EE/CS51

ROBOTRIKE FUNCTIONAL SPECIFICATION

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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  **(S-256)** | Key A3: Speed up 0.4% of max speed  **(S+256)** | Key A4: Show system parameters: (baud, parity) | | 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 15° more to the left  **(D-15)** | Key C4: Move at 15° more to the right  **(D+15)** | | Key D1: Point turret down at -60°  **(T-60)** | Key D2: Point turret up at 60°  **(T60)** | Key D3: | Key D4: |   **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”.  **Key 2: Slow down**  Pressing this key will cause the RoboTrike to slow down by an increment of one-tenth of the maximum speed, which will be determined by the hardware limitations. It will be possible to slow down to a complete stop. There will be 11 speed settings, with 0 being a complete stop and 10 being the maximum speed. When this key is pressed, the display will flash the old speed three times before showing the new speed. If the speed has been decremented to 0, then the display will show “0: STOPPED”. If pressed and held, the speed will decrease all the way down until at a complete stop, at a rate of 2 speed settings per second.  **Key 3: Speed up**  Pressing this key will cause the RoboTrike to speed up by an increment of one-tenth of the maximum speed. The maximum speed is a “10”. When this key is pressed, the display will flash the old speed three times before showing the new speed. If the speed has reached the maximum 10, then the display will show “10: MAX”. If pressed and held, the speed will increase all the way up to the maximum, at a rate of 2 speed settings per second.    **Key 4: Scroll through display**  Pressing this key will allow the user to scroll through the display. The letters are treated as a queue, and the leftmost characters will leave the screen as the unshown letters enter the screen on the right side. The letters will scroll at a rate of 3 new letters per second. When pressing and holding the scroll key, there will be 2 empty characters after the last character before the sequence loops around.  **Key 5: Go forward**  Pressing this key will cause the RoboTrike to move directly forward until a change of direction or a full stop is commanded. Pressing and holding this key or tapping it repeatedly will not cause it to do anything different from simply pressing this key once. The screen will display that the angle of movement is 0 degrees.  **Key 6: Go backward**  Pressing this key will cause the RoboTrike to move directly backward until a change of direction or a full stop is commanded. Pressing and holding this key or tapping it repeatedly will not cause it to do anything different from simply pressing this key once. The screen will display that the angle of movement is 180 degrees.  **Key 7: Go to the left**  Pressing this key will cause the RoboTrike to move directly to the left until a change of direction or a full stop is commanded. Pressing and holding this key or tapping it repeatedly will not cause it to do anything different from simply pressing this key once. The screen will display that the angle of movement is -90 degrees.  **Key 8: Go to the right**  Pressing this key will cause the RoboTrike to move directly to the right until a change of direction or a full stop is commanded. Pressing and holding this key or tapping it repeatedly will not cause it to do anything different from simply pressing this key once. The screen will display that the angle of movement is 90 degrees.  **Key 9: Change angle of movement (counterclockwise)**  Pressing this key will change the angle of movement of the RoboTrike. A degree measurement of 0 indicates that the RoboTrike is moving directly forward, and pressing this key will increment the angle of movement by 15 degrees in the counterclockwise direction. Note that the degree measurement is with respect to the forward direction, not the RoboTrike’s previous direction of movement.  When pressed, the display will flash the old angle three times before displaying the new angle. In the counterclockwise direction, angles will be the negative of the angle they make with the forward direction. The angle with the smallest possible value is -165 degrees. After this, if this key is pressed again, then the direction of movement will be directly backward, and the display will read 180 degrees. After this, pressing this key will result in normal decrements in the angle.  **Key 10: Change angle of movement (clockwise)**  Pressing this key will change the angle of movement of the RoboTrike. A degree measurement of 0 indicates that the RoboTrike is moving directly forward, and pressing this key will increment the angle of movement by 15 degrees in the clockwise direction. Note that the degree measurement is with respect to the forward direction, not the RoboTrike’s previous direction of movement.  When pressed, the display will flash the old angle three times before displaying the new angle. In the clockwise direction, angles are the angle they make with the forward direction. The angle with the largest possible value is 180 degrees. If the RoboTrike is already moving with a direction of 180 degrees from the frontward direction and this key is pressed, then the direction of movement will change to be another 15 degrees clockwise, and the display will read -165 degrees. After this, pressing this key will result in normal increments in the angle clockwise.  **Key 11: Turn on 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 flash “LASER: ON” three times.  **Key 12: 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 flash “LASER: OFF” three times.  **Key 13: Change angle of laser (counterclockwise)**  Pressing this key will rotate the laser by 15 degrees counterclockwise, much in the same way that the angle of movement was controlled. The laser’s angle of orientation is with respect to the front of the RoboTrike, not the current direction of movement.  When pressed, the display will flash the old angle three times before displaying the new angle. In the counterclockwise direction, angles will be the negative of the angle they make with the forward direction. The angle with the smallest possible value is -165 degrees. After this, if this key is pressed again, then the direction of the laser turret will be directly backward, and the display will read 180 degrees. After this, pressing this key will result in normal decrements in the angle. Displaying the laser angle is always in the form “LASER HA: \_\_\_”, with HA representing horizontal angle.  **Key 14: Change angle of laser (clockwise)**  Pressing this key will rotate the laser by 15 degrees counterclockwise, much in the same way that the angle of movement was controlled. The laser’s angle of orientation is with respect to the front of the RoboTrike, not the current direction of movement.  When pressed, the display will flash the old angle three times before displaying the new angle. In the clockwise direction, angles are the angle they make with the forward direction. The angle with the largest possible value is 180 degrees. If the RoboTrike’s laser turret is already pointing a direction of 180 degrees from the frontward direction and this key is pressed, then the direction of movement will change to be another 15 degrees clockwise, and the display will read -165 degrees. After this, pressing this key will result in normal increments in the angle clockwise.  **Key 15: Change angle of laser (increment upward)**  Pressing this key will rotate the laser by 15 degrees upward, and will not change the horizontal angle that the laser turret makes with the frontward direction. The maximum vertical laser angle is 60 degrees, which is when the turret points upward at 60 degrees from the horizontal. Pressing this key when the vertical laser angle is already set to 60 will result in no change.  When pressed, the display will flash the old angle three times before displaying the new angle. Displaying the vertical laser angle is always in the form “LASER VA: \_\_\_”, with VA as an abbreviation for vertical angle.  **Key 16: Change angle of laser (increment downward)**  Pressing this key will rotate the laser by 15 degrees downward, and will not change the horizontal angle that the laser turret makes with the frontward direction. The smallest possible vertical laser angle is -60 degrees, which is when the turret points downward at 60 degrees from the horizontal. Pressing this key when the vertical laser angle is already set to -60 will result in no change.  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.  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 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:   |  |  |  | | --- | --- | --- | | 0 |  |  | | 1 |  |  | | 2 |  |  | | 3 |  |  | | 4 |  |  | | 5 |  |  | | 6 |  |  | | 7 |  |  | | 8 |  |  | |
| 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. |