User Space Customized Recommendation Service Platform System in Mobile Edge Environment

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***Abstract*— Mobile network edge computing is an excellent technology to reduce service latency to users by extending services of existing central cloud computing to network edge. But the service provided to the user in the user space is not a service provided simply by reducing the delay time. The user space service provides a user's preferred spatial environment and automatically and promptly provides the user with preferred contents. So, the user space service is necessary to provide user space service platform infrastructure for automatically and promptly providing a user with a preferred spatial environment and contents. Therefore, this paper proposes a user space customized recommendation service platform system that can provide users with enhanced quality of service using shortened service delay time in mobile edge environment.**

***Keywords*—recommendation service platform, user space service, mobile edge, internet of thing (IoT)**

I. INTRODUCTION

As the age of IoT(Internet of things) is approaching, there is predicted that 50 billion thing devices will be connected to the internet by 2020 [1]. And data usage is growing rapidly, as 90% of the world's data is data generated within the last two years. Transmitting data using only the existing central cloud server could cause bottlenecks and server overload. When a large amount of data is exchanged between the user and the central cloud server, the delay time due to the bandwidth limit becomes longer, which can cause inconvenience to the user. So, instead of sending all the data to the remote central cloud in preparation for the IoT era, it is expanding to a mobile network edge computing environment that can be selectively analyzed and used around the data generation point [2]. Mobile network edge computing is evaluated as an excellent technology to reduce service latency to users by extending services of existing central cloud computing to network edge and providing services close to users [3]. Since the data used in the user space in which the user lives is not only large in amount of data but also has a very short duration in which the data retains meaning, the data becomes meaningless due to the occurrence of high latency time and the quality of service leads to a decline. Thus related studies are proceeding toward improving service quality by deploying a mobile network edge server near the user. However, the user space service is not a service provided simply by reducing the delay time. Accordingly, the user space service that provides a user's preferred spatial environment and automatically and promptly provides the user with preferred contents is provided as a more useful service to the user. So, it is necessary to provide user space customized recommendation service platform infrastructure as a technology for automatically and promptly providing a user with a preferred spatial environment and contents.

Therefore, this paper proposes a user space customized recommendation service platform system that can provide users with enhanced quality of service using shortened service delay time in mobile edge environment located in a base station or a small cell near a user terminal rather than a central cloud. This user space customized recommendation service platform system collects and analyzes the sensing data of the neighboring sensors close to the user and the user's feedback data in the user space (cafe, bookstore, etc.), which is frequently used by the users, and automatically and immediately provides the user with the preferred spatial environment and contents.

II. USER SPACE SERVICE SCENARIO USING USER SPACE CUSTOMIZED RECOMMENDATION SERVICE PLATFORM SYSTEM

As shown in figure 1, in the scenario concept of providing a user space customized recommendation service, a user transmits a user login request to a user space customized recommendation service platform system using a user space customized recommend service application in a smart terminal device. The user space customized recommendation service platform system authenticates the user using the subscribed user information. If the user authentication is normal, a temperature automatic control recommendation service, which is a user space environment control service, and a preferred book recommendation service, which is a content service, are transmitted to the user's terminal device.

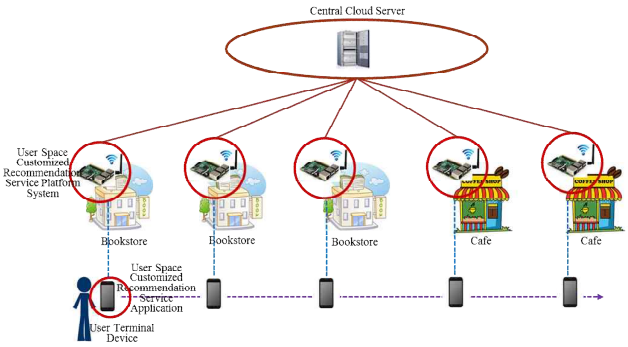

Figure 1. Conceptual diagram of user space service scenario

When the user is located in a user space such as a cafe, the automatic temperature control recommendation service is provided. Then the user space customized recommendation service platform system uses data stored by learning the user's personal preferred temperature and other users' preferred temperature in the same user space and utilizes current temperature and humidity data. And the user space customized recommendation service platform system determines optimum recommended temperature for all the users in the user space and automatically and instantly transmits it to the thing device such as air conditioner to operate at the recommended temperature. Also, if a user selects a thermal index such as cold, cool, slightly cool, moderate, slightly hot, sultry for the recommended temperature change, it is transferred from the user terminal to the user space service platform system. The user space service platform system applies the feedback data on the temperature change of the user to the learned temperature recommendation data repository. In addition, in the process of recommending temperature later, the preferred temperature of the user utilizing the learned temperature recommendation data repository reflecting user feedback data is used.

