CSE 4355/5355 - Mechatronics Lab 8

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LIDAR-Based Room Area Measurement

Objective

The goal of this lab was to measure a room's area using the A1M8 LIDAR sensor integrated with a TM4C123GXL microcontroller. The lab involved data acquisition, processing, and visualization through hardware and software implementations.

Procedure

Hardware Setup

1. LIDAR Sensor Connections:
   - RED (5V) connected to Vbus for power.
   - BLACK (GND) connected to ground.
   - WHITE (PWM) connected to GPO to control the motor.
   - BLUE (TX) connected to U1RX.
   - VIOLET (RX) connected to U1TX.
2. TM4C123GXL Initialization:
   - Configured system clock to 40 MHz.
   - Enabled PWM for motor control.
   - Configured UART for communication at 115,200 baud rate.

Software Implementation

Code Highlights:
1. Initialization:
   - initHw: Configured hardware peripherals, including UART0, UART1, and PWM for motor control.
   - UART initialized to 115,200 baud, 8N1.
2. Commands to LIDAR:
   - sendStop: Sent the stop command (0xA5 0x25) to halt the LIDAR.
   - sendScan: Initiated the scan process (0xA5 0x20).

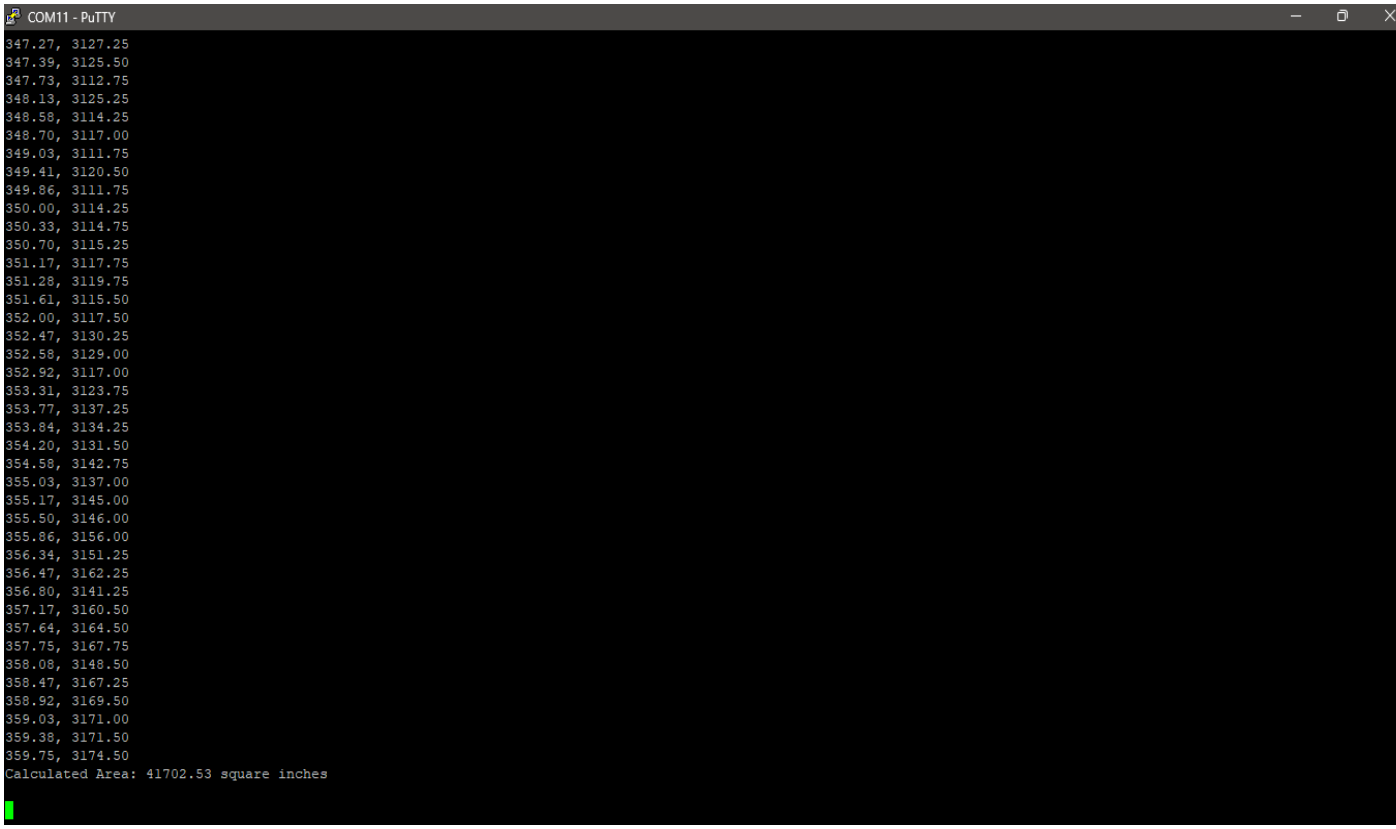
3. Data Acquisition and Processing:
  - readResponse: Retrieved scan descriptors from the LIDAR.
  - processScanData: Parsed bearing (angle) and distance from LIDAR's output data packets.
  - sortData: Sorted the data by angles for processing.
4. Room Area Calculation:
  - Implemented using a trapezoidal approach based on the polar coordinates.
  - Summed up the partial sector areas to compute the total room area.
5. Output:
  - Data output on UART0 in a tabular format (angle, distance).
  - Polar data exported for visualization in a spreadsheet.

