DEVELOPMENT AND REAL TIME CONTROL OF AN ARM FOR PATIENT ASSISTANCE FOR LIFTING MOBILITY ROBOT (PALMBOT)

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PERPUSTAKAAN
UNIVERSITI MALAYSIA SABAH

THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

SCHOOL OF ENGINEERING AND INFORMATION TECHNOLOGY
UNIVERSITI MALAYSIA SABAH
2008
JUDUL: DEVELOPMENT AND REAL TIME CONTROL OF AN ARM FOR PATIENT ASSISTANCE FOR LIFTING MOBILITY ROBOT (PALMBOT)

IJAZAH: Doktor Falsafah (Robotik)

SESSI PENGAJIAN: 2004 – 2008

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DECLARATION

This thesis is the result of my own work with the exception of quotations, excerpts, summaries and references, the sources which have been duly acknowledged.

17 July 2008

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PS04-008-009

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CERTIFICATION

TITLE: DEVELOPMENT AND REAL TIME CONTROL OF AN ARM FOR PATIENT ASSISTANCE FOR LIFTING MOBILITY ROBOT (PALMBOT)

DEGREE: DOCTOR OF PHILOSOPHY (ROBOTICS)

DATE OF VIVA: 27 JUNE 2008

DECLARED BY

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ACKNOWLEDGMENT

Thank you GOD, the Almighty.

I would like to express my unlimited appreciation to Prof. Dr. R. Nagarajan, Assoc. Prof. Dr. Ali Chekima and Prof. Dr. Sazali Yaacob for their valuable supervision and guidance in the research and preparation of this thesis. They provided me with great opportunity and allowed me to go in depth in the applications of areas of robotics, control, sensors, neural network and fuzzy logic. Their consistent motivation and encouragement allowed me to perform better and to unleash my capabilities in my areas, especially in the field related to this thesis.

I would like to express my gratitude to the 1st Vice Chancellor of University Malaysia Sabah, Tan Sri Prof. Datuk Seri Panglima Dr. Abu Hassan Othman and the 2nd Vice Chancellor, Prof. Datuk Dr. Mohd. Noh Dalimin and the current Vice Chancellor, Lt. Kol. Prof. Datuk Dr. Kamaruzaman Hj. Ampon for their permission to carryout this research.

I would also thank Dr. Goh Kim Huat and his team in Niche Frontiere Sdn. Bhd., Ipoh for their dedication and commitment in assisting me in the development of the PALMBOT single arm prototype.

I would like to express my sincere thanks especially to my co-researcher; Ms. Renee Chin Ka Yin, Dr. Mohd. Yunus Hamid, the lecturers and support staff from the School of Engineering & Information Technology and to all the staff of UMS for their kind cooperation in providing moral support during my research.

I would also like to express my sincere gratitude to my colleagues, Mr. M. Karthigayan, Ms. Bamini KPD Balakrishnan, Mr. U. Thangamani, Ms. Vani Annamala, Mr. Hew Yoon Fah and others whom are not mentioned here for their friendly cooperation.

I am grateful to both of my parents Mdm. R. Kamalam and late Mr. A. Mariappan and also my siblings Vijandran, Ravinthran and Uma Devi for all their love, continuous support, patience and encouragement in completing this research work.
ABSTRACT

DEVELOPMENT AND REAL TIME CONTROL OF AN ARM FOR PATIENT ASSISTANCE FOR LIFTING MOBILITY ROBOT (PALMBOT)