On the other hand, if the user is in the user space as the bookstore, the preferred book recommendation service is provided. Then, the user space customized recommendation service platform system fetches the book list preferred by the user and the book list similar to the user preferred book from the learned user book recommendation repository, and outputs the book list to the user terminal device. When the user selects a preferred book from the preferred book list, the user space customized recommendation service platform system brings the detailed information of the book from the book information repository and outputs the detailed information of the book. And when the user gives the score of the book, the feedback data about the score of the book is used later for requesting the high rank book selection. In addition, if a similar book is selected from a similar book list, the user space customized recommendation service platform system brings the detailed information of the book from the book information repository and outputs the detailed information of the book. If the user's book is given a score, the user's book recommendation repository is changed to a book preferred by the user, and the feedback data on the score of the user's book is later used for requesting a high rank book selection.

III. PROPOSED USER SPACE CUSTOMIZED RECOMMENDATION SERVICE PLATFORM SYSTEM

Figure 2 shows the architecture of user space customized recommendation service platform system. The user space customized recommendation service platform system is composed of a user access control function, a service recommendation notification function, a user feedback function, a user space customized service recommendation function, a sensor data collection function, a user space data model making function, an actuator control function. Also the user space customized recommendation service platform system includes a user information table, initial temperature recommendation data model repository, a learned temperature recommendation data model repository, initial book recommendation data model repository, a learned book recommendation data model repository, and a book information repository.

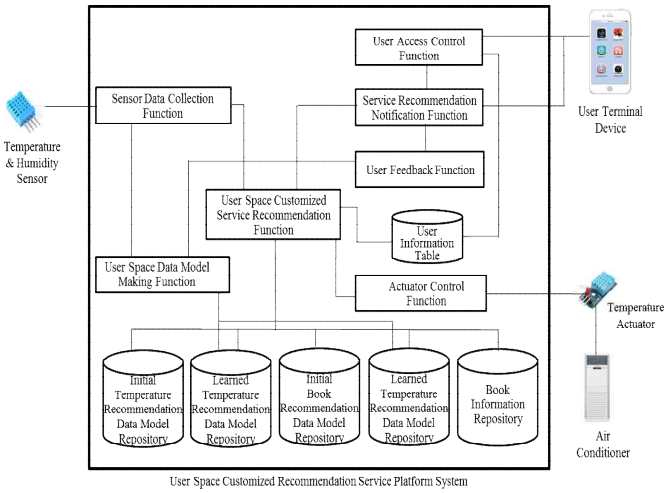

Figure 2. Architecture of user space customized recommendation service platform system

The user access control function determines whether or not the user subscribes to the user space customized recommendation service. When the user requests a login through the user terminal device, the user access control function determines whether there is a user who requests login from the user information table. And if the inputted password is correct, the user access control function transmits user login's success to the user terminal device, and informs the service recommendation notification function that the user is logged in. The service recommendation notification function receives a recommended service suitable for the user space in which the user is logged in and transmits the recommendation service to the user terminal device. So, the service recommendation notification function makes a request to the user space customized service recommendation function to recommend a service suitable for the user space, and transmits the service recommended by the user space customized service recommendation function to the user terminal device. The user feedback function requests the user space data model update using the inputted user data when the user inputs user data for the corresponding user space in order to change the recommended service data. When the user gives a thermal index score for the recommended temperature for the user space such as a cafe, the user feedback function requests the user space data modeling function to reflect the user's preferred temperature.

