Development of Graphical User Interface (GUI) for Dead Reckoning System of a Non-holonomic Mobile Robot

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ABSTRACT

This article presents the creation of GUI for the dead reckoning nonholonomic mobile robot and verifies the completion of designing a user-friendly GUI for controlling and operating, which will help the user to understand the positioning of the robot. The foremost concern is to design the GUI by using Visual Basic software. Moreover, software such as Solid Works and AutoCAD are also used to design 3D model of the robot.

INTRODUCTION

Mobile Robot is like a vehicle that can move around in an environment and it require devices such as power sources, computational resources, sensors and actuators to be equipped and mounted on the robot for performing a designated task. In this article, the use an autonomous mobile robot which non-holonomic constraint is an experiment tool. In an autonomous mobile robot system, one of the important aspects is related to its motion and navigation control (Sehestedt, 2010). The issue of navigation control becomes more complex when the mobile robot has a non-holonomic system where the system is described by a set of parameters subject to differential constraints, such that when the system evolves along a path in its parameter space, the parameters varying continuously in values but finally returns to the original set of values at the start of the path (Li-Li, 2011). Therefore, the non-holonomic constraint states that the mobile robot can only move in the direction normal to the axis of the driving wheel where it is satisfies the condition of pure rolling without slip. Mobile robots are the focus of a great deal of current researches and almost every major universities has laboratories that focus on mobile robot research or design. A typical robot have a movable physical structure, motors, sensors, power supply and a computer that acts as the robot's brain and controls all of the other elements (Dudek, 2010). However, mobile robot is an automatic machine that can traverse on any kinds of terrain and not limited to a specific area (Zhao, 2010).

Furthermore, a mobile robot is suitable for a variety of applications in unstructured environments where a high degree of autonomy is required (Chen, 2012). This desired autonomous or intelligent behavior has motivated an intensive research in the last decade. Mobile robots are mostly found in industrial (Gascueña, 2011), military (Chen, 2012) and security environments (Klančar, 2011). They also appear as consumer products, for entertainment (Chung, 2012) or to perform certain tasks like vacuum (Mautz, 2011), gardening (Chang, 2012) and some other common household tasks (Ciocarlie, 2012). Mobile robots helps human in many ways like for exploring of planet (Yue, 2011) or inhospitable areas on Earth (Johnson, 2013), collecting geological samples (Jian, 2011), seek out landmines in former battlefields (Chen, 2011). The police force sometimes uses mobile robots to search out for bombs (Habib, 2011), or even to apprehend suspects. Hospitals may use robots to transport medications (Bloss, 2011). Some museums use robots for monitoring air quality and humidity levels (Rosenthal, 2012). As the demands for mobile robots in a wide array of applications increases thus the need for robust tracking control of the mobile robots is clearly understood. Hence, a closed-loop sensor based controller is required. For user friendly and easy robot operation, the mobile robot must be developed and equipped with Graphical User Interface (GUI).

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MATERIAL AND METHODS

In addition to visual components, graphical user interfaces also make it easier to move data from one application to another. A true GUI includes standard formats for representing text and graphics because the formats are well-defined so different programs that run under a common GUI can share data. Furthermore, GUI is an important part of software application to enhance the efficiency and to ease of user for the understandying logical design of stored program and design discipline. As a robot hobbyist, user can use software to design their own GUI to interface with microcontroller circuit board, motor controller, PIC Interface Kit etc.

In this article, development of a Nonholonomic Mobile robot known as 'AMAD-R' is done as an experimental validation tool and it is shown in Fig. 1.

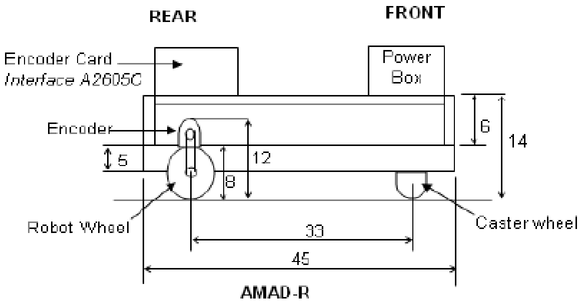

Fig. 1: Structure of the Mobile Robot.

