DEVELOPMENT OF A HUMAN FOLLOWING ROBOT BASED ON BLUETOOTH RECEIVED SIGNAL STRENGTH

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DEDICATION

To my beloved parents – Mr Cheng Keng Meng & Mrs Seow Wai Yee

ABSTRACT

Human following is a technique used by robot and autonomous vehicles to follow a human within a specific range. The implementation of human following robots is being actively carried out in various daily tasks such as load carrying, monitoring a target and navigation for people through interaction and collaboration. Most of the existing developments use one of the various sensor technologies such as Laser Range Finder (LRF), Red Green Blue-Depth (RGB-D) camera, stereo camera, Light Detection and Ranging (LiDAR) and ultrasonic sensor. However, those technologies need the Line of Sight (LOS) condition to operate properly. It is easy to lose the sight of the target when in complex environment. The purpose of this project is to develop a human following robot using a smartphone application through the Bluetooth medium. The developed system consists of two main components which are the microcontroller and motor driver. The distance between the human and robot is estimated based on the Received Signal Strength Indicator (RSSI) of the Bluetooth signal measured by using path loss propagation model. The gyroscope sensor on the smartphone is used to estimate the direction of target movement. Performance evaluation of the robot is conducted based on the accuracy of estimated distance for several values of path loss exponent. The results show that the best path loss exponent is 1.7 in indoor with Line-Of Sight (LOS) condition. The accuracy of the distance in this condition is the highest. The measured distance is decreasing when the actual distance at 1.8m in each condition.

Teknik penjejakan manusia adalah teknik yang digunakan oleh robot dan kenderaan automotif untuk mengikuti manusia dalam jarak tertentu Pelaksanaan robot mengikut manusia dilakukan secara aktif dalam pelbagai tugas harian seperti pemuatan beban, memantau sasaran dan navigasi untuk orang melalui interaksi dan kolaborasi. Kebanyakan system dalam robot ini menggunakan salah satu teknologi sensor daripada perlbagai teknologi sensor seperti Laser Range Finder (LRF), kamera Red Green Blue-Depth (RGB-D), kamera stereo, Light Detection and Ranging (LiDAR) adan ultrasonik sensor. Walau bagaimanapun, teknologi tersebut memerlukan syarat Line of Sight (LOS) untuk beroperasi dengan baik.. Ini menyebabkan robot mudah kehilangan sasaran ketika berada dalam situasi yang kompleks. Objektif projek ini adalah untuk membinakan robot mengikuti orang dengan aplikasi telefon pintar melalui medium Bluetooth. Robot ini mempunyai dua komponen yang utama iaitu pengawal mikro dan pengawal motor. Jarak antara manusia dan robot dianggarkan berdasarkan Received Signal Strength Indicator (RSSI) isyarat Bluetooth dengan menggunakan path loss propagation model. Sensor giroskop dalam telefon pintar digunakan untuk menganggar arah pergerakan sasaran. Penilaian prestasi robot dilakukan berdasarkan ketepatan anggaran jarak untuk beberapa nilai path loss exponent. Hasil kajian menunjukkan bahawa path loss exponent terbaik adalah 1.7 di dalam keadaan kawasan tertutp dengan Line-Of Sight (LOS). Ketepatan jarak dalam keadaan ini adalah yang tertinggi. Jarak yang diukur semakin berkurang apabila jarak sebenar pada 1.8m pada setiap keadaan.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

µs	-	Microsecond
AES	-	Advanced Encryption Standard
A	-	Ampere
b	-	Bit
BCI	-	Brain-Computer Interface
BLE	-	Bluetooth Low Energy
BR	-	Background Region
BSFS	-	Binary Search Feature Selection
BSSID	-	Basic Service Set Identifier
cm	-	Centimetre
CNN	-	Convolutional Neural Network
CPU	-	Central Processing Unit
CW	-	Clock Wise
CWW	-	Counter Clock Wise
DC	-	Direct Current
DWT	-	Discrete Wavelet Transform
EGG	-	Electroencephalogram
EKF	-	Extended Kalman Filter
FHSS	-	Frequency-Hopping Spread Spectrum
FP	-	Fingerprint
FR	-	Foreground Region

GHz	-	Gigahertz
GPIO	-	general purpose input/output
GUI	-	Graphical User Interface
HCI	-	Human-Computer Interaction
HRI	-	Human-Robot Interaction
I/O	-	Input/Output
IoT	-	Internet Of Thing
Kbps	-	Kilobit Per Second
KST	-	Kinect Skeleton Tracker
LAN	-	Local Area Network
LED	-	Light Emitting Diode
LiDAR	-	Light Detection and Ranging
LOS	-	Line of Sight
LRF	-	Laser Range Finder
m	-	Meter
mA	-	Milliampere
Mbps	-	Megabit Per Second
MHz	-	Megahertz
mm	-	Millimetre
ms	-	Millisecond
NN	-	Nearest Neighbour
NST	-	NITE Extension Skeleton Tracker
OAB	-	Online Ada-Boosting

PHD	-	Probability Hypothesis Density
PRM	-	Polynomial Regression Model
PWM	-	Pulse Width Modulation
RANSAC	-	Random Sample Consensus
RFCOMM	-	Radio Frequency Communication
RFID	-	Radio Frequency Identification
RGB-D	-	Red Green Blue Depth
ROS	-	Robot Operating System
RSSI	-	Received Signal Strength Indicator
SDK	-	Software Development Kit
SOAB	-	Selected Online Ada-Boosting
SSH	-	Secure Shell
SVM	-	Support Vector Machine
TTL	-	Transistor-Transistor Logic
UART	-	Universal Asynchronous Receiver Transmitter
UDP	-	User Datagram Protocol
UGV	-	Unmanned Ground Vehicles
USB	-	Universal Serial Bus
V	-	Voltage
VB	-	Visual Basic
VCR	-	Voice Controlled Robot
VGA	-	Video Graphics Array
VPF	-	Virtual Potential Field

Wi-Fi	-	Wireless Fidelity

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter discusses the overview of the project and emphasizes the problem statement, objectives, work scope, contribution and outline of the report

1.1 Background

Robots are very helpful for human to complete a daily task in easier way. Human following is a technique used by robot and autonomous vehicles to follow a human within a specific range. Human following robots are also one type of robots that are used in various service sectors such as load carrying, looking after the elder people, navigation for people and many more. Human following robot is a platform that allows the human to interact with a robot. For example, human following robot can be used in carrying load in hospital, airport and other places. The ability to follow a target is user-friendly. Sometimes, human following robots are also used to obtain and monitor some information related with human subject like heart-beat rate through wearable sensors. Most of the human following robots need the line of Sight (LOS) to follow target whereby the robot only can follow the target if the target is present in the field of view of sensor. These robots need additional hardware like sensor to track the target. Therefore, developing a service robot by using the existing electronic sensor infrastructure such as Wi-Fi or Internet of Thing (IoT) devices that always used in daily life is important. It can reduce the cost in manufacturing the robot. Smartphone is one of the famous IoT devices. The sensors in the smartphone can be used to provide some information such as position of a