Data

The exported polar plot and tabulated data were used to analyze the room's geometry.
Below is a summary:
- Expected Area: 40,320 in^2
- Measured Area: 41,702.53 in^2
- Error: 3.4%

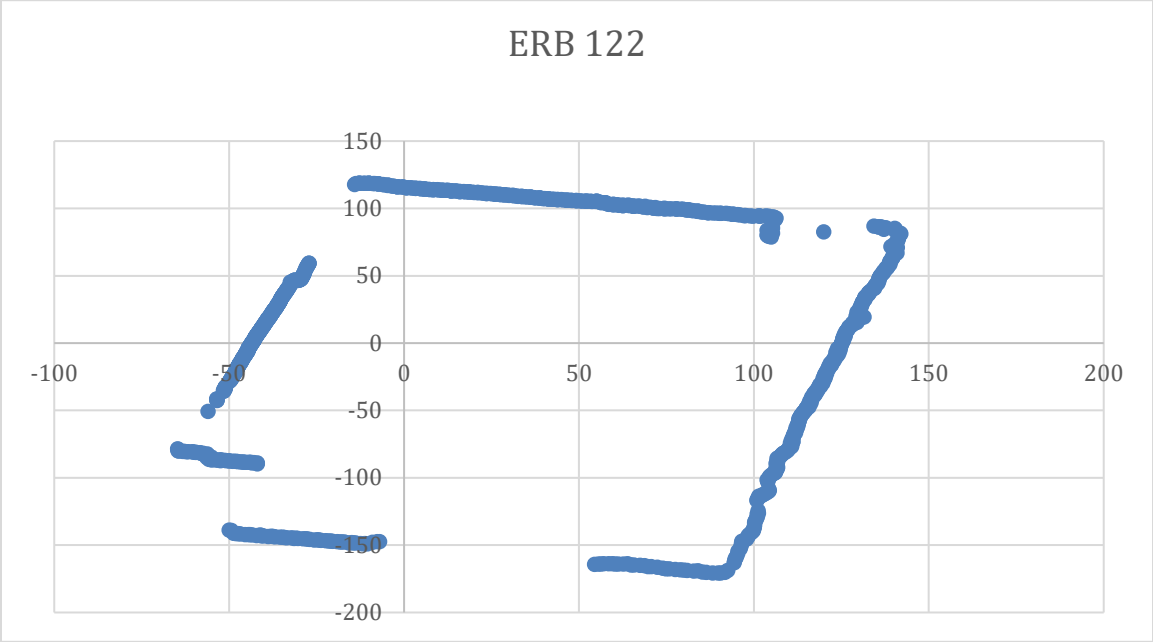
*The excel file where all data was recorded is in the zip file.

Key Observations:
- The measured area exceeded the expected value slightly, likely due to environmental factors such as the door being open or sensor inaccuracies.



Visualization

A polar plot of the LIDAR data was generated, showing the room's outline.



The error margin of ~3.4% was within acceptable limits, considering potential inaccuracies in LIDAR readings and assumptions in area calculation. Sorting and processing data ensured accurate calculations, and the visualized polar plot aligned with physical room dimensions.

Conclusion

This lab successfully demonstrated LIDAR-based room area measurement using the TM4C123GXL microcontroller. The calculated area closely matched the actual room size, verifying the system's accuracy and effectiveness. Minor adjustments to hardware alignment and data filtering could further enhance precision.