DESIGN AND DEVELOPMENT OF AN RS232-BASED ROV CONTROLLER SYSTEM

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ABSTRACT

The overall design of an underwater robot which includes the design of electro-mechanical components and the control circuit diagrams are introduced. The software is also concurrently developed to meet the needs of hardware set-up. The control principle of the system components and their relationships are elucidated. This underwater robot is controlled by the keyboard key, while the feedback data from the robot are displayed on the screen of a host computer in real-time. This is a low-cost, but highly reliable control set-up, suitable for shallow water underwater application, such as typical surface inspection and sampling operation.

1. INTRODUCTION

The use of autonomous and remotely operated vehicles for sub sea measurement and monitoring as well as other tasks is rapidly growing field [1]. Remotely Operated Vehicles (ROVs) is a teleoperated vehicle for underwater application. Autonomuos Underwater Vehicles (AUVs) on the other hand, do not need the sustained attention of a human. Our ROV design uses four DC motors for controlling depth and position of the vehicle, tethering cable including power supply cable and twin optical fiber for communication master surface controlling computer (control using keyboard key) and slave controller (INTEL 8051 microcontroller as a master microcontroller to control all the systems and Basic Stamp 2 microcontroller as a slave microcontroller to control Compass Module with its appropriate peripherals as well as the instrumentation and measurement equipment are placed inside the vehicle.

In this research, a very simple communication link using the ordinary communication protocol RS232 and a fiber optic communication system is used. A pair of optical transceivers (COE Series 200) is used to enable RS232 ports communicate via the optical fiber cable. The communication link should be able to allow a full- duplex data flow, from the surface to the vehicle and vice versa, and this was accomplish using a twin optical fiber cable. This vehicle uses optical fiber in the deep water umbilical to ensure high speed telemetry and video quality. Fig 1 shows configuration all the subsystems included in the described ROV.

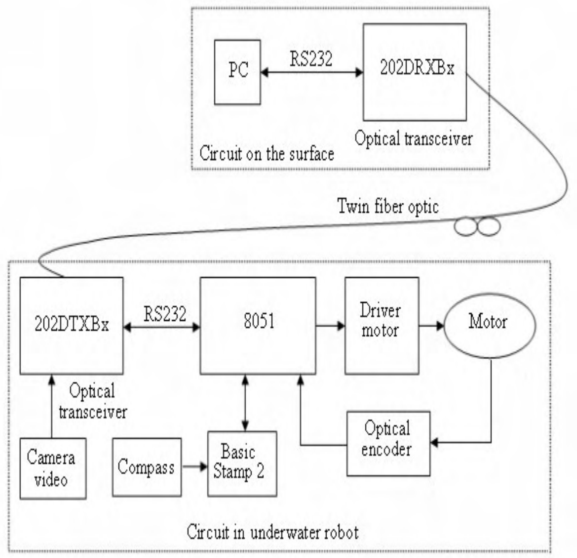

Fig. 1: Block diagram indicating the subsytems included in the described ROV

2. HARDWARE

Basically, underwater robot is a combination of microcontroller system, mechanical system and communication system between robot and PC. The system's structure block diagram is shown in Fig. 2. In this research, a digital controller hardware is designed for ROV usage. An 8 DC motor controller system is implemented for the control of an underwater robotic platform. An optical fiber system and combine it with compass system are utilised. An Intel 8- bit 8051 microcontroller is used to control the DC motor and process the incoming sensor data. The controller can also be used for further expansion. An optical encoder is used to measure the angular position of the DC motor and forms a closed loop control system. The model of ROV is shown in fig. 3.

2.1 Motor Controller

A motor controller which has been designed can control 8 DC motor simultaneously. Fig. 4 shows the block diagram for DC motor controller. The PWM

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technique is used to drive the DC motors to the

