Problem Statement and Goals
PCD: Partially Covered Detection of Obscured People using Point Cloud Data

Team #14, PCD
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Table 1: Revision History

Date	**Developer(s)**	**Change**
September 24, 2024	Harman Bassi and Kyen So	Initial Draft

1 Problem Statement

1.1 Problem

Our team aims to design a software that can reliably detect a person's body from Point Cloud Data (PCD) even if they are blocked by another person or other objects, which existing solutions cannot reliably do so. This helps make future assistive robots with arms designed to help people in their daily lives much safer for the user.

1.2 Inputs and Outputs

The software will take in real-time data from a Kinect sensor or uploaded Point Cloud Data (PCD) files and return the location of visible parts of a person in the coloured point cloud and an estimation of the 3D space that are occupied by the head, torso and limbs.

1.3 Stakeholders

Dr.Gary Bone wishes to create a solution for robots to recognize their surroundings and identify the spaces that are occupied by the people around them. This way, these assistive robots can be used to help people at their homes. Our solution could be used by robotics companies to develop their robots.

1.4 Environment

The software must work in conjunction with the Microsoft Kinect in real-time. Additionally, the software will be designed to work in the Windows operating system.

2 Goals

2.1 Identifying a Person

The application should be able to identify a human within a variety of different environments. This includes detecting the human even if they are partially obscured by an object.

2.2 Model Identified Person using Shapes

The application should be able to provide a rough model based on where it believes the person is in 3D space. A rough shape of the head, torso, and limbs will be shown on the screen to help provide an accurate location of the human on screen.

2.3 Real-time Processing

The application needs to be able to process the data and constantly be updating to see if a human is detected within frame. The reading and processing of the data needs to be done with minimal latency.

2.4 Location Precision

The application is able to provide the spatial coordinate of the person. This would help with visualizing the human within a 3D space and provide the robot with a better understanding of where the person is from its current location.

2.5 Analyze and Process offline PCD files

The application should be able to take uploaded Point Cloud Data files as an input rather than analyzing captured data in real-time. This allows for the testing of various controlled scenarios to ensure that the program can successfully identify a human in different scenarios. Outputs of the application can be easily compared to the expected results of the configured scenario to determine accuracy.

3 Stretch Goals

3.1 Mapping the environment

The application should be able to identify other objects that are present within the environment. Having a better understanding of the environment means that the application would provide better spatial awareness by disregarding objects as being possible body parts.

3.2 Drawing a Humanoid Outline

The application should be able to create a realistic outline with humanoid features for the people it identifies. A more accurate outline provides greater dimension and distinction between what is and isn't part of the human body. This would allow for a more accurate detection and human depiction.

4 Challenge Level and Extras

The challenge level of the project is currently considered to be general. However, the project consists of topics that aren't covered within previous year courses and the majority of the project doesn't fits into the group's current domain knowledge on computer vision and possibly machine learning. There is a learning curve with the computer vision aspect of the program and the challenge level of the project could be considered advanced for the team. The two extras that the project will cover is design thinking and the user manual.

Appendix — Reflection

1. Why is it important to create a development plan prior to starting the project?

   It is important to create a development plan prior to starting the project as it allows most of the heavy lifting behind project planning to be done before any work has started. It allows for expectations and workflow to be clearly defined before any issues arise. It also creates a document that can be referenced at other times to avoid confusion.

2. In your opinion, what are the advantages and disadvantages of using CI/CD?

   Employing CI/CD allows for better issue tracking and rollbacks. Utilizing CI/CD gives the opportunity for teams to better track individual issues and commits, leading to increased awareness and visibility on workflow issues. It also allows for easier time rolling back to a previous version in case something goes wrong. Some disadvantages are with the conceptual depth and speed. Ensuring a specific workflow and constant PR reviews can slow things down as contributors have to make sure that they are following the workflow properly and have to wait for PR reviews (when necessary). Furthermore, it is more effort to set up, both in the codebase and conceptually. The process has to be talked through and understood by all team members.

3. What disagreements did your group have in this deliverable, if any, and how did you resolve them?

   Our group mainly debated how to set up our GitHub workflows. Initially, we considered using individual branches for each issue, but we ultimately decided on a more streamlined approach with two revision branches and separate forks. This allows us to effectively manage pull requests for merging feature changes into the codebase. We reached this agreement after discussing the benefits of clarity and collaboration in our development process.

4. What went well while writing this deliverable?

   This deliverable allowed for the group to be able to discuss standard goals vs stretched goals. Everyone contributed their ideas and we were able to come to a clear conclusion when it came to the goals and problem statement of the project. It also allowed us all to see where the project is headed and how we should properly prepare ourselves so that we can achieve our goals.

5. What pain points did you experience during this deliverable, and how did you resolve them?

   The biggest pain point during this deliverable was being able to decide which goals were too ambitious and outside our design scope. Some goals such as the aspect of outlining the human in the environment were broken up. There was a deep discussion on how to properly decide the goals, but at the end the group got a better understanding of the project.

6. How did you and your team adjust the scope of your goals to ensure they are suitable for a Capstone project (not overly ambitious but also of appropriate complexity for a senior design project)?

   Because our project is presented by a professor, the team already had a pretty clear understanding of the goals that needed to be achieved for our project to be considered a success. The only issue was trying to ensure that the goals can be properly broken down so that a goal that seemed a bit ambitious could be broken into something that seems doable. For example, the human detection is broken into the Minimal and viable product goal and then also extended into the stretch goal. This was an important discussion that the group had to ensure that we deemed our goals to be doable.