EE/CS51 Homework 1

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 RoboTrike will also be able to shoot a laser in different directions, and the user will be able to aim the laser using angular increments both horizontally and vertically.  This system allows an operator to control the RoboTrike via a keypad and display over a possibly wireless serial interface. The system consists of two separate components: a keypad, and a display through which the user interacts with the system. This 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 1: Stop | Key 2: Slow down | Key 3: Speed up | Key 4: Display speed and angle/direction | | Key 5: Go forward | Key 6: Go backward | Key 7: Go to the left | Key 8: Go to the right | | Key 9: Change angle (increase angle to the left) | Key 10: Change angle (increase angle to the right) | Key 11: Turn on laser | Key 12: Turn off laser | | Key 13: Change angle of laser (increase angle to the left) | Key 14: Change angle of laser (incremental rotation right) | Key 15: Angle turret up | Key 16: Angle turret down |   **Key 1: Stop**  Pressing this key will cause the RoboTrike to stop its movement. It will slow down and come to a complete stop starting from the moment during which this key is pressed. Pressing this key will not affect the laser, and 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.  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. 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 rotate it around or point it up or down. The keypad also allows the user to scroll through the display if the displayed information exceeds the space provided by the display.  The display will show the command being executed, and show new changes to the RoboTrike’s motion or the laser’s direction with a flashing display at first. When errors occur, they will be displayed on the screen, and this will take precedence over the status of the RoboTrike’s movement or laser direction. |
| ERROR HANDLING: | Serial port errors will be displayed, but power failures, mechanical and software problems might not be. |
| 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. |