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Context Mining based Mental Health Model for Lifecare Platform

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ABSTRACT

With the emergence of the 4th industrial revolution, IT convergence engineering based artificial intelligence and intelligent system has constantly been researched in today's society. In particular, healthcare service based on IT-BT convergence helps to improve quality of people's life and provide user-oriented healthcare contents actively. Currently, the healthcare industry has gradually changed its healthcare paradigm from conventional healthcare to mental diseases care and tries to solve the social problem with depression, one of mental disorders. This study proposes the context mining based mental health model for the lifecare platform. This study makes use of users' profiles about depression and health weather index provided by Korea Meteorological Administration to classify and define semantic ontology based context information, and to develop the context mining model for depression index service. The proposed context mining based mental health model uses personalized context information so that it is possible to provide personalized depression index service, rather than unified healthcare service. Also, the proposed one uses user-based information for modeling so that it can provide guidelines for developing data model of depression. In addition, it is possible to provide accurate and specified service for users and efficient depression index service through customized service. The result of the proposed method shows that the context mining model not only promotes the theory and practical ability but also consolidates their understanding of web engineering models and concepts.

Keywords: *Depression, Context Mining, Healthcare, Depression Index, Mental Health*

Introduction

With the start of the 4th industrial revolution, IT convergence technology has developed and today's society has become informatization. As a result, people' quality of life has been improved. The top issue in the 4th industrial revolution outstandingly arises in the healthcare area for healthy life [1-4]. In the social change, the number of chronic disease patients is on the rise, and the medical service area changes from disease treatment to personalized preventive healthcare promotion [5-6]. As mobile devices have been popular, medical life has been changed. With the development of mobile phones and tablet PCs based mobile environment, medical service applications have also been more developed. In the circumstance, consumers' demands of self-healthcare have been on the rise. In addition, with the wide distribution of internet and informatization, useful contents and services of healthcare are provided to users through their mobile devices and PCs. Such services have expanded from physical healthcare to mental healthcare. Depression, a typical one of mental diseases, is a disorder explained in the continuous line of the two extremes of emotional status and mental disorder status in everyday life [7]. Although this symptom occurs sometimes or disappears immediately, it causes an extremely stressful feeling. A repeated feeling of depression dominates one's emotion. If such a feeling

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reaches an extreme level, it leads to losing one's life. Accordingly, depression requires continuous treatment for care and prevention.

Depression is found in various age groups from adolescence to senescence. As for depression, music therapy [8], laughter therapy [9], arts therapy [10], and other therapies have continuously been researched. These studies resulted in the development of IT-BT convergence based healthcare service solution in association with the development of various IT devices [3-4]. Unlike other diseases, depression is hard to be quantified. Depending on users, there are many different types of cases. For this reason, it is difficult to efficiently provide depression care service. In order for effective depression care, mental health technology based IT convergence is needed. These days, commercialization of wireless wearable sensors, remote medical diagnosis, and health monitoring have been researched. In mobile devices or wearable devices, such health service as sensing based heart rate measure and respiratory measure is provided. However, in such healthcare service, only health measures found through physical information monitoring are displayed on screen. The service is not personalized. For this reason, simply general treatment service is offered and it is hard to manage the service [11-13].

Therefore, this study proposes context mining based mental health model for the lifecare platform. With the uses of users' context data and mining technique, the context mining model is developed, and thereby the drawn inference rules are applied to depression index service. In addition, the real-time health weather index of Korean Meteorological Administration and Living Health Index Service are applied to make possible personalized service. The composition of this study is as follows. In Section 2, we describe the healthcare models for web-engineering framework, In Section 3, we propose a context mining based mental health model for the lifecare platform. In section 4, provides a conclusion and future work.

Depression Index for Mental Healthcare: Depression as one of mental disorders is the case where more than four of psychomotor changes, including declining enthusiasm, thinking of death, desire for death, lowering thinking and concentration abilities, lethargy, a sense of guilt, fatigue, a loss of appetite, a loss of weight, sleep disorder, and a loss of sexual desire, continue to occur for more than two weeks [14]. Typical symptoms of depression are a sense of depression, declining vitality, fatigue, a loss of interest, a fall in attention, a sense of guilt, a lowering sense of self-esteem a sense of worthlessness, negative view, suicidal idea and action, a loss of appetite, and sleep disorder. According to Honkanen, living satisfaction had negative correlation with depression not only in clinical depression group but in general population group; with lower living satisfaction, a sense of depression was predicted to increase [14]. In Korean self-administrative evaluation, main symptoms of depression were classified in terms of physical, emotional, and physical aspects, and depression scale was prepared.