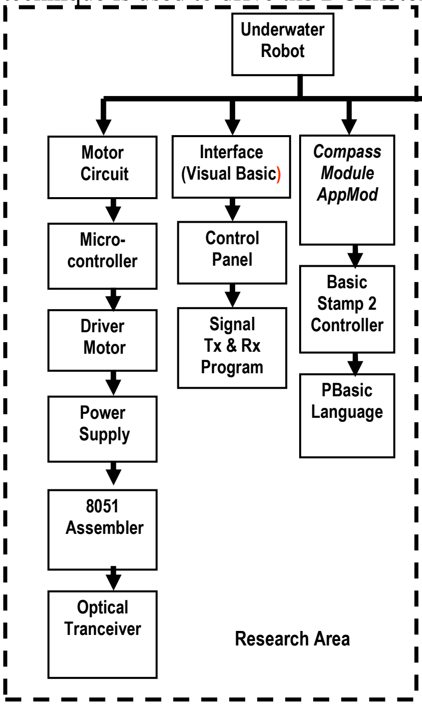

Fig. 2 Block diagram underwater robot system

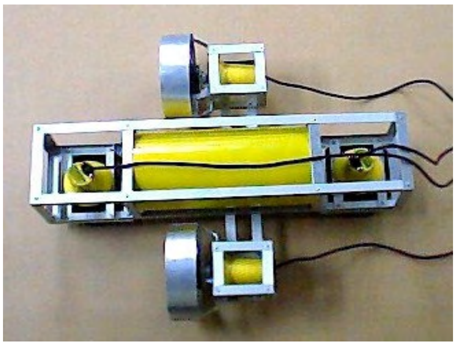

Fig. 3 ROV model

desired positions. Commands to the motors first pass through the motor driver (L293D). This driver provides optically isolated signals to H-Bridge, which in turn provide PWM voltage to the motor. The longer the PWM duty cycle, the larger the speed of the motor will be produced. In order to reduce the burden of CPU, an external 555 timer is used for generating a periodical square waveform. For this

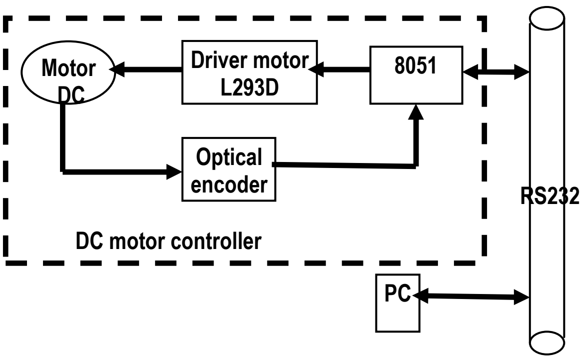

Fig: 4 DC motor controller

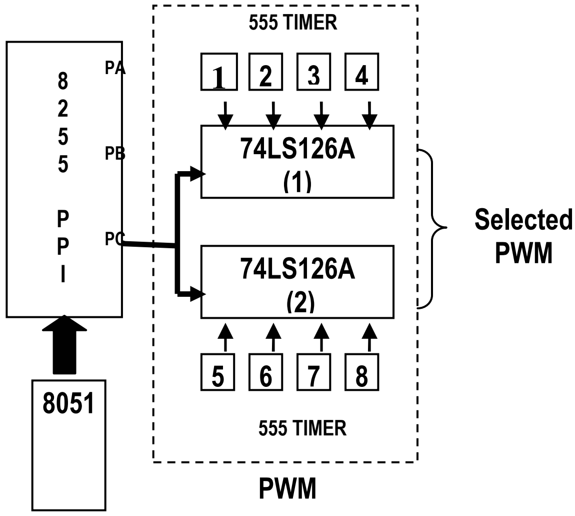

Fig. 5 PWM block diagram

project, 8 variable speed can be chosen by the operator. Two tri-state buffer chips are used to select PWM signal from eight 555 timer with different duty cycle (see fig. 5). The overall design system for 8 DC motor controllers is shown in fig.6. Two tri-state buffer chips (74LS126) are used to select on/off DC motor which is controlled by Port A on 8255 PPI chip.

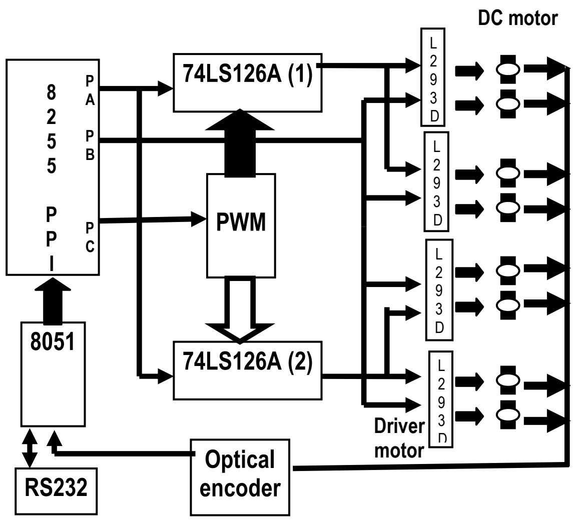

Fig. 6 Overall system design for 8 DC Motor Controller

2.2. Compass Module

Compass is an important component for an underwater robot. Example of its usage can be seen in [2],[3][4]and [5]. This underwater robot is equipped with a Compass Module (AppMod) from Parallax™ for navigation, which handles the serial communication, reads the compass sensor and controls the LEDs.

2.3. Fiber Optic

The fiber optic technology has enhanced the ROV industry in many ways because of its wide bandwidth signal transmission [6-9]. Its give a high quality and high speed communication link [10][11]. This is because the speed of ROV inspection is limited by the dynamics of the vessel/umbilical/ROV system which becomes increasingly unwieldy as water depth increases [12].

2.4. Sensor

Sensors are the perceptual system of a robot and measure physical quantities like distance, light, sound, depth, rotation, magnetism, temperature, inclination, pressure, altitude and etc [13]. Sensors provide the raw information or signals that must be processed through the robot's computer brain to provide meaningful information[14]. A precise navigation system is a crucial part of the ROV. The navigation system is composed of a variety of sensors giving information about position and movement.

