Reliable Contents Recommendation Service Based on Similarity of Users Tagging

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Abstract. As various ubiquitous computing technologies become applied into many smart space systems, most museums attempt to use these techniques for their own domain. Near Field Communication(NFC) is one of wireless technologies primarily used for short range communication between smart phones and similar devices, supporting a variety of information exchange services in some effective way. In this paper, we present a new user similarity-based contents recommendation service to improve the counterpart of our previously developed museum viewing system by using NFC. In order to satisfy this goal, this service utilizes similarity of artifact attached NFC tagging patterns of users. Its desirable feature enables users to actually find and obtain their favorite contents by systematically consulting the tastes of the other users very close to those of the first. Also, the proposed system may considerably reduce overloading on contents providing servers by having smart phone clients get certain parts of basic artifact related contents information directly through NFC tags, not the servers.

Keywords: Ubiquitous Computing, Near Field Communication, Mobile App., User Similarity, Contents Recommendation

1 Introduction

Near Field Communication (NFC) is a standards-based, short-range wireless connectivity technology that enables simple and secure two-way interactions among electronic devices[1]. NFC technology allows consumers to perform contactless purchase transactions, access digital content, and connect devices with a tap or wave of an NFC-compliant component. Although NFC technology is based on radio frequency identification (RFID) but differs from RFID in that NFC is an application initiator, not just a one-way data exchanger[2]. NFC provides global interoperability of contactless smart card technologies and radio frequency identification (RFID) while operating in the 13.56 MHz frequency range, over a maximum distance of a few centimeters.

Previous contactless smart card technology is widely used in the area of the transportation card systems, the credit card systems to pay the bus fare and distribution and logistics in the form of RFID tags. In order to overcome limited

services in the form of a dedicated reader and IC card, in continuing effort to apply contactless wireless communication technology to the personal mobile phones, Nokia Inc. launched its smart mobile phones embedded with NFC. Unfortunately, because of limited wireless Internet connection, limited utilization of general mobile phone and very few mobile phones embedded with NFC, it is a hurdle to the adoption of NFC technology by a wider potential market.

Recently, as an unprecedented growing number of smart mobile phones, there is the movement in nature in NFC technology. It is becoming more realistic to use smart mobile phones embedded NFC as a mobile credit card, RFID readers/ tags and a data transfer device by relying on representative mobile platforms, such as iOS and Android, coping with plenty of internet environment.

In this paper, we present a new user similarity-based contents recommendation service to improve the counterpart of our previously developed museum viewing system[3][4] by using NFC. The developed contents recommendation service has problems that do not satisfy the user's taste because it is based on only information of user's attention and friends. To resolve this problem, in this paper, the proposed service utilizes similarity of artifact attached NFC tagging patterns of users. By doing so, it can improve the quality of service because it enables users to actually find and obtain their favorite contents in response to the tastes of the other users very close to those of the first. In addition, the previously developed system based on RFID has a problem that server overloading occurs when a number of users request information to servers. The proposed system may considerably reduce overloading on contents providing servers by having smart phone clients get certain parts of basic artifact related contents information directly through NFC tags, not the servers.

2 The user similarity-based contents recommendation service

In this paper, the proposed recommendation service combines hybrid and social network-based and user similarity-based.

The hybrid service combines contents-based[5][6] and location-based[7][8]. The social network-based service recommends contents based on the information of user's friend[9].

The user similarity-based contents recommendation service measures the user similarity by using tagging pattens. The tagging patten is the information that its corresponding user has been tagging the NFC tag attached to the exhibit to check the information about it. The user similarity can be measured as equation (1).

$$SIM\ t_{ag}(U, PU) = \frac{(n(T_u \cap T_{pu})\backslash}{n(T_u)_j} \quad (1)$$

In the equation (1), the argument *u* is the current user and *pu* are the previous users who finished their tour. T_u is the set of NFC tagged by *u* and T_{pu} is the set of NFC tagged by *pu*. $n(T_i)$ is the function that finds the number of elements of T_u and $n(T_u \cap T_{pu})$ is the function that finds the number of elements of the intersection of T_u and T_{pu}.

The user similarity weights, P_{st} can be obtained through the sum of the maximum user similarity weight, P_{mst} and the threshold user similarity weight, $P_{t,,}$.

$$Pst = Pmst\ Ptst \quad (2)$$

Pmst is based on the contents that user has purchased after finding the maximum user similarity, *mus* and the user having the maximum value of the user similarity, *msu.* It can be obtained through the following equation (3), (4).

$$max''_{,,n}(sim_{taa}(u, pu)) = \max_{1,0,,} \frac{^{1}\ n(T, I\ T_{pu})^{\backslash}}{n(T_{})} \quad (3)$$

$$(4)\ ^{Pmst(u,c)} - max''_{,,n}(slm_{tao}(u, pu)) \bullet P(c)\ (c\ \text{E}\ SLmsu)$$

0

Equation (3) is *mus,* the maximum user similarity between *u* and *pu.* If there exists contents, *c* in the shopping list, SL_{msu} of *msu,* the equation (4) is $_{Pmst}$ by multiplying the preference of *c, P(c)* by *mus.*

The threshold defines 0.7, meanning very strong relation by Pearson correlation coefficient[10]. $P_{u,,}$ applies weights to *pu* that have more than the threshold and $P_{,,,}$ sums *Pus.*. P_{ut} can be obtained through the following equation (5), (6).

