Mining Minds: Journey of Evolutionary Platform for Ubiquitous Wellness

Wajahat Ali Khan, Muhammad Bilal Amin, Oresti Banos, Taqdir Ali, Maqbool Hussain, Muhammad Afzal, Shujaat Hussain, Jamil Hussain, Rahman Ali, Maqbool Ali, Dongwook Kang, Jaehun Bang, Tae Ho Hur, Bilal Ali, Muhammad Idris, Asif Razzaq, Sungyoung Lee, Byeong Ho Kang

***Abstract*—Customized wellness care is a progressing area to promote self-care management, utilizing the state of the art techniques and technologies to monitor user daily life activities. Mining Minds Platform is one such effort that lies in customized wellness care domain with objective to support personalized health and wellness. This paper focuses on the one year journey of Mining Minds, its evolution into different versions with the challenges and limitations faced while design and development of the platform. We developed two versions (MM V1.0 and MM V1.5) in the first year and are moving towards MM V2.0 in the next year. We will discuss about the experience of building the core technology in these versions on top of the defined service scenario of physical activities.**

I. Introduction

BIG data technologies is transforming the paradigm of health-care and wellness domain. Health-care domain focus is shifting from disease centric model to patient centric model [1] [2], while wellness domain is moving towards user centric model with innovative platforms. Platforms are required to conform to data collection, monitoring, processing, recommending, presenting, and maintaining functionalities. Mining Minds [3] [4] is one such platform that provided layered architecture for providing personalized health and wellness services. So far it's been one year few months duration for Mining Minds platform design and development. There were lots of bottlenecks, challenges, limitations in every cycle of the development. We share these experience in design and development of such volume of project and the incremental evolutionary process of its different versions.

The main objectives of Mining Minds Platform is to utilize big data techniques and technologies for data storage and retrieval, and processing it for building low level and high level context information. Knowledge creation and maintenance on top of the data and information with the involvement of experts is another objective. Curating the data, information, and knowledge for generating and providing personalized services to the users is the ultimate objective. We are in process of achieving these objectives and building the core technology and defining services on top of the technology in different versions.

The first year released two versions, MM V1.0 and MM V1.5. Currently, shortcomings of these versions are identified and features evolution is underway in the MM V2.0. The service scenario on in all these versions is based on physical activity. The focus of these versions was more on building platform rather than writing services on top of them.

II. Mining Minds Platform

Mining Minds Platform is an innovative platform that is based on layered architecture to investigate on human's daily life data, generated from heterogeneous resources, for personalized health and wellness services [3][4]. The platform is divided into five layers: Data Curation Layer (DCL), Information Curation Layer (ICL), Knowledge Curation Layer (KCL), Service Curation Layer (SCL), and Supporting Layer (SL).

DCL provides real-time data acquisition from multimodal data sources and its persistence using big data technologies. Also, activity and context data are mapped for life-logging and personalized predictions from Intermediate data storage. ICL has the goal to create a model for recognizing user's activities in a highly accurate and robust manner. KCL creates and maintains the knowledge using data-driven [5] and knowledge-driven approaches to facilitate the service curation layer for better quality of service [6]. SCL ensures timely and accurate personalized cross-domain recommendation using domain knowledge and users preferences/context. SL provides information to the users in most intuitive manner in a secure environment reflecting his personal needs and preferences.

Figure 1 shows the abstract conceptual view of the Mining Minds Platform, its layers and their interaction with each other. Data is obtained from users using sensors, smartphone, SNS, cameras and other wearables. Personalization aspect is the motivating factor for recommendation services to the users by taking into account their preferences and needs. Detailed description of the platform is provided in our work [3][4].

