A Study on Elderly Disease Prediction Platform for Internet of Everything Environment

Jaehak Yu, Seunghee Hong, Hongkyu Park, Damee Kim, Woongshik You, Sun-Jin Kim, Cheol-Sig Pyo, and *Sejin Park

Abstract—Recently, inspired by Internet of Everything (IoE), the era of connected all the things and people are coming. These advances in IoT and IoE technology have greatly increased the demand to use various things and services in everyday life at anytime and anywhere. Especially, as rapidly changing into an aging society and increasing interest in healthcare, disease prediction and management through various healthcare devices is getting attention. In this paper, we propose a platform structure that can be applied to user-customized health management and real-time disease prediction for elderly people by using IoE technology. The proposed platform structure can be extended for rapidly detecting and predicting new diseases.

Research Keywords—Disease Prediction Platform, Stroke Analysis, Internet of Everything, Machine Learning, Deep Learning

1 Introduction

Recently, the rapid development of ICT technology such as Internet of Everything (IoE), Big Data, and Cloud Computing enables users to exploit a wide variety of service [1], [2]. Thanks to this great enhancement, the users can easily get the information whatever they want, and also share their information with other persons freely [1], [2]. However, this great freedom of information leads to an explosion of information including a lot of useless or falsely disguised garbage data. It is not easy to draw the useful information precisely, represented as knowledge, from those messy data.

According to recent studies, IoE-based framework is considered as the main enabler for various healthcare services and applications [3]. Electronic healthcare platforms or systems have been continuously developed, particularly regarding healthcare data and information as well as wearable miniaturized IoE sensors [4].

Stroke Disease is a major cause of disability and death in the Republic of Korea, especially for the elderly people. Some features of potential stroke risk factors include gender, smoking, age, inherited, diabetes, hypertension, asymptomatic carotid stenosis, and obesity [5], [6]. These features make stroke detection and prediction easier and more accurate.

In this paper, we propose a platform structure that can be applied to user-customized health management and real-time disease prediction for elderly people. Also, the proposed platform has the additional advantages for being extended to rapid detection and prediction of new diseases.

The rest of the paper is organized as follows. Section 2 describes some related works. In Section 3, the

- *Jaehak Yu is with the Department of KSB (Knowledge-converged Super Brain) Convergence Research, Electronics and Telecommunications Research Institute (ETRI), Daejeon, Republic of Korea. E-mail: dbzzang@etri.re.kr.*
- *Seunghee Hong is with the Center for Medical Metrology, Korea Research Institute of Standards and Science (KRISS), Daejeon, Republic of Korea. E-mail: hsh82622@kriss.re.kr.*
- *Hongkyu Park is with the ETRI, Daejeon, Republic of Korea. E-mail: hkpark@etri.re.kr.*
- *Damee Kim is with the KRISS, Daejeon, Republic of Korea. E-mail: dameeing@kriss.re.kr.*
- *Woongshik You is with the ETRI, Daejeon, Republic of Korea. E-mail: wsyou@etri.re.kr.*
- *Sun-Jin Kim is with the ETRI, Daejeon, Republic of Korea. E-mail: sunjin@etri.re.kr.*
- *Cheol-Sig Pyo is with the ETRI, Daejeon, Republic of Korea. E-mail: cspyo@etri.re.kr.*
- *Sejin Park (corresponding author) is with the KRISS, Daejeon, Republic of Korea. E-mail: sjpark @kriss.re.kr.*

2014-2017 © ICRP. Published by the Institution of Creative Research Professionals

proposed our platform structure for elderly stroke disease prediction is presented. Finally, in Section 4, the conclusion and future works are discussed.

2 Related Work

Over the last few years, the IoT and the IoE have been introduced to connect virtual and physical things as well as to provide convenient advanced services to users. IoE technology, which is more advanced than that of the IoT, involves connecting virtual and physical things as well as providing convenient services to users. The IoE allows things to determine appropriate services according to circumstances and to exchange information, thereby providing a new type of service [1], [2].

According to recent studies, the relative risks for major stroke prediction risk features, including diabetes, obesity, hypertension, and ischemic heart disease, were obtained from a recent systematic review of stroke risk features [5]. This study assessed the correlation between the 10-year risk of stroke risk prediction model and carotid intima-media thickness [6].