$$P_{ust}(u,pu,c) \qquad SIM_{tag}(U_{1}pU) \bullet\bullet P(c)\ (0.7 < sim_{tag}(u,pu),\ C\ E\ SL_{ou}) \quad (4)$$

0

$$P_{tst}(u,c) =$$

$$EPust(u,pu,c) \quad (6)$$

$$pu=1$$

The preference about *c* of *u, P(u,c)* can be obtained through the following equation (7) by hybrid, social network-based and the user similarity-based.

$$P(u, c) = P_h\ (u, c)\ P_t\ (u' c)\ Pst\ (u' c) \quad (^{7})$$

3 Experiments

In this section, we can show how effectively the proposed service can recommend visitors their favorite contents. Experiments will be performed in two different ways. The one is the prior preferences of all contents are assumed to be the same. The other is the prior preferences of all contents are assumed to be different depending on the exhibits. Our experimental environment is in table 1.

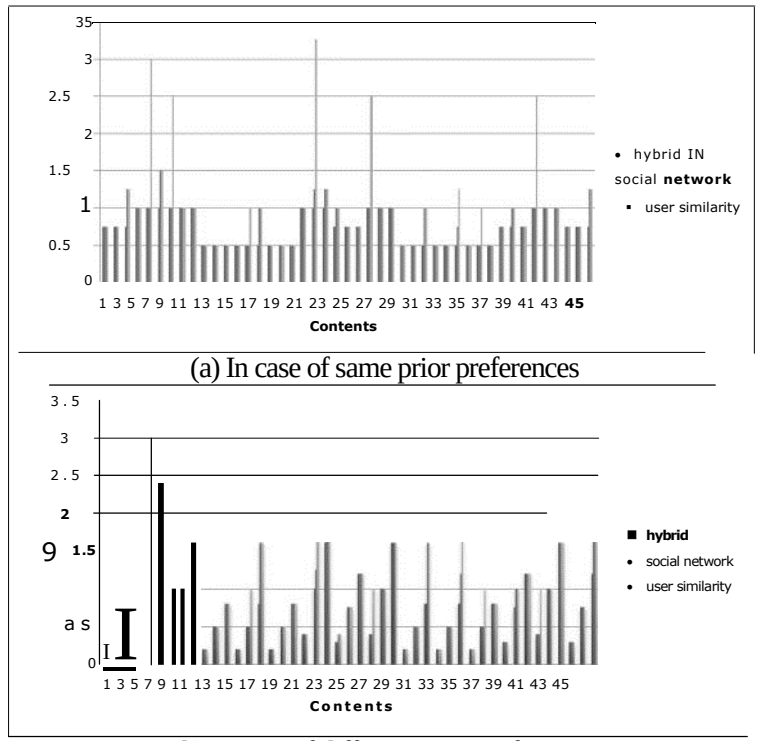
Table 1. Experimental Environment

Parameter	Value
No. of Exhibition Rooms	5
No. of Exhibits	15
No. of Contents	45
No. of Previous Visitors	12

We assume that the number of exhibition rooms is five and each room has three exhibits. So, there are a total of 15 exhibits. The total number of contents is 45. The previous users are divided into three groups and each group consists of four members. The three groups are classified into previously visiting users having tagging patterns similar to the present user's one, tastes very close to the present user's one, and the present user's friends.

For this experiment, the assumptions of the user are as follows. The user has watched room 1, 3 and 5 and tagged exhibit 2, 3, 7, 9 and 14. The user's favorite contents were 5, 7, 20, 25 and 40.

Experiments are performed to find out how the prior preference is changed depending on which services are applied, that is, hybrid, social network-based and the user similarity-based ones. And we can find out how many differences occur between these services to contents based on the user preference.



(a) In case of same prior preferences

(b) In case of different prior preferences

Fig. 1. Experiment Results

In the first experiment, the prior preferences are the same. Figure 1(a) shows that the hybrid and social network-based methods recommend contents related with rooms watched by the user. And the social network-based method recommends contents bought and recommended by lots of friends of the user. The preference of the proposed recommendation service appears larger than those of the others because it applies the weights to the preference by using the user similarity which is more than the threshold. In this proposed recommendation service, the user similarity can be

seen a big difference in this figure 1(a) and help users to find their favorite contents more easily.

In the second experiment, the prior preferences are not the same. The prior preferences are divided into three types: popular contents, common contents and unpopular contents. Figure 1(b) shows that the hybrid and social network-based methods recommend contents related with rooms watched by the user, mainly popular contents. Although the contents 7, 25 and 40 are unpopular, the proposed recommendation service recommends them because the user likes them.

Throughout the experiments, the hybrid and social network-based methods recommend popular contents rather than users' favorite contents. But the proposed recommendation service recommends users' favorite contents. Also, in the case of the first experiment, the favorite contents recommended by the hybrid and social network-based methods have the same similarity with users' distasteful contents, on the other hand, the favorite contents recommended by the proposed recommendation service is very different than the other contents. So it can help users to actually find the favorite contents. And the proposed service is possible to improve user satisfaction by recommending contents that fit the user's taste.

4 Conclusion

In this paper, we proposed a user similarity-based contents recommendation service to improve the counterpart of our previously developed museum viewing system by using NFC. The proposed service utilizes similarity of artifact attached NFC tagging patterns of users. It can improve the quality of service because it enables users to actually find and obtain their favorite contents in response to the tastes of the other users very close to those of the first. Also, the proposed system may considerably reduce overloading on contents providing servers by having smart phone clients get certain parts of basic artifact related contents information directly through NFC tags, not the servers.

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