WIRELESS SENSING HUMAN ACTIVITY RECOGNITION WITH RECURRENT NEURAL NETWORK USING RASPBERRY PI

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

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DEDICATION

I would like to dedicate this project to my supervisor and myself.

ABSTRACT

The advancement and availability of technology have been employed to improve our daily life especially with sensing system. Sensing system are widely used in many fields for the purpose of diagnostics and monitoring. One of the fields that used are in smart home health monitoring which the system will recognize the human activity. Moreover, most of the human activity recognition (HAR) system are mainly explored to intrusive methods such as video based and wearables sensor. These HAR may offer detailed data but the cost higher with some limitation like privacy. Hence, this project is planned to develop a wireless sensing system for human activity to solve the limitation with embedded board Raspberry Pi 4. Deep learning algorithm will be used in training models, analysis the collected data and predict the human activity through the MATLAB applications.

ABSTRAK

Kebelakangan ini, kemunculan dan kecanggihan tecknology telah banyak menaikkan taraf hidup kita terutamanya sistem penderiaan. Penderiaan system ini banyak digunakan di pelbagai bidang untuk diagnosis dan permantauan. Salah satu bidang yang terlibat ialah bidang pemantauan kesihatan rumah pintar dengan menggunakan sistem untuk kenal pasti aktiviti human. Kebanyakkan sistem penderiaan adalah berasas video dan perderia yang boleh dipakai. Kaedah tersebut membolehkan pengguna untuk mendapat data yang lebih teliti.dengan harga yang lebih mahal dengan beberapa pengehadan seperti issue privasi dan bekalan cahaya. Jadi, projeck ini dirancangkan untuk membangunkan wayarless sistem penderiaan untuk kenalpasti aktiviti manusia supaya menyelesaikan had limit dengan Raspberry Pi 4. Algorithma mendalam akan digunakan untuk latih model data, analisis of data dan meramalkan aktiviti manusia melalui MATLAB.

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LIST OF SYMBOLS AND ABBREVIATIONS

WSHA	:	Wireless Sensing for Human Activity
NN	:	Neural Network
OFDM	:	Orthogonal Frequency Division Multiplexing
RSSI	:	Received Signal Strength Indicator
SBCs	:	single-board computers
RNN	:	Recurrent Neural Network
Wi-Fi	:	Wireless Fidelity
CNN	:	Convolutional Neural Network
CTS	:	Clear To Send
LSTM	:	Long short-term memory
RDC	:	Radar data cube
PCA	:	Principal component analysis
SVM	:	Support Vector Machine
MLP	:	Multilayer perceptron
LSTM	:	Long Short-term Memory
CNN	:	Convolutional Neural Network

CHAPTER 1

INTRODUCTION

This thesis proposes the implementation of the wireless sensing system for human activity with recurrent neural network using raspberry pi. This chapter will discuss about the project background, problem statements, objectives of this project, research outline, scope of works and the structure of thesis.

1.1 Project Background

Nowadays, sensing system are widely used in many fields for the purpose of diagnostics and monitoring. One of the uses of sensing system are smart home health monitoring which able to recognize, understand and classified the human activity. Mostly, human activity recognition systems are intrusive such as video-based and wearables which can offer detailed data but the cost higher with some limitation like privacy concern and require light supply. For video approaches, there are group of people concern about their privacy. Hence, this project is planning to develop a wireless sensing system for human activity with recurrent neural network. Deep learning algorithm will be used in data preprocessing, analysis the data and prediction of the human activity through the MATLAB applications. It is expected to enable the system to provide a better accuracy to determine the human activity such as walking, running, and standing.

1.2 Problem Statements

In this world that information can sent in the flash of light, sensing technology have become one of the methods that can be used to implement ambient to the smart home health monitoring. Moreover, most of the sensing technology are commonly used video-based and wearables which can provide users richer data but much expensive prices and existence of the privacy concern. People don’t feel safer and comfort with the cameras either public or private area.

Hence, in this project, the human activity recognition with radio frequency-based approach is used. Then, Channel State Information (CSI) can make use of the low-

cost off-the-shelf Wi-Fi hardware and the human recognition system will be implemented on the Raspberry Pi 4 which is the world's most popular embedded boards. After that, recurrent neural network will be used to design the system to train, test and classified the signal to demonstrate the performance of the human activity recognition.

1.3 Objectives

- To design a wireless sensing system with recurrent neural network based on the collected signals for the human activity recognition.
- To investigate the property of wireless signals extracted from Raspberry Pi for human activity recognition.

1.4 Scope of Works

This project is mainly focused on the recognition of human activity with recurrent neural network which is LSTM. Both hardware component and software are needed to accomplish this project. In addition, WI-FI play a very significant role in this project. It can't be work if there are absence of WI-FI connection. Moreover, there are single deep learning algorithm that will be used which is LSTM. The process of classification and training of model data are work with MATLAB software. There are 2 datasets in this project, the activity samples in the first dataset such as do

nothing, lay, sit down and are self-collected data. The other set of datasets would be the online dataset.

1.5 Research Outlines

Figure 1.1 shows the flow chart of human activity recognition. First, the raw data are collected when there is motion been detected. Signal collected always will be disturb by the noise, humidity, and temperature, therefore pre-processing the data is needed before the data being train. With features extraction, only keep the important information and the other unwanted information will be erased. Then, the collected data will be undergoing classification with LSTM as module dataset. The dataset will be test with trained module data. Finally, the data will be classified, and prediction of the human activity can be made in the test environment. However, the classification & recognition process would be repeat until the result demonstrated is satisfied.

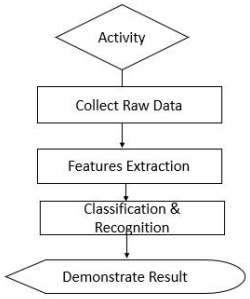

Figure 1.1: Flow Chart of the human activity recognition.

With wireless sensing system, the privacy of users is protected with ambient method for human recognition. Besides, it is environmentally friendly and able to reduce the landfill waste since camera are not used in this project. Cameras are combination of lot of elements and some of them are harmful to us such as halogen and PVC. Moreover, this system can be applied in many fields especially in the health monitoring field for elderly, and digital therapeutics. Patients can always make their appointment online and save waiting times.

1.6 Structure of Thesis

In this thesis, it comprises 5 chapters. Chapter 1 describes the project background, problem statements, objectives of the project, scope of works, limitation, research outlines, and the structure of this thesis. In chapter 2, it mainly discusses about the background study on the sensing system that used in the market, deep learning methods (RNN), Received Signal Strength (RSSI), and Channel State Information (CSI). In chapter 3, it discusses the methodology of the project. Chapter 4 discusses and evaluated the results of the project. Chapter 5 summarized the outcome of the project and proposed suggestions of the project for future work.