3 The Proposed Platform Architecture

In this paper, we propose a platform structure that can be applied to user-customized health management and real-time disease prediction for elderly by using IoE technology. As you can see in Fig. 1, the elderly stroke disease prediction platform consists of three layers real-time healthcare data collected to the analysis results.

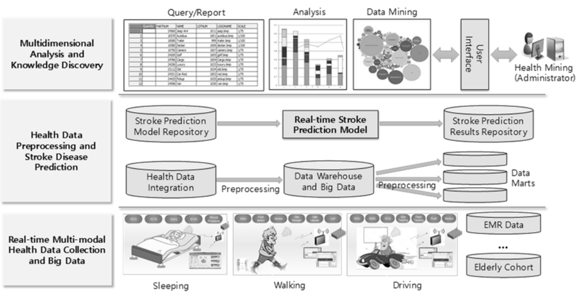

Fig. 1. The overall architecture of the proposed platform

In order to use the stroke disease prediction, we collected it from the elderly cohort DB of National Health Insurance Service (NHIS), Republic of Korea. The elderly cohort DB consists of data on eligibility, economic information, hospital use, and health screening for about 550,000 people from 2002 to 2013. For this experiment, we selected health screening data of stroke patients and normal patients, respectviely, collected from 2009 through 2013. We extracted 38,669 data sets of stroke patients and normal patients, respectively. Finally, the number of data sets used for experiments is 77,338 in total. A decision tree is used as a classification data mining tool aimed to extract useful information from large data sets and to help in decision-making processes. A decision tree is more intuitive in describing the obtained knowledge and it is convenient to generate the rules [7], [8], etc. C4.5 is one of most advanced algorithms, and its function of classification and prediction is already proved [8]. We used three formulas [7] to evaluate the performance of the stroke disease prediction: the stroke detection rate, false negative rate (FNR), and false positive rate (FPR), which are as follows:

$$Stroke\ detection\ rate = \frac{\sum_{i=1}^{n} T_i}{\sum_{i=1}^{n} I_i} \tag{1}$$

$$Flase\ negative\ rate = \frac{\sum_{i=1}^{n} F_i}{\sum_{i=1}^{n} I_i} \tag{2}$$

$$False\ positive\ rate = \frac{\sum_{i=1}^{n} P_i}{\sum_{i=1}^{n} N_i} \tag{3}$$

In the above equations, I is an individual stroke patients record, whine N is a normal record for normal patients. T is a stroke patients record which is classified as an stroke by the our platform. P indicates a normal patients record which is misclassified as stroke patients. F is a stroke patients record which is misclassified as normal patients. The experimental results are shown in Table 1. we used the stroke detection rate, false negative ratio FNR, false positive ratio FPR as the performance criteria.

Table 1. The performance the proposed platform in the stroke prediction

Stroke Detection Rate	FNR	FPR
75.46%	24.53%	21.06%

4 Conclusions

In this paper, we propose a platform structure that can be applied to user-customized health management and real-time disease prediction for elderly people. The proposed platform structure can be extended for rapidly detecting and predicting new diseases.

For the future work, we are planning to develop our platform based on the proposed structure for real-time stroke disease prediction.

ACKNOWLEDGMENT

This work was supported by the National Research Council of Science & Technology (NST) grant by the Korea government (MSIP) (No. CRC-15-05-ETRI).

REFERENCES

[1] J. Gubbi, R. Buyya, S. Marusic and M. Palaniswami, “Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions,” J. Future Generation Computer Systems, vol. 29, no. 7, pp. 1645-1660, September. 2013.

[2] J. Yu, H. Bang, H. Lee and Y, Lee, “Adaptive Internet of Things and Web of Things Convergence Platform for Internet of Reality Services,” J. Supercomputing, vol. 72, no. 1, pp. 84-102, January. 2016.

[3] N. Bui and M. Zorzi, “Health Care Applications: A Solution Based on the Internet of Things,” Proc. 4th International Symp. on Applied Sciences in Biomedical and Communication Technologies, October 26 - 29, 2011.

[4] A. Pantelopoulos and N. Bourbakis, “A Survey on Wearable Sensor-Based Systems for Health Monitoring and Prognosis,” IEEE Trans. on Systems, Man, and Cybernetics, vol. 40, no. 1, pp. 1-12, October. 2009.

