2011 International Conference on Software and Computer Applications
IPCSIT vol.9 (2011) © (2011) IACSIT Press, Singapore

Strategy in Real-Time Software Development Management for Omni - Directional Robot

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Abstract. The aim of this work was to produce an omni - directional robot which would be able to perform demanded motions according the commands from the supreme control centre. Thanks to special rolling wheels and triangular chassis the robot can move in any direction. The robot is equipped by the microprocessor system which receives wireless commands and controls the movements of particular robot's wheels that way to move in required direction.

Keywords: Software, Strategy, Management, Robot, Information

1. Introduction

The mobile robot consists of superstructure formed by electronic and a special chassis. The chassis consists of a frame, three special wheels, gearing and driving mechanism. The frame has a triangular shape with chamfered edges. On each of its sides the driving mechanism with wheel is placed. The total freedom of robot's motions is caused by position of the wheels, (and torsion of the wheels to each other in 120) Fig.1.

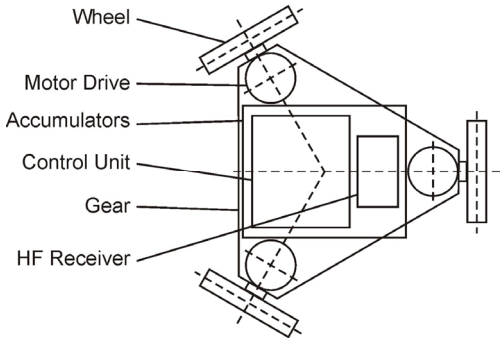

Fig.1 Omni – Directional Robot Model

During the motion in the axis of the wheel cone cylinders turn over and the whole wheel is standing. During the perpendicular motion to the axis the cone cylinders are standing and the whole wheel rotates.

Thanks to the placement of wheels on the chassis it is visible that wheel during the motion of the robot is constantly in slip or in engagement and it can roll in any direction.

As a driving mechanism for the robot we used electric motors PLANETA Power400 with 8000 rotates per minute, reduction 3,7: 1 , 8,4 V/7A, 60W, ROBE with voltage 7,2 to 12 V, what is very favourable factor in regard to feeding. Gears enable motion of the robot on the floor with maximum speed 0,5 m/s. For feeding of driving mechanism and regulators we used accumulators SANYO RC-2000, 1,2V, NiCd) with high capacity (2000 mAh).

The superstructure of robot is formed by RC receiver FP-R 115F, 35/40 MHz, regulators Rocraft 100E, control unit formed by board with microcontroller Motorola (MC68HC11A1) and complementary adapter circuits. The position of robot in firm rectangular coordinates is connected with working environment and its orientation is determined by tree coordinates: x, y, φ, and it is why we needed to convert vectors of speed for

particular wheels. The vector of the resultant speed is divided into two components: to the component parallel to the axis of the wheel and to the direction perpendicular to the axis of the wheel (Fig. 2).

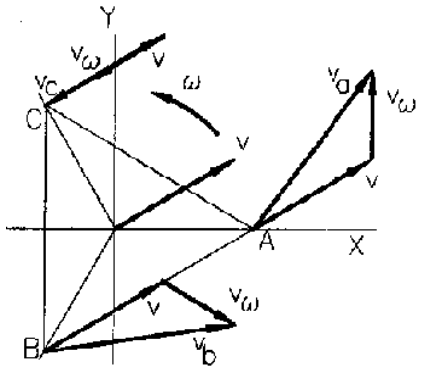

Fig.2 Omni – Directional Robot Trajectory Model

The resultant speed of the motion of particular wheels is given with these relations (1):

$$\begin{aligned} v_a &= v_{ry} + r\omega \\ v_b &= -\frac{1}{2}v_{ry} - \frac{\sqrt{3}}{2}v_{rx} + r\omega \\ v_c &= \frac{1}{2}v_{ry} + \frac{\sqrt{3}}{2}v_{rx} + r\omega \end{aligned} \tag{1}$$

The calculation of the angular speed of curling of robot stands (2):

$$\omega = \frac{v_a + v_b + v_c}{3r} \tag{2}$$

By superposition of these speeds we obtain the resultant motion of robot in coordinate system.

2. Managing of the robot's track by the superior system

The program for simulation of robot s motion and control of robot was compiled in programming language Turbo Pascal 7.0. The program was designed in this way to enable simple handling of particular operating components with the use either keyboard or mouse.

