

Microcontroller Project Functional Requirements

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Embedded Systems Project

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Revision 3

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Change Log

January 27, 2019 – Revision 1

- Introduction (Page 3)
 - Updated introduction.
- Functional Requirements (Pages 5-6)
 - Added Nucleo board requirements.
 - Updated requirements for stepper motor driver.
 - Updated requirements for RS232 driver.
 - Updated requirements for CAN Bus driver.

March 18, 2019 – Revision 2

- Functional Requirements (Pages 5-6)
 - Updated Nucleo Board requirements.
 - Updated DC Power Supply.
 - Removed microphone – time constraint.
 - Updated Stepper Motor.
 - Made many changes to format.
 - Added necessary sections

April 12, 2019 – Revision 3

- Functional Requirements (Pages 5-6)
 - Updated LCD
 - Added Buzzer

Introduction

This project will result in a complete interface for a robot that will be remote controlled over WIFI from a Unix desktop PC. It will have video feed, audio feed, a CAN interface, RS232 communications, DC Motor drivers as well as encoders, A stepper moto, RC Servo motor and an LCD screen. It will be powered via a 12V battery.

Scope Statement

To design an interface board that will communicate between a Nucleo microprocessor and peripherals used to operate a robot. The Nucleo board will also communicate between the interface board and a Unix desktop PC.

Related Documents

1. Top File Block Diagram – January, 2019.
2. Work Breakdown Structure – January, 2019.
3. Altium PCB Design – March, 2019.

Configuration Options

1. Board offers 12V, 5V and 3V3 options.
2. This system is intended for a specific purpose of utilizing a robot in ESE4 at Conestoga College. Usage outside this function does not guarantee performance.

Cost

On the next page there will be a copy of a Digi key order containing the necessary parts for this board. The cost is at the bottom and part numbers are also available.

Functional Requirements

Interface Board

1.1 Nucleo Board

- a. $V_{OH} = 2.4V$ at minimum
- b. $V_{OL} = 0.4V$ at maximum
- c. $I_{IN} = 250mA$ maximum at $9V < V_{IN} \leq 12V$
- d. $I_{IN} = 450mA$ maximum at $7V < V_{IN} \leq 9V$
- e. $I_{IN} = 800mA$ maximum at $V_{IN} = 4V$

1.2 DC Power Supply

- a. $V_{IN} = 2$ parallel 12V batteries
- b. $V_{O1} = 12V$
- c. $V_{O2} = 5V$
- d. $I_O = 2A$ maximum

User Input

2.1 Joystick Controller

- a. Communication between host PC and robot via Wi-Fi will handle joystick input.

2.2 Video Display

- a. Communication between host PC and robot via Wi-Fi will handle video display.

Motor Control

3.1 Motors (Stepper & DC Motor) – DRV8847

- a. $V_{VM} = 2.7V$ at minimum, 18V at maximum
- b. $I_{VM} = 2.5mA$ at maximum (2mA typical)
- c. $V_{IN} = 5V$ maximum
- d. Pins: IN1, IN2, IN3, IN4, NSLEEP, TRQ, SCL, SDA
 - i. $V_{IH} = 1.6V$ at minimum
 - ii. $V_{IL} = 0.6V$ at maximum

3.2 RC Servo

- a. Needs a PWM capable input
 - i. Higher pulse rate will push camera one direction
 - ii. Lower pulse rate will push camera other direction
- b. $V_+ = 5V$
- c. $V_- = \text{Ground}$
- d. 100R resistor on signal line

3.3 Limit Switches

- a. When pressed, signals servo is no longer able to turn in current direction.
- b. Used to determine limits of RC Servo.

3.4 DC Motor Encoders

- a. Will interface with the DC Motors to determine the current location of the motor.
- b. An analog signal will be read from the encoders that will be converted to a digital number representing position.

Other

4.1 LCD Module

- a. $V_{dd} = 5.5V$ recommended max (Will use 5V)
- b. RW will be tied low. Permanent write only.
- c. $V_{IH} = 2.2V$ at min, Vdd at max
- d. $V_{IL} = 0.4V$ at max

- e. $I_{dd} = 1.1\text{mA}$
- f. Will be used in 4-bit transfer mode. Specific initialization is required and found in the datasheet.

4.2 RS232 Driver – MAX3232

- a. **$V_{CC} = 3.3\text{V}$ (Will be used due to logic compatibility with Nucleo)**
 - i. 3V at minimum, 3.6V at maximum if
 - ii. $V_{IH} = 2\text{V}$ at minimum
 - iii. $V_{IL} = 0.8\text{V}$ at maximum
- b. $V_{CC} = 5\text{V}$
 - i. 4.5V at minimum, 5.5V at maximum if $V_{CC} = 5\text{V}$
 - ii. $V_{IH} = 2.4\text{V}$ at minimum
 - iii. $V_{IL} = 0.8\text{V}$ at maximum
- c. $I_{CC} = 1\text{mA}$ at maximum
- d. V_I
 - i. Driver Input Voltage = 0V at minimum, 5.5V at maximum
 - ii. Receiver Input Voltage = -25V at minimum, 25V at maximum
- e. External Components
 - i. 5 – 100nF Capacitors
 - ii. 1 – DP9 Connector

4.3 CAN Driver – MCP2551

- a. $V_{DD} = 7\text{V}$ at maximum (Will use 5V from Nucleo)
- b. $I_{DD} = 75\text{mA}$ at maximum
- c. $V_{TXD} = V_{RXD} = V_{REF} = V_S = -0.3\text{V}$ at minimum, $V_{DD} + 0.3\text{V}$ (5.3V in this project) at maximum
- d. $V_{CANH} = V_{CANL} = -42\text{V}$ at minimum, 42V at maximum
- e. External Components
 - i. 1 – 30pF Capacitor
 - ii. 1 – 100nF Capacitor
 - iii. 1 – 1uF Capacitor
 - iv. 2 – 62 Ω Resistor
 - v. 2 – 10k Ω Resistors
 - vi. 2 – 1x2 Pin Junction
 - vii. 1 – 1x4 Pin Junction

4.4 Buzzer

- a. Logic output of Nucleo is fine.
- b. Signal needs a PWM capable pin to send different frequencies to the buzzer.

Environmental & Regulatory Requirements

1. The board will be properly destroyed at an authorized facility at end of life.
2. The board will be used in a laboratory/educational environment therefore waiving most regulations.

Reliability & Service

1. This board is not guaranteed to function as intended. **It is use at your own risk.**