A Mechanism for Building Ad-hoc Social Network Based on User's Interest

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Abstract—In social networks, user profile can be used as an important factor to define the character of a user and divide users in many social groups and provide suitable services to each social group. Recently, launched mobile devices can perform many functions, such as taking pictures, listening to music, web browsing etc. So, a mobile device can collect a user's data in his/her daily life and create his/her profile. In this paper, we propose a novel system, which can create a user profile automatically based on collected data from a mobile device and build an Ad-hoc social network.

Keywords-Ad-hoc network;Social Network; Interest Inference;

I. INTRODUCTION

Social Network Services such as Face book and Twitter are becoming very popular. This kind of situation shows important things about real-time communications reflecting user's social relationships. Also the rapid growth of mobile device has brought innovation, in which most people can use their own mobile devices in their daily lives and can connect to each other directly. Today, most of recently launched mobile devices are equipped with multiple wireless interfaces such as Bluetooth, WiFi, and cellular radio. As a result, mobile devices are now capable of supporting Ad-hoc communication mode. The rapid growth of mobile devices has brought new concept for social networking which is termed Ad-hoc Social network[1]. Ad-hoc social network is a combination of social network and Ad-hoc network. Ad-hoc Social Network is a social network where one or more people of similar interests connect with others using mobile device such as Smartphone, PDA, etc. From Ad-hoc Social Network, we can provide new type of services which are vastly different from current internet based social network services. For example. Ad-hoc Social Network Service enable users to communicate and share contents which are common interests without the need to access internet. Recently launched mobile devices can perform many functions. They can be used for taking pictures, listening to music, sending e-mail or messages, web browsing and many other things. So there are many data which can be used to analyze user behavior in Mobile Environment. In this paper, we propose a method that applies analysis of collected data from mobile devices to infer user's interest and a method to build an Ad-hoc social network based on user's interest. This paper is organized as follows: In section 2, we introduce the concept of social network, and Ad-hoc network. In section 3, we explain our proposed system for supporting Ad-hoc social network. In section 4, we present performance evaluation. The conclusion and future works are discussed in last section.

II. RELATED WORKS

A. Social Network & Social Network Service

A social network is a social structure which is made up of nodes. In social networks, each node represents an individual or an organization and each node is linked by some interdependency such as friendship, communication, common interest, web links, and etc. These links represent relationship between users. The concept of social network is shown in Figure 1.

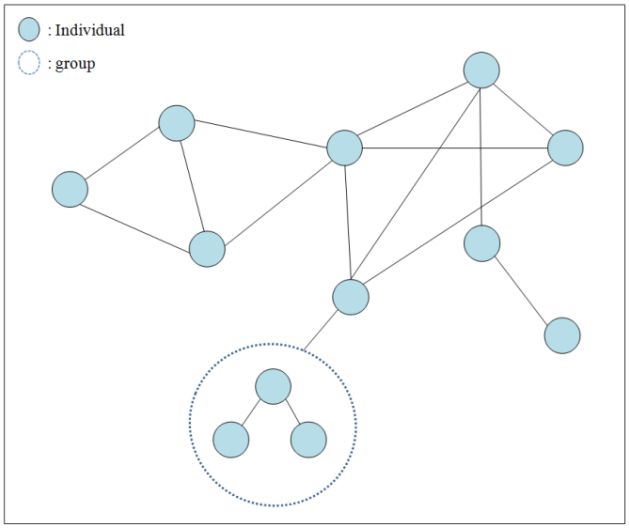

Figure 1. Concept of Social Network

Overlay Social network service[2],[3] brings the concept of interconnectivity among a large number of users into providing services for users. Most of social network services provide means for users to interact over the internet such as e-mail, instant messaging and contents sharing.

B. Ad-hoc Network

An Ad-hoc Network is a self configuring infra-structure-less network of mobile devices connected by wireless links.

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On account of device mobility in Ad-hoc network, devices can form a network autonomously without the need for infrastructures such as base station and access points.

III. PROPOSAL

In social network services, user's profile is used to build a social network between users. User's profile such as age, hobbies, and interests is predefined by the user before using social network services. This kind of predefined social profile is used in most of current social network services. Current social network service is static because current social network services can only provide a chance to access pre existing social network which is built by predefined user's interests. However, user's interests are changed as time goes by. Therefore, social network in real life is essentially dynamic in nature. Dynamic social networks enable users with the common interest to communicate and share common information in the dynamic environment based on parameters such as hobbies, location, and etc. In this paper, in order to support dynamic social network, we propose a method of inferring a user's interest in real-time.

