Abstract

Title : Non-intrusive Human Sensing: Techniques and Applications

The thesis is aimed at non-intrusive human sensing. It is envisaged that the contributions made in this thesis are applied to scenarios wherein non-intrusive human sensing is needed. Such applications include assisted living, elderly care, digital health, human robot interaction, pedestrian safety, border security. The success of all these applications are dependent on the accuracy of human detection. The thesis follows a bottom up approach. The first half of the thesis introduces the methods to improve the accuracy of human sensing followed by the deployment of human sensing to analyze the human behavior for health and wellness. The thesis commences with a description of various sensors that could be used for human sensing and the manner in which the features obtained from the raw signal from an ultrasonic sensor can be used for non-intrusive sensing. Combining the information from multiple heterogeneous sensors to improve the accuracy of human sensing has also been described. The above combination of sensors along with a camera was mounted on-board a robot and the efficacy of the multi-modal human sensing system was studied in a real environment. This along with investigations into dynamic environments forms the next part of the thesis. In order to reduce redundancy in the set of features extracted thereby reducing computational costs, an immuno-inspired mechanism has been proposed, next. This mechanism was implemented using a Pyro Infrared (PIR) sensor and an Analog Ultrasonic Sensor (AUS). One of the prominent areas where human sensing is required is in the domain of health and wellness. For this it is essential to extract the behavior of a human being given his/her profile. The subsequent part of the thesis thus proposes an approach for detection early symptoms of cognitive impairment using spatio-temporal data which has been obtained using human sensing. Since it is not feasible to capture spatio-temporal data for every possible scenario, a method to use this learned information in other scenarios, where there is no/insufficient data, is highly essential. The last part of the thesis thus describes the manner in which transfer learning can be used to achieve the same.

The work reported in this thesis provide ample scope and promulgate several clear directions for future research endeavors. This thesis in no way discourages intrusive human sensing but highlights the benefits of using non-intrusive human sensing and how it can be achieved. Further due to the dynamic behavior of human beings, this thesis does not claim to have solved the human sensing problem in totally. The problem still has several unanswered questions which open the gates for future research.