[5] T. Lumley, R. Kronmal, M. Cushman and T. Manolio, “A Stroke Prediction Score in the Elderly: Validation and Web-based Application,” J. Clinical Epidemiology, vol. 55, no. 2, pp. 129-136, February. 2002.

[6] A. Khosla, Y. Cao, C. Lin, H. Chiu and J. Hu, “An Integrated Machine Learning Approach to Stroke Prediction,” Proc. 16th ACM SIGKDD Int. Conf. on Knowledge Discovery and Data Mining, pp. 183-192, Washington, DC, USA, July 25-28, 2010.

[7] J. Yu, H. Kang, D. Park, H. Bang and D. Kang, “An Indepth Analysis on Traffic Flooding Attacks Detection and System using Data Mining Techniques,” J. Advanced Smart Vehicular Communication System and Applications, vol. 59, no. 10, pp. 1005-1012, November. 2013.

[8] S. Ruggieri, “Efficient C4.5,” IEEE Trans. on Knowledge and Data Engineering, vol. 14, no. 2, pp. 438-444, March. 2002.

Jaehak Yu received his B.S. degree in Computer Science from Konkuk University in 2001. He received his M.S. and Ph.D. degrees in Computer Science from Korea University, Korea, in 2003 and 2010, respectively. Since 2010, he has been working at Electronics and Telecommunications Research Institute (ETRI), Daejeon, Rep. of Korea, where he is currently a senior member of KSB (Knowledge-converged Super Brain) Convergence Research Department. His recent research interests include data and information analysis, data mining and self-machine learning algorithm, AI framework and intelligence network mining.

Seunghee Hong, PhD., in the department of industrial engineering. She is currently working as a senior research scientist at Korea Research Institute of Standards and Science (KRISS). Her research interest includes human factors, ergonomics, seating comfort, Internet of Things, Elderly health monitoring, and HCI.

Hongkyu Park received his BS degree in Computer engineering from Chungbuk National University, Rep. of Korea, in 2006. He received his MS degrees in Bioinformatics from Chungbuk National University, Rep. of Korea, in 2008. He has been working at Electronics and Telecommunications Research Institute (ETRI), Daejeon, Rep. of Korea, where he is currently a senior researcher of KSB(Knowledge-converged Super Brain) Convergence Research Department. His research interests include Bioinformatics, Machine learning and Health care.

Damee Kim received master degree in Industrial Management Engineering from the Korea University in 2016. I am working as researcher at the Korea Research Institute of Standards and Science (KRISS). I mainly focused on Human factors, Industrial Engineering.

Woongshik You received his B.S, M.S and Ph.D. degrees in Computer Engi-neering from Chungnam National University in Korea in 1997, 2000 and 2013, respectively. In 2000 he joined ETRI (Electronics and Telecommunications Research Institute) in Daejeon, where he works as a researcher in the KSB Convergence Research Department. His research interests include AI framework, machine learning and deep learning.

Sun-Jin Kim received the Ph.D. degree in IT business from KAIST (Korea Advanced Institute of Science and Technology), Korea in 2006. She is currently a principal researcher at Electronics Telecommunications Research Institute. The area of her research interests includes IoT(Internet of Things) platform, data analysis, machine learning and business model/strategy.

Cheol-Sig Pyo received the BS degree in electronic engineering from Yonsei University, Seoul, Rep. of Korea, in 1991, and the MS degree in electrical engineering from the Korea Advanced Institute of Science and Technology(KAIST), Daejeon, Rep. of Korea, in 1999. He was a visiting researcher at Georgia Institute of Technology from September 2014 to August 2015. Since 1991, he has been working at Electronics and Telecommunications Research Institute (ETRI), Daejeon, Rep. of Korea, where he is currently the Managing Director of KSB (Knowledge-converged Super Brain) Convergence Research Department. His research interests include sensor network, internet of things(IoT), machine learning, smart machine technology.

Sejin Park is working as a full-time research scientist at the Center for Medical Metrology, Division of Convergence Technology in Korea Research Institute of Standards and Science (KRISS). He holds a Ph.D., in Ergonomics. His field of interest includes ergonomics, biomechanics, 3D anthropometry, human factors and affective engineering, etc.