The motion of physical robot can be simulated with the use of this program by entering of coordinates in the existent coordinate system.

On the screen of the program is disposable a few items and with them we can give the program consequent commands:

- motion of robot on coordinates (x, y)
- return of robot to the initial position
- immediate stop of robot
- continuation in motion of robot after the stop
- enter the robot's speed
- enter of criteria for motion in the coordinate system

The control of the robot with the help of PC is solved by sending informations (signals) in a communication protocol. Signal is formed by sequence of four pulses which contain information in four channels. For communication between PC and the robot only three channels are used. The signal has level 12 V and period 20 ms (Fig. 3). "K" is the constant gap 400 μs between CH 1 to CH 4.

Information channels of the width 1000 to 2200 μs.

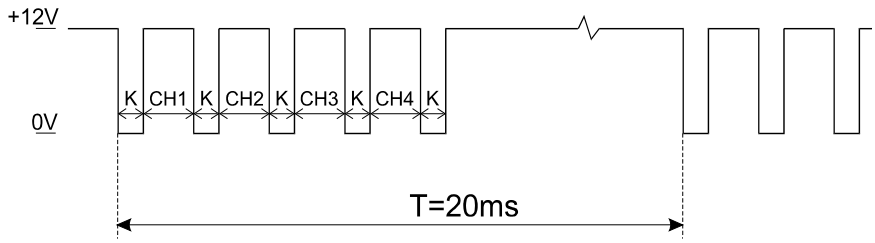

Fig.3 Pulse Code Command Frame

3. Information microprocessor system

The 68HC11-G4 microcomputer module is based on the MC68HC11A1 microcontroller. The microcontroller works in an extended mode. The module includes 8kB of static RAM for the program and data, which is useful for the program debugging. When the program is successfully debugged, it can be loaded into EPROM memory and fitted in the appropriate onboard socket.

3 pulse-width modulated (PWM) signals from the receiver are connected to input pins IC1 - IC3 of port A. Another 3 pins of this port OC3 - OC5 are used as output pins to direct the motor controllers. These controllers accept the same PWM signal as the receiver emits.

4. Summaries

The entire control software for MC68HC11 is written in the C language and it makes use of specific points of MC68HC11 microcontroller. The program executes especially PWM signal receiving and transmitting, it calculates the required power of motors from the direction of motion, furthermore it includes FIFO buffer for the incoming coordinates and finally it implements the transfer protocol commands. The program also generates the accurate PWM output signals for motor controllers abstractly from receiving the input signals. Some functions in that computation use included floating point mathematical library. There are transmitted absolute Cartesian co-ordinates from the PC.

The robot should hold information about its current position considering the previous movement and the starting co-ordinate to determine its next relative movement. The rated relative vector is then normalised and the run time is determined.

5. Acknowledgements

The work and the contribution were supported by the project Grant Agency of Czech Republic – GAČR 102/08/1429 “Safety and security of networked embedded system applications”. It was also supported by the Ministry of Education of the Czech Republic under Project 1M0567. Students Grant Agency SGS SV450021,” Biomedical Engineering Systems VII”

6. References

[1] K. A. Adam, G. Garani, G., Samaras, N., Srovnal, V. Koziorek, J. Kasik, V., Kotzian, J. Design and Development of Embedded Control System for a Lime Delivery Machina *In Proceedings of the 10th Wseas International Conference Mathermatical Methods and Computational Techniques MMACTEE' 08*: p. 186-19,2008, ISBN: 978-960-6766-60-2

[2] J. Skapa, V. Vasinek, P. Siska, Analysis of Optical-Power Redistribution for Hybrid Optical Fibers *In Book Fiber Optic Sensors and Applications Volume 6770*, 2007 ISSN: 0277-786X, ISBN: 978-0-8194-6930-4, DOI: 10.1117/12.752587

[3] B. Palan, K. Roubik, M. Husak, Courtois, B. CMOS ISFET-based structures for biomedical applications In Proceedings Medicine & Biology at 1st Annual International IEEE-Embs Special Topic Conference on Microtechnologies, Pages: 502-506 Published: 2000, ISBN: 0-7803-6603-4

[4] J. Hozman, V., Zanchi, R. Cerny, P. Marsalek, P.,Z. Szabo, Precise Advanced Head Posture Measurement In Book Challenges in Remote Sensing - Proceedings of the 3rd Wseas International Conference on Remote Sensing (REMOTE '07) p. 18-26, 2007, ISSN: 1790-5117, ISBN: 978-960-6766-17-6