A. Assumption

In our proposal, we assumed the following conditions:

- Web page's URLs(Uniform resource locators), which mark the address of a resource on the World Wide Web are often human readable information.

- URLs consist of meaningful words which are easy to obtain a hint about the category of the resource.

B. Collecting user's data from mobile device

Currently, most frequently used service in mobile device is web browsing service. Mobile web browsers are useful tools in web surfing. In addition, they download web contents such as source code, file, images, URLs, etc. The browsers also stores browsing history. These information together with viewing time and number of web pages accessed can be used to analyze user's interests.

C. Creating user's profile

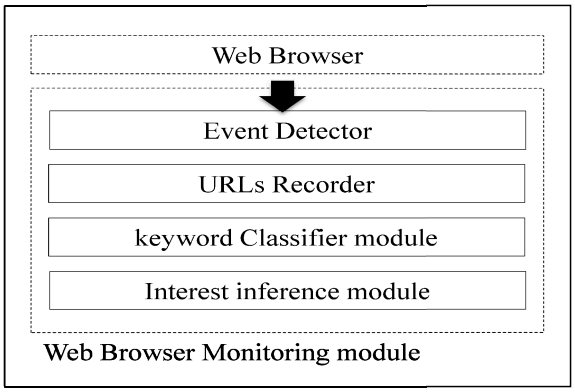

Figure 2. Web Browser Monitering Module

In Social Network Services, social profile is an important factor to divide social groups. As a result, Social network services can organize social groups and provide suitable services to each group based on the social profile. In this paper, we propose a new approach to build an Ad-hoc social network based on social profile reflecting user's interest in real time. We can see system architecture in figure 2. In order to create social profile reflecting user's interest, we extract information from URLs which is requested by user. When a user connect to web service over the internet, HTTP[4] is used to request and then receive the requested web page. Event detector in web browser monitoring module can detect web page request and retrieval. A Web page has a unique URL on the Internet. URLs mean "Uniform Resource Locator". It means that URLs are used as addresses on the World Wide Web to indicate the location of resources. The URL itself is usually informative. Generally, URLs consist of directory or folder of the content of resource. From given URLs, we can predict that, for example, basketball web page and baseball web page belongs to the sports category. In order to infer user's interest from web pages, we use a Hierarchical Model for interest inference. Figure 3 shows that Hierarchical Model for interest inference.

TABLE I. URL LIST

http://~.com/sports/basketball
http://~.com/sports/baseball
http://~.com/entertains/music
http://~.com/entertains/movie
http://~.com/entertains/movie/action
http://~.com/entertains/movie/comedy

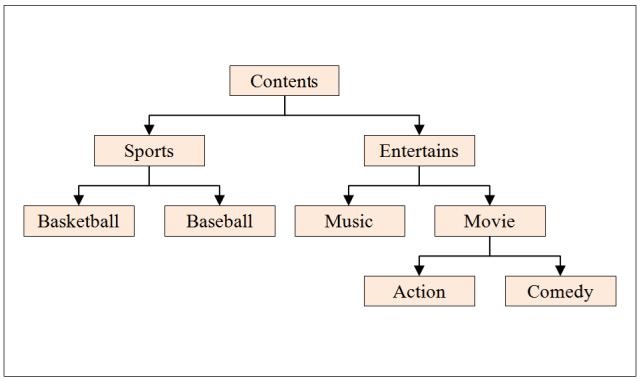

Figure 3. Hierarchical Model for interest inference

Hierarchical Model is a data structure used to construct abstract data structure. It consists of a set of nodes and directed edges. Every node in Hierarchical Model has one edge from its parent node and a parent node has many child nodes. A node in the Hierarchical Model has a keyword and a value. Keyword is the name of category extracted from URLs and the value is degree of interest level. From this Hierarchical Model, it is possible to infer interests more efficiently. For example, a user interested in basketball can be assumed to be interested in sports and also, a user interested in movies can be assumed to be interested in action or comedy which is the genre of movies. In this system, user profile is decided depending on the interest level.

The process of interest inference from collected data is as follows:

1) When a user access a web page through the web browser, the system records the visited URLs information.

