EE/CS 51

ROBOTRIKE FUNCTIONAL SPECIFICATION

Jennifer Du

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| DESCRIPTION: | The RoboTrike is a three-wheeled robotic car that can be controlled using a keypad and display. It will be able to move in the four directions through translational motion, and will be able to fire a laser depending on user commands. It will face a certain direction, and it will be able to move in directions at various angles with reference to its initial direction. The user will be able to aim the laser using angular increments vertically.  This system allows an operator to control the RoboTrike via a keypad and display over a serial interface. The system consists of two separate components: a keypad, and a display, through which the user interacts with the system. The motor unit can also send back a status to be displayed. The two units communicate over a serial interface using a defined protocol. Since the serial data may be arriving much faster than it can be acted upon by the RoboTrike or displayed, it will be necessary to buffer the serial port data. |
| INPUTS: | The keypad will have 16 keys, which are shown and described below:   |  |  |  |  | | --- | --- | --- | --- | | Key A1: Stop everything, turn off laser  **(STOPPED)** | Key A2: Slow down by 0.4% of max speed  **(V-256)** | Key A3: Speed up 0.4% of max speed  **(V+256)** | Key A4: Set direction to 90°  **(D90)** | | Key B1: Stop robot mvmt,  Speed = 0  **(S0)** | Key B2: Move at max speed  **(S65534)** | Key B3: Set direction to 0°, forward  **(D0)** | Key B4: Set direction 180°, backward  **(D180)** | | Key C1: Turn laser on  **(F)** | Key C2: Turn laser off  **(O)** | Key C3: Move at 10° more to the left  **(D-10)** | Key C4: Move at 10° more to the right  **(D+10)** | | Key D1: Point turret down at -60°  **(T-60)** | Key D2: Point turret up at 60°  **(T60)** | Key D3: Set direction to 270  **(D270)** | Key D4: Reset error flag, escape error message |   **Key A1: Stop**  Pressing this key will cause the RoboTrike to stop its movement, turn off its laser, and move laser turret angle all the way down to resting position. The display will read “STOPPED”. The commands passed to the Robotrike’s motor unit are in the form of a string: “S0 O D0” with a carriage return between each command.  **Key A2: Slow down**  Pressing this key will cause the RoboTrike to slow down by a percentage of its maximum speed. This key will decrease the current speed by 256 out of 65534 possible speed settings. It will be possible to slow down to a complete stop. When this key is pressed, the display will show “V-256”, followed by an updated motor speed and laser status string. If the speed has been decremented below 0, then the robot will slow to a stop. If pressed and held, the speed will decrease all the way down until at a complete stop, at a rate of -256 speed settings per second.  **Key A3: Speed up**  Pressing this key will cause the RoboTrike to speed up by a percentage of its maximum speed. This key will increase the current speed by 256 out of 65534 possible speed settings. When this key is pressed, the display will show “V+256”, followed by an updated motor speed and laser status string. If the speed has been decremented beyond the maximum speed, then the robot will travel at its maximum speed. If pressed and held, the speed will inrease all the way until it is going at its maximum.  **Key A4: Move at 90 degrees**  Pressing this key will will set the robot’s new direction of movement 90 degrees with respect to its front-facing side.  **Key B1: Stop Robot Movement**  Pressing this key will cause the RoboTrike to stop. The speed of the robot will be set to 0, and no other system parameters change. The screen will display that the speed of movement is 0s.  **Key B2: Move at maximum speed**  Pressing this key will cause the RoboTrike to move at the maximum speed: 65534. The screen will display ‘S65534’.  **Key B3: Set direction to 0 degrees**  Pressing this key will cause the RoboTrike to move at an angle of 0 with respect to the direction it is facing. The command sent through the serial port is “D0”, and the screen will also display “D0”.  **Key B4: Set direction 180 degrees**  Pressing this key will cause the RoboTrike to move directly backward. The screen will show the command “D180” and send that command through the serial channel to the motors unit.  **Key C1: Turn Laser On**  Pressing this key will turn on the laser. The direction and speed of the RoboTrike will not be affected. When pressed, the display will show “LASER ON”, and will send a serial command “F” to the motors unit.  **Key C2: Turn off laser**  Pressing this key will turn on the laser. The direction and speed of the RoboTrike will not be affected. When pressed, the display will show “LASER OFF”.  **Key C3: Move at 10 degrees more to the left**  When this button is pressed, the robot’s direction will be decremented by 10 degrees, so that it rotates 10 degrees to the left with respect to its current direction. The display will show “D-10” to show that the direction of movement angle has decreased by 10 degrees (counter clockwise).  **Key C4: Move at 10 degrees more to the right**  When this button is pressed, the robot’s direction will be incremented by 10 degrees, so that it rotates 10 degrees to the right with respect to its current direction. The display will show “D+10” to show that the direction of movement angle has increased by 10 degrees (clockwise).  **Key D1: Point turret angle down at an angle of -60 degrees**  Pressing this key will set the turret elevation to -60 degrees with respect to the horizontal. The display will show “T-60”, and this also happens to be the command that is sent over the serial channel to the motor unit.  **Key D2: Point turret angle up at an angle of 60 degrees**  Pressing this key will set the turret elevation to +60 degrees with respect to the horizontal. The display will show “T+60”, and this also happens to be the command that is sent over the serial channel to the motor unit.  **Key D3: Set direction angle to be 270 degrees with respect to front-facing direction**  Pressing this key will cause the RoboTrike to move directly to the left. The screen will show the command “D270” and send that command through the serial channel to the motors unit.  **Key D4: Clear error message**  When an error arises, the system will give the error message priority over serial characters being received. This is implemented with an errorFlag variable, and pressing this button will clear the error flag. When the error flag is cleared, the system operates normally, and serial characters will be displayed normally. When the error flag is set, this indicates that an error message is being shown, and takes precedence over possible serial characters coming in.  Autorepeat is available for the keypad, and pressing and holding any key will cause that request to be repeated automatically. Autorepeat will occur at a rate of once per second.  Multiple key presses is also available for the keypad. In the second row, pressing keys one and two at the same time sets the robot's movement to half  speed. Pressing keys three and four at the same time causes the robot to move at 90 degrees.  In the third row, multiple key presses are also allowed. Pressing key three and four at the same time will cause the robot to move at an angle of 270 degrees.  For the fourth row, multiple key presses are also allowed. Pressing the first key by itself will send a turret elevation -60 degrees command, and the 2nd key by itself will send a turret elevation 60 degrees command. Pressing both will result in a turret elevation of 0 degrees with respect to the horizontal. Combining keys 1 and 3 will result in a turret elevation of -30 degrees, and combining keys 2 and 3 will result in a turret elevation of positive 30 degrees.  All numbers sent as commands when keys are pressed will be  Serial input will be through a standard serial port using a 16C450 UART. |
| OUTPUTS: | The display is an 8-digit display capable of showing letters as well as numbers. This will be a 14-segment display, utilizing all 14 segments of each digit available for LED display. Depending on user input, the display can be automatically scrolled through if the information exceeds 8 characters.  Three DC motors are used to move the RoboTrike via PWM, one stepper motor rotates the turret, one servomotor sets the angle of the laser. All motors are controlled via 11 bits of parallel output of an 8255. |
| USER INTERFACE: | The user controls the RoboTrike using a keypad that then sends commands to the motor unit over a serial interface. The user moves it manually via the keypad (using keys such as Right / Left / Forward / Reverse) and sends these commands via the serial interface to the motor unit. The motor unit sends back status information which is displayed along with the current information about the RoboTrike movement.  Using the keypad, the user can make the RoboTrike move forward, backward, to the left, right, or stop. Users can also define their own direction using the angle incrementing keys that change the angle of movement of the RoboTrike with respect to the front of the robot. In addition to the direction, users can also set the speed they wish the RoboTrike to move at. The user can also turn the laser on and off, and point it up or down.  The display will show the command being executed, and show new changes to the RoboTrike’s motion or the laser’s direction by displaying the motor’s current movement and laser settings. When errors occur, they will be displayed on the screen according to the error codes shown below in this functional specification. |
| ERROR HANDLING: | Power failures, mechanical and software problems might not be displayed.  The following errors may arise, and in each case, the user will be notified of it on the LED display.  **Invalid key error:** key or combination of keys pressed by user does not correspond to a valid command  **LSR/Serial error:** serial port has issues, or line status register indicates errors. Errors falling under this category are overrun error, parity error, framing error, or transmit queue full error.  **Parse error:** command was not able to be parsed or executed correctly in the motor unit  Critical errors arise when the event queue for either the motor unit or the remote unit fills completely. This results in the system being overwhelmed by tasks to handle. In this case, the entire system will re-initialize and start over. No critical error message will be displayed.  The following chart provides a legend for each error message that may be seen on screen:   |  |  | | --- | --- | | Error Message | Corresponding errors | | Error: T | Transmit queue is full, no more data can be enqueued and sent through serial | | Error: O | Overrun error | | Error: P | Parity error | | Error: F | Framing error | | Error: B | Break error |   Any other error message is simply a combination of the latter 4 errors, since they are all obtained from reading the LSR.  Critical errors |
| GLOBAL VARIABLES: | None. |
| ALGORITHMS: | Binary to hex, hex to binary, holonomic drive algorithm. |
| DATA STRUCTURES: | Queues, arrays. |
| LIMITATIONS: | There is no feedback in the system, meaning there is no way of telling if the system moved the correct distance or direction. This is one major drawback of the system.  Operations are limited by the RoboTrike hardware. For instance, maximum speed is determined by the RoboTrike hardware, and the acceleration as well as deceleration cannot be as instantaneously expressed as it is commanded. Also, the laser cannot rotate through all 360 degrees of motion because of hardware limitations. |
| KNOWN BUGS: | None. |
| SPECIAL NOTES: | None. |