W.A.Khan, M.B.Amin, O.Banos, T.Ali, M.Hussain, M.Afzal, S.Hussain, J.Hussain, R.Ali, M.Ali, A.Razzaq, D.Kang, J.H.Bang, T.H.Hur, B.Ali, M.Idris, and S.Y.Lee are with Department of Computer Engineering, Kyung Hee University, Seocheon-dong, Giheung-gu, Yongin-si, Gyeonggido, Republic of Korea, 446-701, {wajahat.alikhan, mbilalamin, oresti, taqdir.ali, maqbool.hussain, muhammad.afzal, shujaat.hussain, jamil, rahmanali, maqbool.ali, dwkang, jhb, hth, bilalrizvi, idris, asif.razzaq, sylee}@oslab.khu.ac.kr

B.H.Kang is with School of Computing and Information Systems, University of Tasmania, Australia Byeong.Kang@utas.edu.au

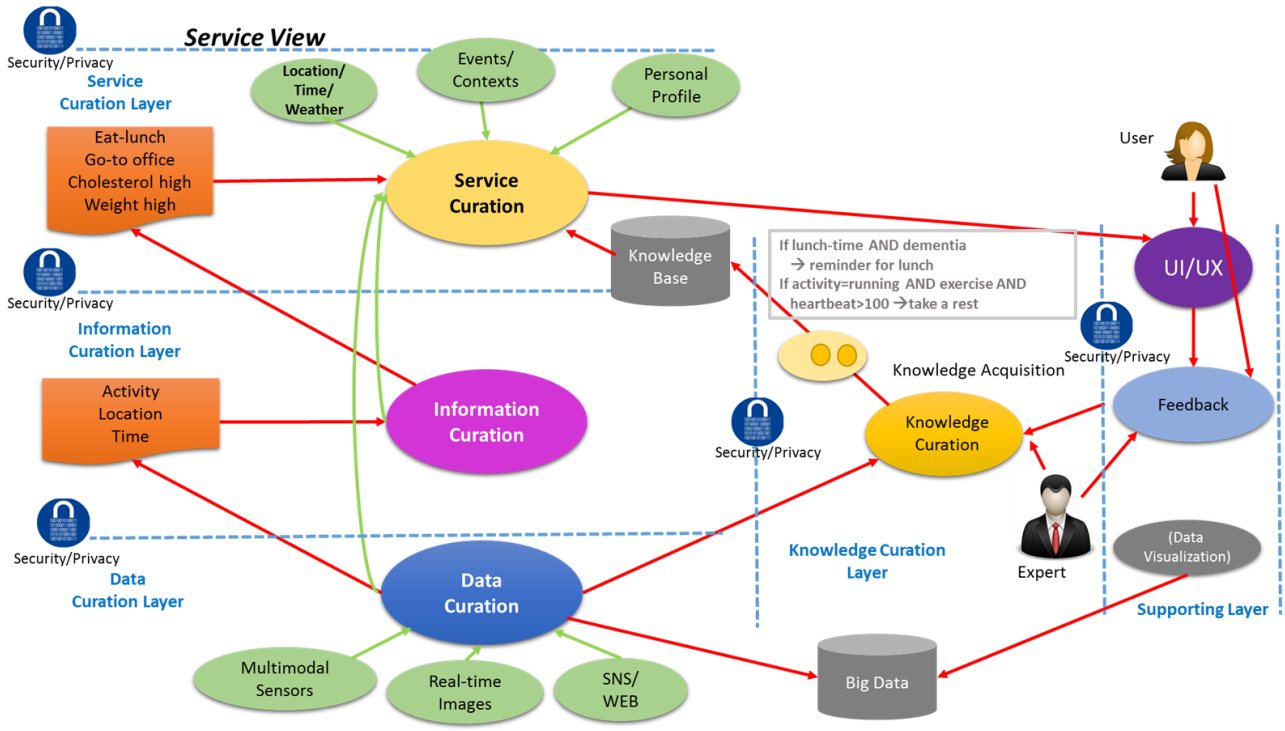

Figure 1: Conceptual View of Mining Minds Platform

III. Mining Minds Platform Versions Evolution

A. *Mining Minds V1.0*

The scope of this version was providing recommendations to users based on calories based physical activity recognition. Smartphone based accelerometer and GPS were utilized as input sensors for business to consumer (B2C) scenario. The recommendations were restricted to five activities identified such as Walking, Running, Standing, Bus, and Subway. The system worked on request based communication with SOAP web services. User and Admin views were provided to the stakeholders. Token based authentication scheme was used for user authentication.

