DEVELOPMENT OF LOW COST AUTONOMOUS WHEELCHAIR USING GPS FOR OUTDOOR PURPOSES

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kerusi roda elektrik telah digunakan secara meluas bagi membantu dan memudahkan usaha pengguna untuk bergerak dengan sendiri. Pengguna lebih memilih untuk mengawal pergerakan kerusi roda sendiri tanpa pertolongan orang lain. Walaupun kerusi roda elektrik adalah penyelesaian yang baik untuk mengurangkan usaha menggerakkan kerusi roda sendiri, tapi malangnya kerusi roda elektrik adalah mahal di Malaysia. Lebih-lebih lagi, kebanyakan kerusi roda elektrik yang terdapat di pasaran hanya menggunakan kayu ria sebagai alat kawalan. Walaubagaimanapun, kayu ria tidak sesuai untuk kebanyakan kes. Sebagai contoh, pengguna yang cacat penglihatan, pengguna yang cacat mental atau lumpuh kedua-dua belah tangan, tidak mampu memegang dan mengawal kayu ria. Pengguna sebegini memerlukan bantuan daripada orang lain. Namun, orang lain tidak selalunya ada untuk membantu disebabkan oleh pelbagai kekangan. Menggunakan alat kawalan lain mungkin mampu menyelesaikan separuh daripada permasalahan ini tapi ini masih tidak mencukupi. Justeru itu, kerusi roda perlukan penambahbaikkan ke arah sistem kawalan bijak yang boleh menyelesaikan beberapa masalah yang kritikal seperti pengguna yang tidak dapat menggunakan kedua belah tangan dan kaki. Kajian ini fokus kepada membangunkan sistem kawalan untuk membenarkan kerusi roda untuk bergerak dengan sendiri dari satu titik ke satu titik yang lain menggunakan Sistem Kedudukan Global (GPS). Masalah utama dalam membangunkan sistem bertindak sendiri adalah bacaan GPS yang tepat dan konsisten. Untuk menyelesaikan masalah tersebut, satu algorithm mudah telah dibangunkan untuk meningkatkan ketepatan dalam mengenalpasti kedudukan dan perancang jalan kepada kerusi roda. Teknik purata telah diaplikasikan dalam mengenalpasti kedudukan untuk menambahbaik ketepatan dan mendapat bacaan GPS yang konsisten. Kedudukan GPS menjadi lebih tepat kerana teknik purata mengurangkan bacaan GPS kepada dua bacaan yang konsisten berbanding lima bacaan yang berbeza. Dari sudut ketepatan, jarak antara titik sebenar dan yang diukur oleh GPS berkurang daripada 4 meter kepada 3 meter sahaja. Sudut berhenti diubah dengan menukar putaran pemalar sudut berhenti kerana kerusi roda tidak berhenti secara serta merta pada putaran yang dikehendaki disebabkan oleh Hukum Tarikan Inertia. Nilai pemalar sudut berhenti perlu ditetapkan melalui proses percubaan dan pembetulan sudut pergerakan. Cadangan penyelesaian menggabungkan putaran encoder dan kompas. Pemalar kp=60 telah diaplikasikan dalam pembetulan pergerakan lurus, dan boleh dilihat roda sentiasa mencuba untuk mendapat keseimbangan antara satu sama lain. Beberapa eksperimen telah dijalankan untuk menguji kebolehan sistem ini dan memenuhi tugasan untuk sampai ke destinasi yang ditetapkan dengan tepat. Kerusi roda ini boleh digunakan untuk pergerakan luar kerana bacaan GPS lebih tepat di luar bangunan. Sebagai contoh, pengguna mahu pergi ke klinik atau taman terdekat dalam jarak 1 kilometer dari rumah mereka. Hal ini akan menjimatkan masa mereka kerana mereka tidak perlu menunggu bantuan daripada orang lain.

ABSTRACT

Electric wheelchair has been widely used to facilitate and minimize the user's effort to move independently. Users prefer to control the movement of the wheelchair on their own without any assistance. Although electric wheelchairs are considered a good solution to minimise the effort in independently moving the wheelchair, but unfortunately, electric wheelchairs are expensive in Malaysia. Moreover, most of the available electric wheelchairs in the market use only the joystick as control device. However, the joystick is not suitable for most cases. For example, blind users, users with mental disorders or with both hands paralyzed, are unable to hold and control the joystick. Such users still need to be assisted by others. However, other people will not always be available to help due to any constraints. Using other means of control devices may partially solve the issues but may not be entirely resolved. Therefore, wheelchair needs some improvement utilising smarter and low cost control system that can resolve some critical cases for example the users that are unable to use both their hands and legs. This research main focuses on developing a control system to allow wheelchairs to move autonomously from one point to another using Global Positioning System (GPS) while saving the cost to make it affordable for the users. The main problem in building an autonomous system is the accuracy and consistency of GPS reading. To solve that problem a simple algorithm is developed to improve the accuracy in positioning and path planning for the wheelchair. The averaging technique was applied in positioning to improve the accuracy and consistency of the GPS reading. The GPS positioning becomes more accurate as the averaging technique reduced the GPS reading to two consistent readings instead of five different readings. In terms of accuracy, the distance between the actual point and the GPS measured point had decreased from 4 meters to only 3 meters. The stop angle was adjusted by changing the setting for the stop angle's constant because the wheelchair does not immediately stop at the desired turning point due to the Law of Inertia. The value of that constant has to be experimentally set according to error in turning angle. The suggested solution is by integrating rotary encoder with the compass. The constant kp= 60 pulses was applied in straight movement correction, and can be seen that the wheels always trying to balance each other. Experiments have been conducted to test the ability of the system and fulfil the task of reaching a pre-stated destination accurately. This wheelchair can be used for outdoor movement as the GPS is more accurate outside of the building. For instance, the users want to go to the nearest clinic or park within 1 kilometre from their home. This will save time as they don't need to wait to seek for assistance.

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LIST OF SYMBOLS

dBm	decibel-milliwatts
V	Voltage
W	Watt
μA	micro Ampere
Π	Constant pai, an approximate value is 3.14159

LIST OF ABBREVIATIONS

2WD	2 Wheel Drive
AMR	Android Meets Robot
BCI	Brain-Computer Interface
CVM	Curvature Velocity Approach
EEG	Electroencephalography control
GPS	Global Positioning System
K-NN	K- Nearest Neighbor
LCD	Liquid-Crystal Display
LIDAR	Light Detection and Ranging
$LiFePO_4$	Lithium Iron Phosphate
MICA	Mobile Internet Connected Assistant
PDA	Personal Digital Assistant
RFID	Radio-Frequency Identification
SEW	Smart Electrical Wheelchair
SLAM	Simultaneous Localization and Mapping
TDS	Tongue Drive System
TTL	Transistor-Transistor Logic
VFH	Vector Field Histogram
WPS	Wi-Fi Positioning System

LIST OF APPENDICES

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