2) In order to infer user's interest, the system extract meaningful words from recorded URLs

3) Extracted words are compared with all of the nodes in the Hierarchical Model.

a) If an extracted word from URL does not exist in the Hierarchical Model, it is added to the Hierarchical Model and interest level is initialized.

b) Otherwise, the extracted word is in the Hierarchical Model, and the interest level of the word is increased.

After the process, the highest keyword of interest level can be used as a representative of user profile to create links in social network.

When the system generates a user profile in social network, it considers two types parameters, interest and curiosity. We define interest as Hobbies in which a user usually do or browse regularly which is mainly entertainment. Curiosity is defined as occasional interests or occurrences which are happening in the local or global surroundings which may concern or affect on the user which is mainly information or news.

D. Method for building Ad-hoc social network

To build an Ad-hoc social network, the important thing is to discover other users with similar interests.

1) Mobile device A broadcasts a neighbor discovery message including user's interest to discover neighbors with similar interests.

2) When mobile device B receives a neighbor discovery message from A, it can get A's profile form received neighbor discovery message.

3) After that, the mobile device B calculate similarity between A and B and sends response message if the similarity is high and otherwise, discard the neighbor discovery message.

4) If mobile device A receives the response message, A and B form a virtual link to interact.

We adopt a vector space model and cosine similarity[5] to calculate the similarity between the user's profile. The cosine similarity of two user's profile ranges from 0 to 1. The result of cosine similarity is equal to 1 when the angle is 0. It means that the two profiles are congruent. On the other hand, the result of cosine similarity equals to 0 means that two profiles are completely different. The similarity value varies between 0 and 1. In order to adapt to Vector Space Model, each user profile is represented as vector $P = \{p_1, p_2, p_3, \dots, p_n\}$ and we define interest level as weight of p_i in vector P as $W = \{w_1, w_2, w_3, \dots, w_n\}$. For example, we assume the following scenario: there are two mobile devices A and B. The profile of A is P_A and weight of profile A is $W_A = \{u_1, u_2, u_3, \dots, u_n\}$, the profile of B is P_B and weight of profile B is $W_B = \{w_1, w_2, w_3, \dots, w_n\}$. In order to calculate similarity of interest, cosine similarity is calculated as follows:

$$\text{Similarity}(P_A, P_B) = \frac{P_A \cdot P_B}{|P_A| \times |P_B|} \quad (1)$$

$$= \frac{\sum_{i=1}^{n} u_i w_i}{\sqrt{\sum_{i=1}^{n} u_i{}^2} \sum_{i=1}^{n} w_i{}^2}$$

If the result of cosine similarity is higher than the threshold value which is defined to measure relationship, mobile devices create virtual link to connect between each mobile devices. Otherwise mobile devices will discard a received neighbor discovery message. Using created virtual links, mobile devices can now interact with other mobile devices in transmission range.

IV. PERFORMANCE EVALUATION

In this section, we present a performance evaluation of the proposed system. We start by discussing the simulation environment. To evaluate the performance of the proposed system, we implemented simulation model for Ad-hoc social network.

A. Simulation Setup

This simulation model is implemented with Objective Modular Network Testbed in C++(Omnet++)[6] simulator. Figure 4 shows architecture of mobile device which is implemented by Omnet++.

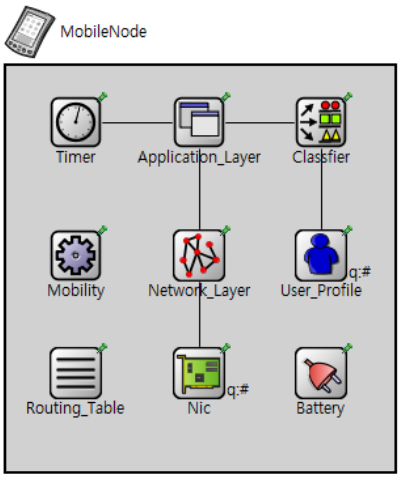

Figure 4. Implemented Mobile Device for Simulation

Mobile device which is implemented for simulation consists of nine modules. In the Application Layer module, we define web pages which are provided to users through web browser. Table 2 shows web page lists.

TABLE II. CONTENTS LIST FOR SIMULATION

	Contents
Sports	Soccer, basketball, volleyball, baseball
Economic	Estate, consumer, finance, industry
Foreign	Japan, China, Asia, America, Europe
Culture	Weather, Life, Health, Fashion, Book

Entertain	Music, Drama, Movie, Abroad
Politics	Assembly, President, Administration

Timer module allows Application Layer module to request web pages randomly. Classifier module classify category of web page which is generated by Application Layer module. After that User profile module infer user's interest from collected data and generate a user profile. In this system, user profile is periodically updated.