2.5. Video Camera

This is an optional part. The camera is set at the front-end of the underwater robot in order to capture the image that the place is difficult for human to reach. The images changes to digital data and then transmit to computer via optic link.

3. SOFTWARE

The system was developed on a host PC, using the Windows operating systems, and the GUI runs under Windows while on the system vehicle is an embedded processor. Our robot is controlled by Visual Basic programmed on the PC, 8051 assembly language for Intel 8051 and PBasic language for Basic Stamp 2.

The function of Visual Basic is served for operator to control the underwater robot moving and stay at particular place. The operator can control the underwater robot direction, destination and speed via computer. He can also control the reading of the data from compass module. The on-board computer interfaces with the Intel 8051 using an RS232 serial port and have a maximum data rate of 115kbps [3][4][15]. It also receives a serial feed from compass. All commands are sent over serial interface using simple ASCII protocol, allowing full driving capability from a terminal window. The flowchart for the assembly language programming is shown in Fig. 7. (last page of this paper).

4. CONCLUSION

An underwater robot controlled by DC motor has been designed and a viable prototype built. Command signals are sent to the underwater robot via a fiber-optic connection using the RS232 protocol. The control software enables the user to observe the motion of the robot thru the host computer. This will allow real-time control of the underwater robot in the real field possible. The underwater robot system developed is a low-cost but highly reliable robotic system.

5. ACKNOWLEDGEMENT

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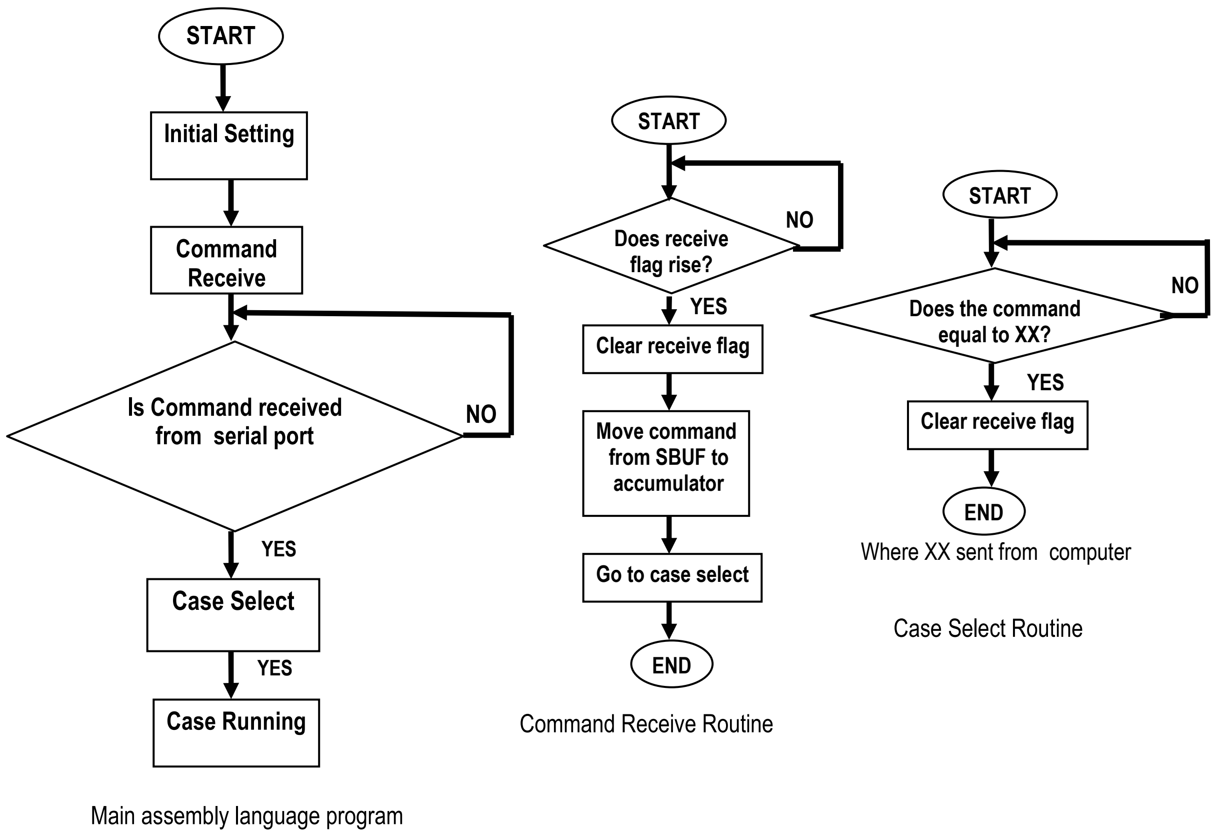

Fig. 7: Flowchart assembly language