Table 1 shows the mechanical specification of the robot. The robot is equipped with encoder sensor on the both side of the rear wheel connected by the rubber chain in-order to decode the position of the mobile robot and the speed of the wheels. The resolution of the optical quadrate encoder is 1024 pulse/ rev. The mobile robot uses 8cm in diameters' of wheel so that the each pulse of the encoder could counter a distance of 8 x 3.1415 / 1024 = 0.02454cm per pulse.

Table 1. Mechanical specification

Height	14 cm
Width	46 cm
Length	45 cm
Radius of 2 driving wheels: r	4 cm
Circumference of wheel: $2\pi r$	25.1327 cm
Distance between 2 wheels: 2d	43 cm

The system configuration of mobile robot is shown in **Fig. 2**.

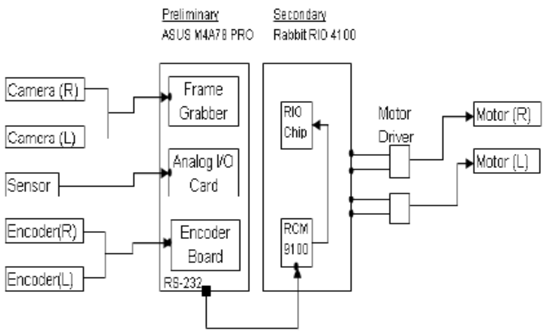

Fig. 2: Robot Block Diagram.

RESULT AND DISCUSSION

Besides two encoders are connected to the DC motors, one unit of ultrasonic sensor is also installed at the front of the mobile robot for sensing and obstacle avoidance. Two units of CCD Camera is planned to be mount to the mobile robot for image recognition and navigation. The mobile robot is already equipped with Frame Grabber and Graphic card for image processing. In the future development, more ultrasonic sensor and other sensor will be attached to this mobile robot. All signals from the various sensors will processed by the Interface Analog

Input-Output PCI-A3521 card. Interface encoder PCI-A6205C card is mounted on the computer motherboard ASUS M4A78 PRO for converting encoder output signal and send it to secondary processor Rabbit RIO RCM4100. Rabbit RIO processor will process the data and converting it to PWM signal for controlling the speed of DC motors which steer the mobile robot during it trajectory tracking.

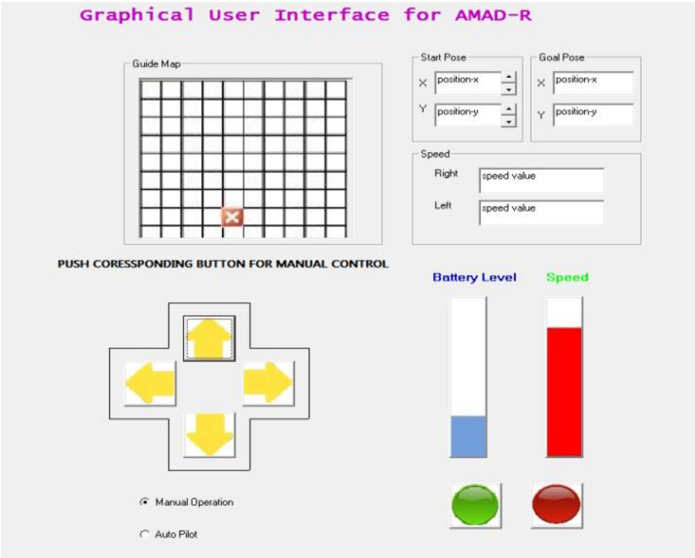

Fig. 3: GUI Design.

Conclusion:

In this article, from the designing and testing process, we succeeded in creating an efficient GUI that displays accurate data to the user in an easy-to-interpret. This accomplishes beneficial interaction functionality because of its collaboration between a software and hardware solution. Future work will focus on the lessons learned from this experiment, particularly designing more accurate GUI to interface which will be more simple and straight forward.

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