The user space customized service recommendation function recommends a service suitable for the user space using the user space data model, sensor data, user information, and the like. When the service recommendation notification function requests the user space customized service recommendation to the user space customized service recommendation function, it is necessary to distinguish whether the user is the first user using the user space customized recommendation service or not. Therefore, in the case of a user space such as a bookstore, the user space customized service recommendation function provides a book

recommendation list made by distinguishing between the age and sex using the initial book recommendation data model repository for the first user. On the other hand, if the user is not the first user, the user space customized service recommendation function provides a book list of the user's preferred book and a similar book list of the preferred book using the learned book recommendation data model repository. If the user is a user space such as a cafe, the user space customized service recommendation function provides the first user with a preferred temperature using the recommended temperature that is differentiated by age using the initial temperature recommendation data model repository. On the other hand, if the user is not the first user, the user space customized service recommendation function provides the temperature preferred by the user using the learned temperature recommendation data model repository. The user space customized service recommendation function provides the user space recommended temperature of the corresponding cafe determined using the current temperature and humidity obtained through the current temperature and humidity sensor and the preferred temperature of the users currently logged into the cafe. At the same time, the user space customized service recommendation function controls the temperature of the air conditioner to operate at the recommended temperature through the actuator data control function.

The sensor data collection function transmits the data collected from the temperature and humidity sensor to the user space data model making function and the user space customized recommendation function. In the case of the cafe, which is a user space, the temperature and humidity sensor data collected from the sensor data collection function is used to make a learned temperature data recommendation data model of the users by the user space data model making function. In addition, the user space customized service recommendation function periodically provides the recommended temperature of the cafe which is the user space, and the collected temperature and humidity sensor data is used to determine the periodic recommended temperature of the user space. The actuator data control function transmits the user space recommendation temperature provided from the user space customized service recommendation function to the temperature actuator, and allows the actuator to operate the air conditioner at the recommended temperature.

The user information table stores the information of the subscribed users. Since the user must input user identifier number, password, age, and gender information in order to subscribe to the user space customized recommendation service, the user information table stores user identifier number, password, age, gender, login state. The initial book recommendation data model repository stores a list of books based on age and gender. In the case of the first user, an initial book recommendation data model repository is used to provide a book recommendation list distinguished by age and gender. The learned book recommendation data model repository stores a list of books preferred by each user and a list of books similar to their favorite books. In the case of the non-first user, the learned book recommendation data model repository is used to provide a list of books preferred by the user and a list of books similar to the preferred book. The book information repository stores detailed information about books that are similar to your favorite books of users as well as favorite books of users. The detailed information of book includes title of the book, barcode, author, publisher, date of publication, number of pages, summary, book score, and price. Initial temperature recommendation data model repository stores temperatures based on age and gender. In the case of the first user, the initial temperature recommendation data model repository is used to provide a recommended temperature that is differentiated by age and gender. The learned temperature recommendation data model repository stores the preferred temperature for each user. For a user who has used multiple times, the learned temperature recommendation data model repository is used to determine the user space recommendation temperature of the corresponding cafe with the current temperature and humidity obtained through the temperature and humidity sensor, and the preferred temperature of the users currently logged in the cafe.

IV. CONCLUSION

Recently, various studies on service using the mobile network edge computing method have progressed. But, the present mobile network edge service focuses on providing services that simply reduce latency. Also, the present service environment of mobile network edge does not support the service platform infrastructure for automatically and promptly providing a user with a preferred spatial environment and contents. Therefore, this paper proposed a user space customized recommendation service platform system that can provide users with enhanced quality of service using shortened service delay time in mobile edge environment near a user terminal device. And this user space customized recommendation service platform system provides the mechanism which automatically and immediately offers the user with the preferred spatial environment and content by collecting and analyzing the sensing data of the neighboring sensors close to the user and the user's feedback data in the user space which is frequently used by the users. So, we think that this user space customized recommendation service platform system will contribute to compose a new mobile edge network service ecosystem and to create various mobile edge network service business model.

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REFERENCES

[1] Sukriti Jalali, "M2M Solutions-Design Challenges and Considerations," 2013 IEEE Recent Advances in Intelligent Computational System, 2013.

[2] Nhu-Ngoc Dao, Yunseong Lee, Sungrae Cho, Kim Eung Ha, Ki-Sook Chung, Keum Chang Sup, "Multi-tier Multi-access Edge Computing: The Role for the Fourth Industrial Revolution", ICTC, 2017. 10.

[3] 3GPP TR 23.703 Study on architecture enhancements to support Proximity based Services(ProSe) v1.1.0, 2014. 01.