The dawn of medical robots for hospital applications has enormously enhanced the services rendered to the patients. The medical robots, spanning from surgical to rehabilitation, provide their support not only to the doctors but to the patients as well. In spite of such advancement, some major health hazards still exist for the hospital nurses. Lifting and moving the patients in hospitals are the usual duties of nurses. Injuries and backache occur while they frequently lift the unconscious, uncooperating or immobile patients. This research highlights on the development of a single prototype arm of a Patient Assistance for Lifting Mobility Robot (PALMBOT) as an effort in order to resolve this problem. Fieldwork conducted in Queen Elizabeth Hospital and Nursing Training College, Kota Kinabalu reveals that 83.9% of nurses have backache and back injuries due to patient handling. Observations on lifting techniques and hospital specifications were used to conceive the PALMBOT. The PALMBOT is a semi-automatic robot designed especially to assist nurses to perform lifting and transferring patients to different locations, thereby reducing the chances of nurses getting injured during these tasks. The three arms of the PALMBOT, which perform the automatic patient loading and unloading process, use a set of open end conveyor systems. Since safety is a primary concern of the PALMBOT, Artificial Intelligence (AI) was incorporated in developing various sensing and control modules. Neural network was employed for the detection and execution systems which consist of Patient Position Tracking System (PPTS), Danger Monitoring System (DMS), Automatic Procedure Sequencing System (APSS) and Fail Safe and Automatic Recovery System (FSARS). The intricacy faced in maintaining the tension of the conveyor was resolved by using fuzzy logic in the Conveyor Tension Control System. A prototype single PALMBOT arm was fabricated. All the hardware and software modules are interconnected by using several tools such as MATLAB, EPOS Position Control and MPLAB® IDE PIC C working on the LABVIEW V8.0 as a common platform. The PALMBOT system is tested by a set of experiments and by simulated studies and found to be demonstrating an acceptable performance. It is envisaged that the PALMBOT is a very useful addition to the modern hospital facilities.
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<td>Automated Guided Vehicles</td>
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<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>APSS</td>
<td>Automatic Procedure Sequencing System</td>
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<tr>
<td>CALL</td>
<td>Communication Aid for Language and Learning</td>
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<td>CAN</td>
<td>Control Area Network</td>
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<tr>
<td>CS</td>
<td>Conveyor Sequence</td>
</tr>
<tr>
<td>CTCS</td>
<td>Conveyor Tension Control System</td>
</tr>
<tr>
<td>DARPA</td>
<td>Defense Advance Research Projects Agency</td>
</tr>
<tr>
<td>DMS</td>
<td>Danger Monitoring System</td>
</tr>
<tr>
<td>DOF</td>
<td>Degree of Freedom</td>
</tr>
<tr>
<td>EP</td>
<td>Electronic Personality</td>
</tr>
<tr>
<td>FL</td>
<td>Fuzzy Logic</td>
</tr>
<tr>
<td>FR</td>
<td>Fail Recovery</td>
</tr>
<tr>
<td>FSARS</td>
<td>Fail Safe and Automatic Recovery System</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>HEX</td>
<td>Hexadecimal</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
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<tr>
<td>I/O</td>
<td>Input Output</td>
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<td>KS</td>
<td>Korean Industrial Standards</td>
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<tr>
<td>L</td>
<td>Load / Loading</td>
</tr>
<tr>
<td>LABVIEW</td>
<td>Laboratory Virtual Engineering Workbench</td>
</tr>
<tr>
<td>MAid</td>
<td>Mobility Aid for Elderly and Disabled People</td>
</tr>
<tr>
<td>MEL</td>
<td>Mechanical Engineering Laboratory</td>
</tr>
<tr>
<td>MSE</td>
<td>Mean-Square Error</td>
</tr>
<tr>
<td>NEDO</td>
<td>New Energy &amp; Industrial Technology Development Organization</td>
</tr>
<tr>
<td>NGI</td>
<td>Next Generation Internet</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute for Occupational Safety and Health</td>
</tr>
<tr>
<td>NN</td>
<td>Neural Networks</td>
</tr>
<tr>
<td>PALMBOT</td>
<td>Patience Assistance for Lifting Mobility Robot</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>PIC</td>
<td>Peripheral Interface Controller</td>
</tr>
<tr>
<td>PPTS</td>
<td>Patient Position Tracking System</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolution Per Minute</td>
</tr>
<tr>
<td>Seq.</td>
<td>Sequence</td>
</tr>
<tr>
<td>SIU</td>
<td>Spinal Injury Unit</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Science</td>
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<tr>
<td>STRIPS</td>
<td>Stanford Research Institute Problem Solver</td>
</tr>
<tr>
<td>U</td>
<td>Unload / Unloading</td>
</tr>
<tr>
<td>VIs</td>
<td>Virtual Instruments</td>
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<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Kgf</td>
<td>Kilogram Force</td>
</tr>
<tr>
<td>N</td>
<td>Number of Samples</td>
</tr>
<tr>
<td>u(.)</td>
<td>Net value</td>
</tr>
<tr>
<td>f(.)</td>
<td>Activation function / Threshold function</td>
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</table>
1.1 ROBOTS
The first robot, Ternstedt Unimate used by General Motors is a programmable machine that operated totally independent of human presence appeared in 1961 four decades after Karl Cepek coined the word 'robot' (Steven, 2002). Since then, these robots were effectively seen as a potential solution in any work settings of “3D”: Dirty, Dangerous and Dull. This definition changed along time as the application flourished due to the technological advancement. From its industrial origin, robots have now spanned into many areas from sea to space. Figure 1.1 and Figure 1.2 show a planet terrain exploratory robot and humanoid robot respectively. A significant contributing factor to this increased use is the robot’s ability to dynamically interact with its environment in a precise manner (Preising et al., 1991).

Although Capek introduced the term 'robot', the word ‘robotics’ was pioneered by Isaac Asimov in 1942 (James, 1999). He underlined three fundamental laws of robotics to ensure that robots are built with safety measures in mind to assist human beings. These laws have been further added and made clear that in any basic engineering design, the robot should obey the laws in order to preserve mankind and
REFERENCES


PEBBLES. 2007. (Providing Education by Bringing Learning Environment to Student), a project providing hospitalized children with a virtual presence in their regular classroom, is described at (Online) <http://www.ryerson.ca/pebbles>


Steven, W. Holland. 2002. Robotics History & GM. Historical Documents Related to the PUMA Robot Development Compiled for the General Motors Corporation
Donation of the Original PUMA Prototype Robot “Alice” to the Smithsonian Institution. April 19.


