COMPENG 2DX3

Final Project Report

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# Device Overview

# Features

|  |  |
| --- | --- |
| * All-In-One LIDAR System   + Suitable for Indoor Use   + Close Range LIDAR Scanning and Visualization Package   + Connectivity to PC for Visualization of Data * Texas Instruments MSP432E401Y SimpleLink™ Ethernet Microcontroller   + Arm Cortex-M4F Processor Core   + 12-MHz Bus Speed   + 1024KB of Flash Memory, 256KB of SRAM, 6KB EEPROM   + Input Voltage: 4.75 VDC to 5.25 VDC Via XDS-110 USB Micro-B   + Status LEDs for Data Scanning Ready and Transmission of Data to PC   + Programmed in C language (optionally Assembly or C++) | * VL53L1X Time-Of-Flight Sensor   + Up to 400 cm Distance Measurement   + Up to 50 Hz Ranging Frequency   + I²C Interface (up to 400 KHz)   + Input Voltage: 2.6 VDC to 5.5 VDC * MOT-28BYJ48 Stepper Motor with ULN2003 Driver   + Input Voltage: 5-12 VDC   + 512 Steps Per Rotation * Visualization   + Python 3.8 (64-bit) IDLE   + Open3D package for model creation * Communication   + I2C Communication Between Microcontroller and ToF   + UART Communication Between Microcontroller and PC, with 115,200 bps baud rate |

# General Description

This all-in-one embedded spatial measurement system scans indoor spaces and creates 3D reconstructions of a particular area. It records 360-degree distance measurements in the YZ plane and is manually moved in the X plane for each new 360-degree measurement. The number of samples taken per 360-degree measurement depends on the step-size of the motor used and affects the resolution of the final image created. This data is then sent to a PC for visualization using Open3D on Python.

The hardware of the system is comprised of a TI MSP432E401Y microcontroller for control of the embedded system, a VL53L1X Time of Flight sensor for distance data, a MOT-28BYJ48 stepper motor with the ULN2003 driver for 360-degree scanning, two user pushbuttons, and two user LEDs. The microcontroller is programmed in C-language for the control-loop and communication between the ToF and PC. Python is used on the PC for visualization with the Open3D package for mesh-creation using transmitted data.

The VL53L1X package calculates the distance measurement from the time of flight of a light pulse. The sensor angle is variable and is adjusted by rotating the stepper with the desired step size. The data is acquired via I2C and stored locally on the embedded platform; this is repeated for the desired number of measurements in the X plane. When done, the data can be sent to the PC via UART to be visualized in Open3D and Python.

# Block Diagram

Timeline

Description automatically generated

Figure 1: Data Flow Graph of System

# Device Characteristics Table

|  |  |
| --- | --- |
| General System Setup | |
| Feature | Description |
| Bus Speed | 12 MHz |
| UART Baud Rate | 115,200 bps |
| Python Version | 3.8 (64-bit) |
| COM Port | COM5 (Device Dependent) |
| Microcontroller Power | USB to PC (5 VDC) |
| VL53L1X Setup | |
| VL53L1X | Microcontroller |
| VDD | - |
| VIN | 5V |
| GND | GND |
| SDA | PB3 |
| SCL | PB2 |
| XSHUT | - |
| GPIO1 | - |
| LED Configuration | |
| User LED | Assignment |
| PN0 | Measurement Status |
| PN1 | Data Transmission Status |
| Pushbutton Configuration | |
| User LED | Assignment |
| PJ0 | Start Data Acquisition |
| PJ1 | Initiate Data Transfer to PC |
| ULN2003 Setup | |
| ULN2003 | Microcontroller |
| + | 5V |
| - | GND |
| IN1 | PM0 |
| IN2 | PM1 |
| IN3 | PM2 |
| IN4 | PM3 |

Table 1: Device Characteristics