Chapter 43
Use of Internet of Things With Data Prediction on Healthcare Environments: A Survey

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ABSTRACT

Internet of Things (IoT) is a constantly growing paradigm that promises to revolutionize healthcare applications and could be associated with several other techniques. Data prediction is another widely used paradigm, where data captured over time is analyzed in order to identify and predict problematic situations that may happen in the future. After research, no surveys that address IoT combined with data prediction in healthcare area exist in the literature. In this context, this work presents a systematic literature review on Internet of Things applied to healthcare area with a focus on data prediction, presenting twenty-three papers about this theme as results, as well as a comparative analysis between them. The main contribution for literature is a taxonomy for IoT systems with data prediction applied to healthcare. Finally, this article presents the possibilities and challenges of exploration in the study area, showing the existing gaps for future approaches.

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INTRODUCTION

Internet of Things (IoT) is a computational concept where physical objects and ``things'' are connected through a network structure and are part of the internet activities in order to exchange information about themselves and about objects and things around themselves (Singh & Kapoor, 2017). The development of this paradigm is in constant growth because of the continuous efforts of the research community since IoT allows unlimited applications to solve unlimited needs in all spheres of life. Thus, in a not-so-distant future, everything in our homes, workplaces, and study will have a unique internet address and, through the network, it will be possible to monitor and control any of our "things" (Singh & Kapoor, 2017). According to Sarhan (2018), IoT is used in various domains, such as airports, military, and healthcare. IoT enables the devices to interact not only with each other but with services and people on a global scale (Akeju, Butakov, & Aghili, 2018). The world is undergoing an unprecedented technological transformation that evolves isolated systems to ubiquitous internet-enabled "things" capable of generating and exchanging large amounts of valuable data. The IoT is a new reality that is completely changing everyday life. In addition, it also promises to revolutionize healthcare applications, enabling a more personalized, preventive and collaborative way of caring for patients (Pinto, Cabral, & Gomes, 2017).

According to Senthilkumar, Manikandan, Devi and Lokesh (2018), IoT remote health monitoring systems have advantages over traditional health monitoring systems. Patients can use health sensors 24 hours a day for monitoring. A nurse or doctor can observe a patient for a limited time by day, but critical health issues can occur at any moment. Based on this, 24/7 monitoring of health facts is crucial, and it is necessary. In this context, IoT assisted patients can be accessed for medical staff over the internet and by other systems, the health state of a patient can be supervised uninterruptedly, being possible to detect health risk situations at the right time, in order to be possible to apply the appropriate countermeasures. Also, IoT can support to collect health records that can be used to generate statistic information correlated to a health condition. Using these statistics, surveillance and risk drawing of diseases can be completed using remote health data. According to Singh (2018), using IoT, systems are able to analyze and predict health disorders in early stage through Data Prediction techniques applied to generated data.

There are people who, when they have a health problem, can make an appointment in a clinic with a doctor they trust. Other people decide to go to the most appropriate hospital for their needs. In other cases, the health situation is so critical that the only alternative is to go as quickly as possible to hospital care. Thus, hospitals and healthcare environments are extremely important service points for the general population to perform one of the most important tasks: to ensure medical treatment. There are many environments, resources and processes within a hospital to accomplish this task. Thus, it becomes interesting to have effective control over how these resources and processes are being used and executed in order to identify optimization points. This becomes even more necessary when it comes across the Brazilian reality, where hospitals are increasingly crowded with people to attend. When a hospital or emergency care unit is opened, usually it takes a long time until it exceeds its service capacity. If it were possible to identify when the points of care and resources would have a demand higher than their ability to attend, it would be possible to establish action plans to minimize or perhaps even eliminate these bottlenecks in the healthcare environments systems. However, how can one analyze and define when this moment is about to arrive? Relying only on the judgment of people who work with these resources, with no efficient way of recording their uses, and no statistically reliable prediction system can become a problem, with a high probability of errors in their evaluation.