[5] G. Garani, G. K. Adam, Qualitative modelling of manufacturing machinery In Book - 32nd Annual Conference on IEEE Industrial Electronics, IECON 2006 VOLS 1-11 p. 1059-1064, 2006 , ISSN: 1553-572X, ISBN: 978-1-4244-0135-2

[6] R Gono., M Kratky., S. Rusek Analysis of Distribution Network Failure Databases, PRZEGLAD ELEKTROTECHNICZNY, Vol. 86, Issue 8, pp. 168-171, 2010 ISSN: 0033-2097

[7] J. Skapa, V. Vasinek, P. Siska, Analysis of Optical-Power Redistribution for Hybrid Optical Fibers In Book Fiber Optic Sensors and Applications Volume 6770, 2007 ISSN: 0277-786X, ISBN: 978-0-8194-6930-4, DOI: 10.1117/12.752587

[8] I. Bernabucci, S. Conforto, M. Schmid, T. D'Alessio, A bio-inspired controller of an upper arm model in a perturbed environment, In proceedings The 2007 International Conference on Intelligent Sensors, Sensor Networks and Information Processing Pages: 549-553 ISBN: 978-1-4244-1501-4

[9] T Sikora,. Wear-Out Characteristics of Electric Distribution System Components. EPE: Proceedings of the 9th International Scientific Conference Electric Power Engineering 2008, 2008, p. 432.

[10] L. Prokop, V. Kral,. And Z. Hradilek, Software OCENS - a tool for outage costs and energy not supply calculation. Przeglad Elektrotechniczny, 2009, vol. 85, no. 3, p. 227-230.

[11] V. Srovnal, Z. Machacek, V. Srovnal, “Wireless Communication for Mobile Robotics and Industrial Embedded Devices”, *In* 2009 EIGHTH INTERNATIONAL CONFERENCE ON NETWORKS, Mar 01-06, pp. 253-258, Gosier, France (2009)

[12] L. Prokop, S. Misak, And Krejci, P. Analysis of Long time WPP PowerFlows Measurement. edited by S. RUSEK AND R. GONO. Edtion ed., 2009. 373-378 p. ISBN 978-80-248-1947-1.

[13] Z. Hradilek, L. Prokop, And Tinka, M. Estimation Of Energy Not Supply And Load Curves. Edited By S. Rusek And R. Gono. Edtion ed., 2005. 191-197 p.

[14] Z. Medvec, And L. Prokop, Analysis of the cost of downtime during a disruption in the supply of electricity. edited by S. RUSEK AND R. GONO. Edtion ed., 2005. 340-345 p.

[15] P. Brida, N. Majer, J. Duha, P. Cepel, “A Novel AoA Positioning Solution for Wireless Ad Hoc Networks Based on Six-Port Technology”, *In IFIP*, Volume 308, Wireless and Mobile Networking, pp. 208-219. (2009)

[16] Z. Machacek, V. Srovnal, “Automated system for data measuring and analyses from embedded systems”, *In* 7th WSEAS International Conference on Automatic Control, Modeling and Simulation, Mar 13-15, pp. 43-48, Prague, Czech Republic (2005)

[17] O. Krejcar, Problem Solving of Low Data Throughput on Mobile Devices by Artefacts Prebuffering. EURASIP Journal on Wireless Communications and Networking, 2009, Article ID 802523, 8 pages. Hindawi publishing corp., New York, USA, DOI 10.1155/2009/802523

[18] O. Krejcar, R. Frischer, Non Destructive Defects Detection by Performance Spectral Density Analysis, Journal Sensors, MDPI Basel, Vol. 11, No. 3., pp. 2334-2346. (2011)

[19] O. Krejcar, R. Frischer, Detection of Internal Defects of Material on the Basis of Performance Spectral Density Analysis, Journal of Vibroengineering, 2010 – Vol. 12, No. 4 - pp. 541-551.

[20] O. Krejcar, D. Janckulik, L. Motalova, Complex Biomedical System with Biotelemetric Monitoring of Life Functions. In Proceedings of the IEEE Eurocon 2009, May 18-23, 2009, St. Petersburg, Russia. pp. 138-141. DOI 10.1109/EURCON.2009.5167618