IoT and cloud for e-health

Subjects: Computer Science, Information Systems
Contributor: Patricia Takako Endo, Kayo Monteiro

The world population's life expectancy has gradually increased. According to the World Health Organization (WHO), the life expectation will reach 90 years by 2030, and this quality of life is one of most important aging aspects. The academic and business communities are devoting many efforts to develop new applications that promote quality of life for this portion of the population; services, such as vital signs monitoring, fall detection systems, heart attacks, among others, are increasingly in evidence. Most of these e-health systems are focused on intelligent devices - Internet of Things (IoT). However, IoT by itself is not able to process, store and guarantee the quality of service of these services due to hardware capacity limitations. So, to mitigate this issue, IoT has two major allies in order to be able to provide e-health services with high availability and quality, fog and cloud computing. This paper presents in progress e-health architecture using IoT for data acquisition, fog for data pre-processing and short-term storage, and cloud for data processing, analyze and long-term storage. We also describe main challenges to provide an e-health application with high availability, high performance and accessibility, at low deployment and maintenance cost.

Keywords: e-health ; cloud ; iot ; fog

Introduction

The increase in the elderly population is already a reality. Studies show that in 2020, we will have the largest number of older people in the history, and at first time, it will surpass the number of children up to five years old. Moreover, according to the World Health Organization (WHO), up to 80% of the elderly will live in low and middle income countries[1].

This fact challenges the current health care systems, particularly because the elderly people have a greater predisposition to present chronic diseases or to suffer from some type of disability or physical limitations, needing constant care and monitoring. According to [1], most recent estimates make an alert indicating that the number of elderly people with dementia should increase to 135 million by 2050. The integral follow-up done by a health care professional and the real-time monitoring often ends up out of the patient his/her or family's financial reality. Using IoT devices is one of the main alternatives to follow up the elderly and develop health care systems. Trough intelligent devices, vital data can be sent to a medical center, and if any thing goes beyond normality, the system can generate an alarm [2] [3]. The greater demand for long-term patient health care and the need of controlling health care expenditures require the efficient use of low-cost technologies in order to apply them in the best possible way.

Nowadays, smartphones and smart devices are very popular, and more cheap than medical specialized devices. By 2017, it is estimated that about 1.57 billion smartphones and 310.4 million mobile electronic devices were sold worldwide, representing an increase of 16.7% over 2016[4]. With these IoT devices, it is possible to collect different vital signals, such as heart rate, body temperature, blood pressure, or still identify if the user has suffered some accident, such as fall. However, commonly these IoT devices have limited computation and storage capacities[5]. To mitigate this issue, the user's data can be sent to the fog devices or to the cloud to be processed and stored.

Architecture for e-health system based on IoT, fog and cloud

Figure 1 highlights a basic architecture that can be used to deploy a IoT based e-health system integrated with fog and cloud. In a general way, IoT devices (sensors) are responsible for collecting the patient vital signs continuously and send data for microcontrollers in order to unify the patient data. In turn, the microcontrollers send this data to fog devices, where the data can be pre-processed, guaranteeing the rapid response of the system if any abnormality is identified. The fog layer will also send the patient data to the cloud in order to catalogue and store for further analyze. According to Miotto [6], if any abnormality is identified, then fog layer guarantees the rapid response of the system. Therefore, our architecture states that there should have some technology implemented at fog to analyze the data and diagnose this irregularity. Nowadays, Deep Learning (DL) is proving their potential in many areas, including biomedical[6], being used, for instance, to detect human falls, cardiac arrhythmia or epilepsy attacks.

Figure 1. E-health system architecture[7]

In a context of e-health monitoring systems, high availability and high performance are essential, since any information delay may be crucial for the patient's welfare and life[5]. Beyond theses technical aspects, in this work, we focus on giving quality of life at low cost implementation. Currently in the market, there are several IoT devices able to collect patient vital signs, however the price of these devices makes them unattainable for most part of the population. Therefore, providing e-health systems with high availability, high performance and low cost is one of the biggest challenges faced by the community.

The entire article has been published on: https://ieeexplore.ieee.org/abstract/document/8605747/

References

1. World Health Organization . WHO website. Retrieved 2020-12-24
2. Ghosh, A. M., Halder, D., & Hossain, S. A. (2016, May). Remote health monitoring system through IoT. In 2016 5th International Conference on Informatics, Electronics and Vision (ICIEV) (pp. 921-926). IEEE.
3. Corotinschi, G., & Găitan, V. G. (2017, October). The use of IoT technologies for providing high-quality medical services. In 2017 21st International Conference on System Theory, Control and Computing (ICSTCC) (pp. 285-290). IEEE.
4. What Will Be the Most Coveted Devices for this Holiday Season? . Gartner. Retrieved 2020-12-24
5. Kotronis, C., Minou, G., Dimitrakopoulos, G., Nikolaidou, M., Anagnostopoulos, D., Amira, A., ... & Djelouat, H. (2017, September). Managing criticalities of e-health iot systems. In 2017 IEEE 17th International Conference on Ubiquitous Wireless Broadband (ICUWB) (pp. 1-5). IEEE.
6. Miotto, R., Wang, F., Wang, S., Jiang, X., & Dudley, J. T. (2018). Deep learning for healthcare: review, opportunities and challenges. Briefings in bioinformatics, 19(6), 1236-1246.
7. Monteiro, K., Rocha, E., Silva, E., Santos, G.L., Santos, W. and Endo, P.T., 2018, December. Developing an e-health system based on IoT, fog and cloud computing. In 2018 IEEE/ACM International Conference on Utility and Cloud Computing Companion (UCC Companion) (pp. 17-18). IEEE.