The scale is comprised of six dimensions: negative mind-set of the future, lack of self-esteem and self-confidence, anxiety and impatience, a sense of depression, and physical symptoms, and lack of enthusiasm. BDI (Beck Depression Scale) as a tool of measuring a level of seriousness of depression is widely used in the world [15]. Zung (Self-rating Depression Scale; SDS) evaluates depression on the basis of frequency of depression symptoms. In other words, depending on how often depression symptoms occur, a level of depression is evaluated. In this evaluation method, if a severe symptom occurs sometimes, not often, a low score can be given. Hamilton Rating Scale for Depression (HRSD) as an observer's rating scale, vis most widely used to evaluate depression symptoms. This is used for an evaluator to present one of sentences showing severity of a symptom after semi-structured interview. Center for Epidemiologic Studies Depression Scale (CES-D, Korean version) is used as the primary screening tool of depression [16]. In this method, t level of severity is measured on the basis of the time when a symptom appears. Therefore, this scale is much used in epidemiologic studies, especially comparative analysis on prevalence of depression depending on nationality, age, and sex.

Context Mining based Mental Health Model for Lifecare Platform

Pattern Analysis using Context Mining: In order to provide proper and personalized depression index service to users, it is necessary to analyze each user's environment and apply it efficiently. Accordingly, the context information which can influence a user's mental healthcare is classified and defined, and then inference rules are created through context mining. For intelligent

depression index service, a user's context information mining is performed in a functionally excellent ontology model. To find association of a user's context information, context mining analysis is conducted. For depression index service, inference rules are created. This method improves a conventional ontology model which generates service-intensive inference rules [5,17,18]. Context mining information is defined in seven groups-individual, medical sciences, service, position, device, action, and environment data-and context data are classified. The proposed context mining based mental health model uses static and dynamic context data. Based on context information, a variety of each user's information such as surroundings and tendencies is collected and analyzed. And then a personalized context mining model is developed. It includes environment data or medical data which can influence depression and is classified [3-5, 19].

Context mining creates knowledge base with the use of semantic ontology based inference engine. Context mining is applied to the context information collected by an IoT device with the use of FP-Tree algorithm. A semantic ontology based model generates a user's internal, external and service context mining relation and inference rules of knowledge base. Figure 1 illustrates the process of context mining pattern analysis based on semantic ontology. The purpose of such generation is to improve simple inference results when inference rules are created by inference engine in a semantic ontology context model. Therefore, to solve the problem, context mining is applied so as to the association of each layer context information. In the proposed context mining based mental health model, FP-Tree algorithm is applied to the context information of internal, external, and service layers in order for mining.

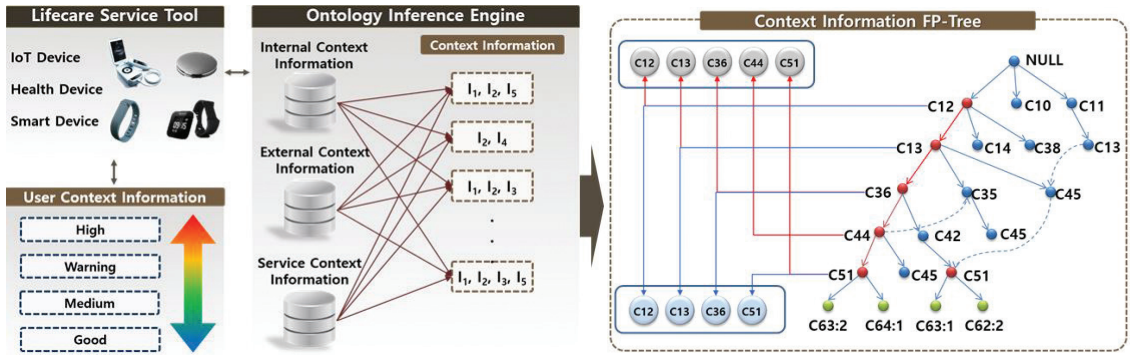

Figure 1: Process of context mining pattern analysis based on semantic ontology

Context Mining Model for Lifecare Platform: Depression index service is a user-oriented personalized index service to which context mining model is applied for a lifecare platform. On the basis of a user's context mining information, health weather index and living weather index of Korea Meteorological Administration, personalized depression index service is offered [20]. To provide depression index service, a context mining model based on personal context information is needed. The context mining model is expressed in top-down tree structure so that it is efficient at classifying, predicting, and analyzing data [21]. Therefore, with the model, it is possible to analyze the result easily, and its big data can be used in a general computing environment with stability. A context mining model is good at easily drawing rules in machine learning, artificial intelligence, ambient intelligence, information retrieval, and is much used in the areas for prediction [22]. Figure 2 presents the context mining model for lifecare platform.