The limitations of this version includes poor communication performance due to SOAP-based web services. Also, stress on RDBMS due to excess of data storage and persistence, primitive amount of activities, request based recommendations, and message integrity can be compromised during communication, are other shortcomings of this version. Therefore, we tried to resolve these issues in our next version, Mining Minds V1.5.

persistence, lack of high level context determination (the focus was only on recognizing the low level context), and static rules for recommendations generation. In both MM V1.0 and MM V1.5, selected components from the platform were selected for implementation and incrementally this huge platform is build. The shortcoming of MM V1.5 will be resolved in MM V2.0 to be released later with significant modifications in the previous versions based on our experience.

B. *Mining Minds V1.5*

This version covers most of the limitations of the previous version. The input data sensors includes smartphone based accelerometer, GPS, and wearable device as an addition. The services were categorized into three levels; calories based physical activities recognition with 15 activities, recommendations in the form of educational facts, and healthy habits induction. Rule authoring environment was also provided to the experts for rules generation. An expert view providing analytics and visualization was also at expert disposal for better decision making. Data integrity check during communication and access model for domain experts were also adopted in security and privacy. The communication was real-time socket based, and restful web services with cloud push model was utilized for recommendations generation. This version also focused on the B2C model.

The limitations includes use of big data only for

C. *Mining Minds V2.0*

Based on our experience in the previous versions, we identified considerable contributions in MM V2.0 in the same physical activities service scenario. We will be explaining these layer wise starting from DCL to SL.

DCL features includes communications aspects, big data and intermediate data, lifelog mapping and representation, and life log monitoring and prediction. Communication in this version should be Node.js and restful web services for non-blocking communication. This will resolve the scalability

issues with the previous blocking communication. Big data read and write both should be incorporated, with the intermediate data only taking care of data for particular duration. For fast access, intermediate database should be used, while for performing analytics on the data, large pool of data from the big data storage should be utilized. Lifelog mapping and representation for storage into the intermediate database should be based object oriented techniques. This module should be responsible for handling the data coming from all the layers into the intermediate database.

ICL features are human activity recognition, location detection, emotion recognition, and high level context awareness. Human activity recognition features included 5 to 15 activities in the previous versions. We will be adding more activities and also increasing the level of accuracy for smartphone, wearable devices and video based activities recognition. Location detection and emotion recognition features were missing in the previous versions which should be added in this version for personalized recommendations. The above mentioned activities are categorized as low level context activities, and based on these high level context aware activities will be recognized and fed to the upper layers for accurate recommendations [7]. These reflect the user behavior and ontological reasoning approach is adopted for finding the high level context activities.

KCL role in the previous two versions was not defined, but it plays an important role in rule creation, storage, and modification in this version. Its role is divided into expert driven and data driven knowledge acquisition. Expert based knowledge acquisition consist of rules based knowledge base creation by experts, guideline integration, and situation handling scheme. Data driven knowledge acquisition is based on automatically knowledge creation from the lifelog data stored in the big data storage.

SCL utilizes the data from the DCL, information from ICL, and knowledge from KCL for reasoning to provide recommendations. Also, with reasoning feature, it also provides interpretation and explanation mechanism for personalized recommendations provision to the user. Service scope and types also depends on this layer.

SL provides the features of user experience, descriptive analytics, and security and privacy in this version of MM platform. The UI is enriched with the UX in this version as compared to the previous ones.

These features of the layered architecture will be integrated for achieving the goal of personalized recommendations provisioning to the end users. Also, this version plans to enhance the previous expert view for providing the data analytics results to the experts. An easy to use authoring environment will be also benefited by the experts for creation and storage of the rules in the knowledge base.

IV. Conclusion

The journey of Mining Minds platform development so far is mainly focused on core technology development. Physical activities service scenario is designed and developed and with feedback from the users, incremental improvements are continuously added to the system. Data, information, and knowledge are utilized for provision of personalized recommendation services to the users.

The service scenario in future versions should include nutrition, chronic disease patients as well with physical activities. Also, the future versions will include feedback analysis, security and privacy, service orchestration, data driven knowledge acquisition, and predictive analytics modules as part of the core technology of the Mining Minds Platform.

Acknowledgment

This work was supported by the Industrial Core Technology Development Program (10049079 , Develop of mining core technology exploiting personal big data) funded by the Ministry of Trade, Industry and Energy (MOTIE, Korea)" and was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIP) NRF-2014R1A2A2A01003914.

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