartphone application runs on iPodTouch, iPhone or iPad. The image of smartphone application is shown in Fig. 3. To collect activity information, the user does the following. Firstly, user selects an activity type. Secondly, user selects an attachment position. Finally, sensing starts. When the sensing ends, the data is saved in the smartphone. Afterward, when smartphone is connected to the network, it sends the data to the activity information sharing server.

ALKAN2 shows a ranking view and a history view.

E. Web Application

Web application has the following functionalities:
1) content view,
2) contents management,
3) movie registration,
4) management of activity types, and,
5) management of user information.

Content view uses web browser on a client computer. Content view shows movies, the waves of sensor data, evaluations of content and comments. Moreover, a viewer can evaluate contents, and comment.

Content management can link movie data and sensor data. Movie registration uses a web browser on a client computer. the view of movie registration is shown in Fig. 4.

When movie registration is performed, the user sets start position and end position. The purpose of this is to correct gap between sensor data and movie data. Moreover, a user sets title, description, and thumbnail at the time of movie registration.

Management of activity types manages activity types and activity lists. A registration of activity types needs title, description, and METs. METs is a unit of movement strength.

Activity types can be classified by so called activity list. Moreover, other users can use the user’s activity list because it is opened to the public. Such as, list for healthcare, that for exercises, that for agriculture, and that for dance. Therefore, ALKAN2 can be applied to various fields.

Management of user information manage basic information of users. Such as, “Change password” and “Change E-mail”.

F. Activity Information Sharing Server

The activity information sharing server provides function of web application in Sec. III-E for users, and receives movie data from client computer and receives sensor data from smartphones. Moreover, the server communicates with smartphones, and update activity lists.

IV. VISUALIZATION OF COLLECTED DATA

Visualization of collected data is important because user understands features of collected data. User can understand the features of the data by visualizing numeric information. Therefore, the user can see the feature of data. Moreover, the user can see the features of other users. For example, in ”walk”, a user looks at two clusters, she/he knows there are two types of walking. Therefore, the user is possible to confirm her/his feature. Moreover, the user can see the users who belong to each cluster.

In the system, a user’s activity data is displayed in some location of the map generated by SOM. Therefore, the user can know the feature of the activity and other users who look like the user.
A. Requirements analysis

The requirements which will be important for users are as follows:

1) activities which are similar each other can be easily captured.
2) the feature of activities are clarified.
3) The visualization results are understandable by beginners.

For 1), the user can know other users who looks like her/him, or she/he is unique. Moreover, the user can see the position of the users’ activity.

For 2), for example, if “walk” divides into several clusters, the user can see users’ cluster by visualization.

For 3), this point is necessary, because this system is also useful for beginners who want to visualize or categorize their own activities in daily life.

We tried to visualize with SOM for these requirements. SOM can project the multidimensional data to two dimensions, and can show features of activities.

B. Self-Organizing Map for ALKAN2

ALKAN2 adopted hexagon map and torus SOM[15]. The plain SOM has a problem in which winner units have differences between the edge and else of the map. Therefore, we adopted torus SOM.

We called a hexagon of map “element”.

C. Process of data

The sensor data of ALKAN2 are gathered by iPodTouch and iPhone. They contains attach motions and detach motions. These activities are unnecessary for the learning of SOM. Therefore, we deleted 15 seconds before and behind the sensor data. Moreover, we delete a 30 seconds in total. Therefore, under 30 seconds data was excluded.

D. Coloring

Coloring is important for usability. We used gray scale to coloring the map because users’ position search is difficult if a lot of colors are used. In this system, we used gray scale for user to capture the position of user’s data. Their comparisons are shown in Fig. 5 and Fig. 6.

E. Experiment

We experimented and observed the effect of visualization. We used 100 data of “trousers pocket (right)” of “walk” and 100 data of “trousers pocket (right)” of “sit”.

Parameters of SOM are shown in Table I.

3) based on the learning data, adjust the gray scale on the map.
4) put a color on the location which is the closest by Euclidean distance to the activity data.

Users’ coloring colors change according to users.. Characteristic values used for learning are as follows. Duration of activity, maximum values of XYZ of 3-axis accelerometers, averages of XYZ of 3-axis accelerometers, variances of XYZ of 3-axis accelerometers.
F. Results

The result maps are shown in Fig. 7 and Fig. 8. Color elements is users’ element. In the Fig. 7 and Fig. 8, several element are close.

Therefore, these are considered to be similar from the map. Firstly, in the point of “activities which are similar each other can be easily captured.”, the user can search other users who looks like the user. Therefore, the user can check position of the users’ activity.

Secondly, in the point of “the feature of activities are clarified.”, In “walk”, we confirm at least two clusters. we confirmed at least two clusters. In “sit”, it seems to failed to cluster. However, in “sit”, there is a possibility that clusters clusters do not exist. Moreover, the best parameter of “walk” and “sit” of SOM are different. Therefore, we need to search the best parameter of all activities.

Finally, in the point of “The visualization results are understandable by beginners.”, user’s elements are recognizable by gray scale mapping. However, if element has one user, it is ok, but if a element has a lot of users, it is not expressible. Therefore, we need technique for expressing all users corresponding to an element.

Figure 7. Result of SOM(walk)

V. Conclusion

We developed activity information sharing system "ALKAN2". Users are able to receive the advantage of collecting activity information in ALKAN2.

We tried visualization method of sensor data in ALKAN2 using SOM. As a result, we provided a functionality to confirm user’s feature. However, improvement for multiple users associated with the same element is necessary. Therefore, we need a new approach to similar users. As future work, the method of visualization is to be examined.

Figure 8. Result of SOM (sit)

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