In order to provide a mental health service, context mining information and significant data for depression factors are judged and then a rule based context mining model is created in the lifecare platform. In order to generate a rule based context mining model, context mining tree technique and mining technique are applied [23]. This study makes use of the improved ID3 algorithm 'C5.0' and Apriori algorithm to create a context mining model. Apriori algorithm is applied to a context mining model, and its association rule is mined with the use of context mining information and depression factor data. Support and confidence are based on the significance level 0.05, and an optimal context mining model is generated. With the use of health weather index and living weather index of Korea Meteorological Administration [24], a context mining model is additionally applied for real-time personalized service depending on a user's position and environment [25]. The inference based result can be served through a depression index in lifecare platform [26].

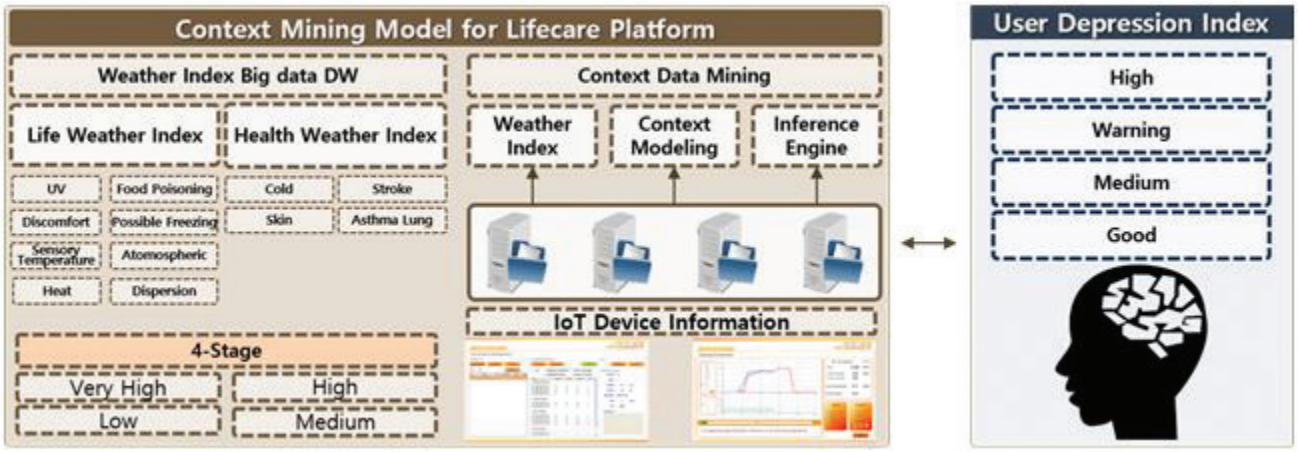

Figure 2: Context mining model for lifecare platform

Table 1: Inference rules of context mining for knowledge management

Service	Inference rules
Context Data Analysis	(?Depression_Level((?Threshold.index) ∩ (?Customer(Locations,Seoul)) ∩ (?Weather_Index(Location,Seoul,Careful)) ∩-> (?GIS ?Seoul) (?Depression_Level((?Threshold.index) ∩ (?Customer(Locations,Suwon)) ∩ (?Weather_Index(Location,Suwon,Careful)) ∩-> (?GIS ? Suwon) (?Customer hasRain ?Rain) ∩ (Environment hasTime ?Morning), (?Customer has ?DeepSleep) ∩ ((?Environment hasTime ?Minute.30) ∩ (?Environment ?hasTime ?Morning)) ∩ ((?Environment hasTime ?Minute.30) ∩ (?Environment ?hasTime ?Night))-> (?ActionGuidelineInformation ?MeasureAdvice), …
Depression Management	If(user's BMI exceeds 26 ∩ Stress Index exceeds 3) ∩ Context(Depression Lv1) Then ServiceContext (Depression Status, Health Weather Index, Mental Index, SDNN, Event, TRUE), If(user's BMI exceeds 20 ∩ Stress Index exceeds 4) ∩ Context(Depression Lv2) Then ServiceContext (Depression Status, Health Weather Index, Mental Index, SDNN, Event, TRUE), If(user's BMI exceeds 24 ∩ Stress Index exceeds 5) ∩ Context(Depression Lv3) Then ServiceContext (Depression Status, Health Weather Index, Mental Index, SDNN, Event, TRUE), …
Management Coach	If((User Status(hasBlue, TRUE)) ∩ (IntempStatus(hasIndoor)=Low Temperature) ∩ (timeStatus(hasTime)=night)) ∩ Then LowLevelContext (DepressService, NONE),-> (?ActionGuidelineInformation ?MorningRainAlam) ∩ (?ActionRecommand hasActionRecommand ?Action1_MentalHhealth), (?Customer hasStress ?Stress) ∩(Environment hasTime ?Morning) ∩ (?Environment_Weather hasTemp ?Temp >29) -> (?ActionGuidelineInformation ?MorningStressAlam) ∩ (?ActionRecommand hasActionRecommand ?Action2_Stress), (?Customer hasStress ?Stress) ∩(Environment hasTime ?Evening) ∩ (?Environment_Weather hasTemp ?Temp >32) -> (?ActionGuidelineInformation ?EveningStressAlam) ∩ (?ActionRecommand hasActionRecommand ?Action4_Stress), …

