Data mining for wearable sensors and Applications in Health monitoring systems

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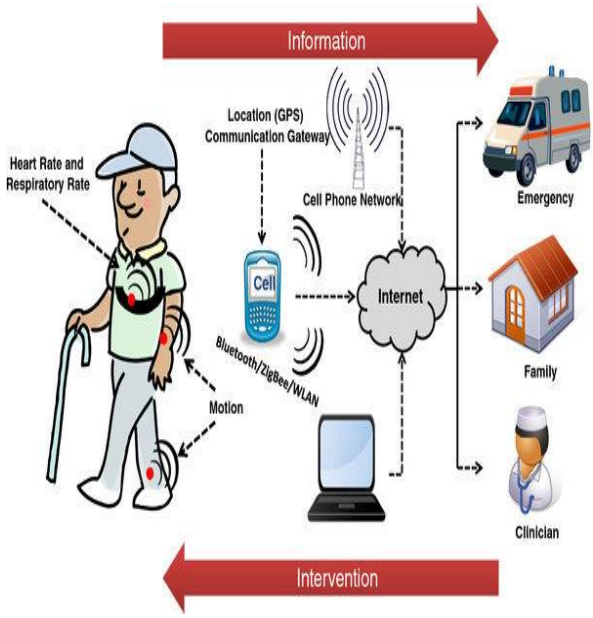
Abstract: The past few years have witnessed an increase in the development of wearable sensors for health monitoring systems. This increase has been due to several factors such as development in sensor technology as well as directed efforts on political and stakeholder levels to promote projects which address the need for providing new methods for care given increasing challenges with an age population. An important aspect of study in such system is how the data is treated and processed. This paper provides a recent review of the latest methods and algorithms used to analyze data from wearable sensors used for physiological monitoring of vital signs in healthcare services. In particular, the paper outlines the more common data mining tasks that have been applied such as anomaly detection, prediction and decision making when considering in particular continuous time series measurements. The More details suitability of challenging data mining and machine learning methods used to process the physiological data and provides an overview of the properties of the data sets used in experimental validation. Finally, based on this literature review, a number of key challenges have been outlined for data mining methods in health monitoring systems.

Keywords:
Data mining, wearable sensors, healthcare, physiological sensors, health monitoring system, machine learning technique, vital signs, medical informatics.

Introduction:

The US health care system faces daunting challenges. With the improvements in health care in the last few decades, residents of industrialized countries are now living longer, but with multiple, often complex, health conditions. The description of healthcare use in non-clinical environments using vital signs provided by wearable sensors, the want to mine and process the physiological measurements is growing significantly. Health monitoring services are to be designed that can address the growing market needs and opportunities in pervasive sensing such as distributed health monitoring and long-term prevention. This paper attempts to explain how certain data mining methods have been applied in the literature. It also attempts to reveal trends in the selection of the data processing methods based on the requirements of the monitoring system.Reviewing the data mining and pattern recognition methods used in the prose for applications involving wearable sensing technologies. Focus is put on the algorithms and data sets that have been used in order to provide an overview of

the algorithm's capabilities and shortcomings.



Related Review Papers

A number of inclusive reviews on the hub of health monitoring with wearable sensors have been previously presented in the literature. Many such reviews focus on giving a global overview of the topic. Studies on health monitoring systems include wearable, mobile and remote systems. Maximum are works such as which focus on the needs to have wearable sensors and overcoming important bottlenecks for the use of wearable sensors such as the clinical position and interoperability in health records. According to smart wearable systems supports complex healthcare applications and enable low-cost wearable, non-invasive alternatives for continuous 24-h monitoring in Bioinformatics, imaging informatics, clinical informatics, and public health informatics. In view of the data mining reviews for healthcare and sensors, currently most of them are related to general studies for healthcare i.e., well known problems in healthcare with simple and routine data Mining approaches. Recently, Sow categorized the main challenges of sensor data mining in five following stages: acquisition, preprocessing, transformation, modelling and evaluation. The authors in construct the data mining algorithms generally in two types (1) descriptive or unsupervised learning (i.e., clustering, association, summarisation) and (2) predictive or supervised learning (i.e., classification, regression). However, they are lacking deeper insight into the suitability of the algorithms for handling the special characteristics of the sensor data in health monitoring systems.