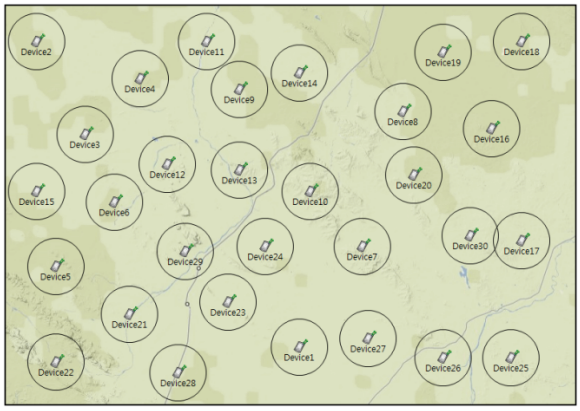

Figure 5. Simulation Setup

In this scenario all mobile devices are deployed randomly and start moving according to the random waypoint mobility. In order to evaluate the performance of proposed system in terms of efficiency, we compared the system to Epidemic Routing[7]. We measure the average number of messages generated in network due to constructing network among mobile devices

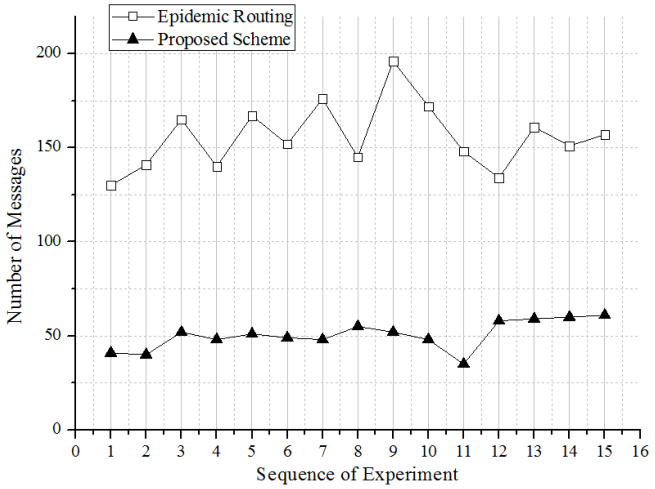

Figure 6. The number of generated message

From simulation results, when the network topology is dynamically changing because of devices' mobility, we showed that the required number of messages for constructing network is reduced.

Due to limited battery power, when we design a new system on mobile devices, we have to consider the Energy efficiency. So in order to evaluate proposed system in terms of Energy efficiency, the simulation evaluation model is used to compare Energy consumption when mobile devices construct an Ad-hoc social network.

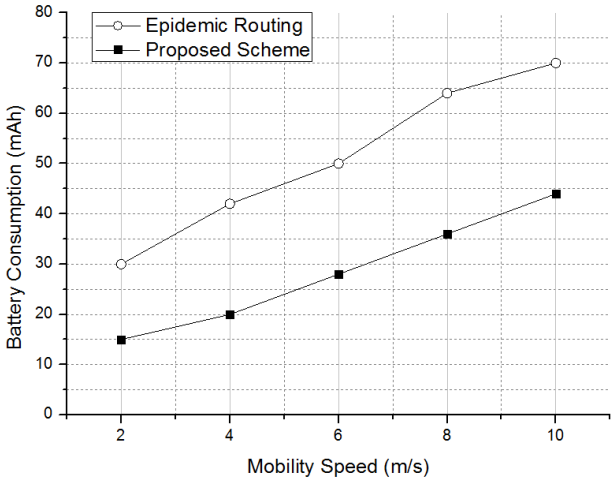

Figure 7. Energy Consumption in Mobile Device

Simulation results for energy consumption are shown in Figure 7. The proposed system is more efficient than existing Epidemic Routing.

V. CONCLUSION AND FUTURE WORKS

In this paper, we present a new method for building Ad-hoc social network. This method collects user's data from mobile device and infers user's interest to support Ad-hoc social network. Also performance evaluation has shown that our proposed system can achieve superior simulation results using Omnet++ simulation model. Ad-hoc social network provides new type of services enabled by mobile devices. In this paper, we only conducted simulations as an experiment to analyze the performance. In our future work, we will try and implement it on mobile devices in real environment.

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