To apply the result of context mining analysis to depression index, inference rules are needed. The inference rules of context mining are classified into monitoring & position of a user's context mining information, into a region, and into personal context information. Then, the context mining information in need is drawn. After that, the inference rules of external context mining information and of internal context mining information are created, and thereby service inference rules are created. With the use of the ontology based semantic inference engine Jena 4.0, a user's health conditions are judged in the rule base and the inference rules for depression index service are generated [3, 5-6, 11]. Table 1 shows the inference rules of context mining for knowledge management.

Conclusions

With the development of IT convergence and information, today's society rapidly changes. The IT convergence is also applied to the area of healthcare area. Therefore, research on healthcare has been conducted actively. As the paradigm of healthcare research expands and changes from physical health to mental health, efficient and systematic healthcare is recognized to be the most important in the healthcare area. Conventional healthcare service fails to understand a user's situation or environmental factors. As a result, it is difficult to achieve care and service for mental diseases. In addition, although general treatment and temporary service can be provided according to medical guidelines, it is hard to find any metal disease care service in terms of disease prevention. Therefore, this study proposed context mining based mental health model for the lifecare platform in order to improve the conventional healthcare service. The proposed model used a user's context information which can be obtained in everyday life. In addition, this study developed the inference rules of context mining model which met the medical standards of healthcare and applied the service information and features of depression. Context mining was used to design a user's context information based on semantic ontology, and the rules of inference were created in a context mining model. The inference rules were applied for the context mining model for depression index service. In addition, with the use of health weather index and living weather index provided in real time by Korea Meteorological Administration, a context mining model was developed to make personalized service depending on a user's position and environment. In the future, a mobile program for depression index service will be implemented. Furthermore, based on the proposed method, the contents related to mental disease prevention and depression improvement will be additionally applied for service. This work will be very helpful for engineering research of context mining based mental health model. The proposed context mining based mental health model uses the personalized information modeling so that it can provide guidelines for developing web-engineering models of the healthcare. To clarify the developing model for a web-based health platform, the research is core knowledge for a health platform in machine learning, artificial intelligence, data mining, and health information system. This health platform makes use of the improved ID3 algorithm 'C5.0' and Apriori algorithm to suggest a context mining model. Apriori algorithm is applied to a context mining model, and its association rule is mined with the use of a health information system and data mining for web-engineering framework factors.

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REFERENCES

1. Kim, H., Jo, J., Choi, Y., Oh. J., Lee. J., Yoon, K. Ubiquitous Health Care system for Chronic Disease Management, Journal of Korea Information and Communications Magazine. 2015; 27(9): 3-8.
2. Jung, H., Chung, K. Y., Lee, Y. H. Decision Supporting Method for Chronic Disease Patients based on Mining Frequent Pattern, Multimedia Tools and Applications. 2015;74(20): 8979-8991.
3. Center for Health Industry Information & Statistics. Weekly Healthcare Industry Trends, Korea Health Industry Development Institute. 2015; 155: 1-2.
4. Jung, H., Chung, K. Sequential Pattern Profiling based Bio-Detection for Smart Health Service, Cluster Computing. 2015; 18(1): 209-219.
5. Jung, H., Chung, K. Knowledge based Dietary Nutrition Recommendation for Obesity Management. Information Technology and Management. 2016;17(1):29-42.
6. Jung, H., Yoo, H., Lee, Y., Chung, K.-Y. Interactive Pain Nursing Intervention System for Smart Health Service. Multimedia Tools and Applications. 2015;74(7):2449-2466.

