1. Record Nr. TD17002511

Autore JANJUA, ZAFFAR HAIDER

Titolo SENSOR-BASED BEHAVIORAL MONITORING FOR EARLY DETECTION OF COGNITIVE DECLINE. [Tesi di dottorato]

Editore Università degli Studi di Milano, 2016-06-14

Lingua di pubblicazione	Inglese
Formato	Tesi di dottorato
Livello bibliografico	Monografia
Note	diritti: info:eu-repo/semantics/openAccess In relazione con info:eu-repo/semantics/altIdentifier/hdl/2434/391782

Sommario

The advancement in medical science has increased life expectancy in developed countries, which results in a rise in the elderly population. Consequently, age related health issues are also increasing and aging societies are continuously searching for new technologies to provide better healthcare services to the elderly population. One of the prominent health issues relates to the elderly population is cognitive impairment. The decline in cognitive health does not only affect day to day matters of the individual, but also creates difficulties for clinicians and caregivers in terms of providing necessary support to individuals suffering from cognitive disorder. Therefore, an early detection of cognitive impairment is very important, so that clinicians, caregivers, and individuals can take necessary measures to support a cognitively impaired person. In medical literature, the term Mild Cognitive Impairment (MCI) is recognized as a transitional phase between normal aging and dementia. Several studies show that in early stages of the disorder, signs are quite subtle. Hence, it is difficult to capture subtle signs through episodic medical workups. Studies in this domain also conclude that the deteriorated cognitive health significantly affects the ability of an elderly person to correctly perform routine life activities. Therefore, a continuous monitoring of the daily routine of

the elderly can be helpful for clinicians to diagnose the early onset of MCI. Thanks to the recent advancement in the pervasive technology, which allows us to develop such systems which can continuously monitor daily routine of the elderly through a smart space. This thesis focuses on the detection of fine-grained anomalies found in the daily behavior of the subject; an elderly person who lives independently in a smart home. We particularly focused on those anomalies which reflect early onset of MCI. In order to model abnormal behavior, we have collaborated with neuro-science experts and clinicians. The medical model provides natural language descriptions of fine-grained anomalies. We proposed FABER, a novel technique for Fine Grained Abnormal BEhavior Recognition (FABER). FABER is a modular architecture and relies on artificial intelligence techniques for the recognition of abnormal behavior. FABER is developed with the objective to support clinicians for a proper diagnosis of MCI. In FABER, we have exploited a combination of statistical, symbolic, and hybrid techniques to infer fine-grained anomalies. Complex human activities are characterized by wide variability; a person can adopt several different patterns of simple actions to perform an activity. Simple actions are detected by various multi-modal sensors deployed in a smart space. For the sake of privacy, we do not consider audio and visual sensors. The data stream from multimodal sensors contain several activities performed by a smart home resident. FABER recognizes boundaries of activities i.e., the start and end time instants of an activity. We have considered various techniques to recognize boundaries of activities. These techniques include supervised machine learning such as Random Forest and hybrid techniques such as Markov logic network (MLN). After recognizing activities, the next step is the detection of fine-grained anomalies. We constructed a knowledge-base to recognize these fine-grained anomalies. For this purpose, we have represented knowledge using a symbolic technique: first-order logic. Knowledge is acquired from various sources: 1) experts provide us knowledge of abnormal behavior and other necessary information required for the detection of fine-grained anomalies such as a medical prescription to detect an anomaly missed medicine; 2) contextual information is acquired from multi-modal sensors which includes spatio-temporal information; 3) recognized activities are obtained from activity recognition module. In order to infer anomalies, natural language descriptions of fine-grained anomalies are translated into first-order logic rules. In an ?if-then? rule, the antecedent is based on conditions defined by the clinical model for an anomaly and the consequent is a single class of fine-grained anomaly to be recognized. The clinical model also specifies seriousness level of each anomaly such as a critical anomaly or a non-critical anomaly. The critical anomaly alerts clinicians for a serious behavioral modification, whereas the non-critical anomaly indicates routine life errors that may occur due to negligence, hastiness or personal habits. In general, knowledge representation is a challenging task and depends on several factors. These factors include smart home layout, environmental conditions, personal habits of the subject, and physical health of the subject. In order to formulate rules, a knowledge engineer must understand the hidden relationship between these factors and the relevant anomaly class. Moreover, manually formulated rules are not seamlessly portable to different environments. In order to solve these issues, we have considered a rule induction technique, RIPPER, which automatically learns rules from a set of features. In this way, we can automatically generate anomaly detection rules for different environments while using same feature set for each environment. In order to evaluate the proposed framework, we have conducted experiments with two datasets: 1) a smart home lab data set in which actors simulated daily behavior of MCI patients; 2) a real home dataset in which a real patient performed activities. According to the directions of clinicians, we have selected three activities for the experimentation which includes taking medicines according to a medical prescription, preparing a meal during mealtime, and eating a meal during mealtime. The system periodically infers fine-grained anomalies, in our case we infer anomalies at the end of each day i.e., by 12:00 a. m. midnight. We have used k-fold cross validation to validate the performance of the system. In each fold, the data acquired for exactly one day serve as test set, whereas data acquired for the rest of days serve as training set.

Localizzazioni e accesso	http://memoria.depositolegale.it/*/http://hdl.handle.net/2434/391782