

Problem Statement and Goals

Mechatronics Engineering

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Table 1: Revision History

Date	Developer(s)	Change
26/Sep/2022	Jonathan Casella	Initial Release

1 Problem Statement

3D scanning should be a low cost and user friendly technology, so that it can be used by the widest audience. It should not require expensive or specialized hardware, nor should it require that the user have any domain specific knowledge.

1.1 Proposed Solution

LiDart aims to build a low cost, simple to use, WiFi connected 3D scanning robot. LiDart plans to do this by using easily available, low cost LiDAR sensors and consumer grade webcams alongside inexpensive location markers. The user will interface with the robot through a desktop application that will allow them to remotely drive the robot and perform 3D scans.

1.2 Desktop Application Inputs and Outputs

The desktop application will connect to the robot over WiFi. While connected the user will be able to drive the robot using the keyboard, the user will also be able to see the video from the webcam(s) aboard the robot and a visualization of the LiDAR data.

While driving the robot, the user will be able to perform 3D scans. The output of these scans can then be exported from the desktop application and saved as a Wavefront OBJ file.

1.3 Robot Inputs and Outputs

Aboard the robot will be one or more consumer webcams, a low cost LiDAR module and other miscellaneous sensors for the various moving mechanisms. Data from all of these inputs will be both relayed to the desktop application and used by the software onboard the robot for tasks like localization. The robot will also receive commands over WiFi from the desktop application that will be used to remotely drive the robot and perform 3D scans.

The video feed from the webcam(s) will be used to detect inexpensive location markers that will be scattered around the robot's environment.

1.4 Stakeholders

Stakeholders in the project include all parties that would benefit from low cost, easily accessible 3D scanning. Examples of groups that fit this criteria include small visual effects studios, independent mechanical designers, and manufacturing firms.

All of the aforementioned groups lack domain specific knowledge related to robotics and 3D scanning, as such a focus for this project will be to make the 3D scanning process as user friendly as possible.

1.5 Environment

The robot is expected to operate indoors on flat surfaces. The robot's environment is also expected to have been pre-populated with inexpensive location markers.

The desktop application will be designed to run on a computer running a desktop operating system with WiFi connectivity and sufficiently powerful hardware. The robot software will run aboard the robot on an embedded computer.

2 Goals

2.1 Accurate 3D Scanning

The produced 3D scans should be accurate within a given threshold. This threshold may not be as small as commercial solutions, but should be small enough that the results can be used for most tasks.

For example, the scans produced by LiDart's robot may not be accurate enough for use by an engineer designing mission critical components, but should be accurate enough for rapid prototyping.

2.2 Low Cost Hardware

The hardware used to build the robot should be low cost and easily accessible. It should also be able to swap components with equivalent alternatives without any major effort.

For example, it should be easy to replace our choice of consumer webcam with another choice that meets similar specifications.

2.3 Ease of Use

Producing 3D using the LiDart robot should only require the user to drive around their object of interest and instruct the robot to perform a scan. A user with no knowledge of the inner workings of the system should be able to operate it with only a brief explanation.

The ease of use could be measured using a group of test subjects with no prior knowledge of the system.

3 Stretch Goals

3.1 Autonomous Scanning

The operation of the robot as specified above involves the user remotely piloting the robot. As this could be time consuming for the user, an additional feature LiDart could implement is autonomous scanning.

While autonomously scanning, the robot would explore its environment without any user intervention, scanning while it goes. The user could then export this scan and import it to their software package of choice to select the part of the environment that they wish to keep.

3.2 Camera Based Scanning

As specified above, the robot will have both a LiDAR module and one or more consumer grade webcams. It is possible to remove the LiDAR module and instead use only consumer grade webcams for both localization and 3D scanning. This would allow LiDart to reduce cost by removing the LiDAR.