7. An, J. Y., Seo, E-R., Lim, K. H., Shin, J. H., Kim, J. B. Standardization of the Korean version of Screening Tool for Depression. Journal of the Korean Society of Biological Therapies in Psychiatry. 2013;19(1): 47-56.
8. Park, J. S., Cho, H. K., Kim, Y. T. Impact of Music Therapy Program on the Self-Esteem and Depression of Middle-Aged Women. Journal of Rehabilitation Psychology. 2012;19(1): 63-83.
9. Lee, D. Y., Seo, H. Y., Sim, I. O., Lee, H. M. The Effect of Laughter Therapy on Depression, Suicidal ideation and Resilience for Adolescent. Journal of the Korean society for Wellness. 2015;10(2): 137-146.
10. Jang, E-J., Lim, H-C. Psycho-dynamic Group Art Therapy for Middle-aged Women with Depression. Journal of Rehabilitation Psychology. 2012;19(3): 601-616.
11. Jung, H., Chung, K. PHR based Life Health Index Mobile Service using Decision Support Model. Wireless Personal Communications. 2016;86(1):315-332.
12. Jung, H., Yang, J. G., Woo, J. I., Lee, B. M., Ouyang, J., Chung, K., Lee, Y. H. Evolutionary Rule Decision using Similarity based Associative Chronic Disease Patients. Cluster Computing. 2015;18(1):279-291.
13. Korea Centers for Disease Control and Prevention. 7th Korean National Health and Nutrition Examinations Survey (KNHANES V-1), Centers for Disease Control and Prevention;c2016. Available from: https://knhanes.cdc.go.kr.
14. Hopkins, J., Campbell, SB., Marcus, M, et al. Role of Infant-related Stressors in Postpartum Depression. Journal of Abnormal Psychology. 1987;96(3):237-241.
15. Beck, CT. Predictors of postpartum depression: An update, Nursing Research. 2001;50(5):275-285.
16. An, J. Y., Seo, E. R., Lim, K. H., Shin, J. H., Kim, J. B, et al. Standardization of the Korean version of Screening Tool for Depression. Journal of the Korean Society of Biological Therapies in Psychiatry. 2013;19(1):47-56.
17. Schilit, B. N., Adams, N., Want, R. Context-aware Computing Applications, In Proc. of the Workshop on Mobile Computing System and Applications. 1994;85-90. DOI: 10.1109/WMCSA.1994.16
18. Sheng Q. Z., Benatallah, B. ContextUML: A UML-Based Modeling Language for Model-Driven Development of Context-Aware Web Services, In Proc. of the International Conference on Mobile Business. 2005;206-212. DOI: 10.1109/ICMB.2005.33
19. Gauvin, M., Boury-Brisset, A. C., Auger, A. Context, et al. Ontology and Portfolio: Key Concepts for a Situational Awareness Knowledge Portal, In Proc. of the 37th Annual Hawaii International Conference on System Science. 2004;111-120. DOI: 10.1109/HICSS.2004.1265291.
20. Kim, J. C., Chung, K. Neural-Network based Adaptive Context Prediction Model for Ambient Intelligence. Journal of Ambient Intelligence and Humanized Computing. 2018;DOI: 10.1007/s12652-018-0972-3.
21. Jung, H., Chung, K. P2P Context Awareness based Sensibility Design Recommendation using Color and Bio-signal Analysis. Peer-to-Peer Networking and Applications. 2016;9(3):546-557.
22. Chung, K., Park, R. C. Chatbot-based Heathcare Service with a Knowledge Base for Cloud Computing. Cluster Computing. 2018;DOI: 10.1007/s10586-018-2334-5
23. Jung, H., Chung, K. Life Style Improvement Mobile Service for High Risk Chronic Disease based on PHR Platform. Cluster Computing, 2016;19(2):967-977.
24. Jung, H., Chung, K. P2P Context Awareness based Sensibility Design Recommendation using Color and Bio-signal Analysis. Peer-to-Peer Networking and Applications. 2016;9(3):546-557.
25. Kim, J. C., Chung, K. Emerging Risk Forecast System using Associative Index Mining Analysis. Cluster Computing. 2017;20(1):547-558.
26. Kim, J. C., Chung, K. Depression Index Service using Knowledge based Crowdsourcing in Smart Health. Wireless Personal Communication. 2017;93(1):255-268.