Data Mining Tasks for Wearable Sensors

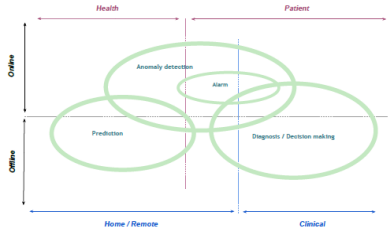
Healthcare services consist of identifying on data mining tasks to have deeper knowledge representation. Based on the selected literature, three types of data mining tasks are predominant. These three tasks are: prediction, anomaly detection which may include the subtask of raising alarms, and diagnosis where a decision making process is made to often categorize the data into different groups depending on the diseases. Each of these tasks is further described in this section provides a depiction of each task in relation to three dimensions.

1. The first dimension involves the setting in which the monitoring occurs. The more monitoring applications which consider home settings or remote monitoring deal predominantly with prediction and anomaly detection whereas the applications in clinical settings are typically focused on diagnosis.

2. A second dimension in the Figure shows the main data mining tasks in wearable sensors with respect to the type of subjects used. For patients identified medical records, both diagnosis and specifically the

possibility to raise alarms are key tasks. For health monitoring which typically include healthy individuals who want to ensure the maintenance of good health, prediction and anomaly detection are used in the literature.

3. The final dimension depicted in the Figure considers the three main data mining tasks in relation to how the data is processed. For all three tasks data has been addressed both in an online and offline manner, with more alarm related tasks being naturally used in the context of online and continuous monitoring.



Prediction

Prediction is an mothod that is widely used in data mining field that helps to identify events which have not yet occurred. The role of the predictive data mining considering wearable sensors is nontrivial due to requirement of modeling sequential patterns acquired from vital signs. This method is also known as supervised learning models where it includes feature extraction, training and testing steps while performing the prediction of the data behavior.

Diagnosis/Decision Making

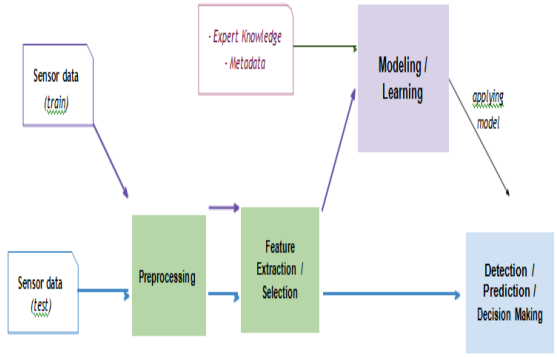
Decision making in diagnosis is one of the important tasks of clinical monitoring systems which is often based on retrieved knowledge using vital signs, and also other information such as electronic health records and metadata. The diagnosis/decision making is related to the anomaly detection in data mining in order to extract useful information of sensor data such as events, outliers, and alarms which are meaningful for decision.

Other Data Mining Tasks for Wearable Sensors

The major role of data mining in healthcare monitoring systems is retrieving information (i.e., anomaly detection, prediction and diagnosis decision making), and there are several tasks considering wearable sensors that data mining methods are able to carry out. According to most healthcare systems are dealing with the following issues:
(1) data acquisition using the adequate sensor set.
(2) senting of data from subject to clinician.
(3) integration of data with other descriptive data.
(4) data storage Considering these issues leads to investigate some data mining tasks such as data cleaning, noise removing, data filtering and compressing as a part of any physiological data monitoring frameworks.

Data Mining Approach

In health monitoring systems, the character of data analysis is to extract information from the low level sensor data and bridge them to the high level knowledge representation. For this reason recent health monitoring systems have given more attention to the data processing phase in order to catch more valuable information based on the expert user requirements. Data mining techniques that have been enforced to wearable sensor data in health monitoring systems have varied and it is also not uncommon that several techniques are used within the same architecture.
A generic architecture of the main data mining approach for wearable sensor data.



The main steps of the data mining approach consist (1) data preprocessing; (2) feature extraction and selection; and (3) modelling data learning the input features (considering expert knowledge and metadata) to perform the tasks such as detection, prediction, and decision making.

Conclusion

The plan of this study was to provide an overview of recent data mining techniques applied to wearable sensor data in the healthcare domain. This article has attempted to clarify how certain data mining methods have been applied in the literature. This paper have (1) data mining tasks for wearable sensors (2) data mining approach and (3) data sets and their properties. In particular, the review outlined the more common data mining tasks that have been applied such as anomaly detection, prediction and decision making when considering in particular continuous time series measurements.

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