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**
Date1	Name(s)	Description of changes
Date2	Name(s)	Description of changes
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1 Problem Statement

1.1 Problem

Our team aims to design a software that can reliably detect a person's body from sensor data 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 data 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, horso and limbs.

1.3 Stakeholders

Dr Gary Bone wishes to create a solution for future mobile robots with arms 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 must be designed using C++ and/or Python and will be designed to work in the Windows operating system.

2 Goals

Goals	Explanation	Importance
Identifying Humans	The program needs to able to detect a human within a given environment.	• This goal is important as its the main function of the program • Being able to detect human helps with finding the location of the person
Be able to outline a human	The program needs to be able to create a rough outline based on where it believes a human is.	• Its important to understand the basic outline of the human so that the robot is able to create a basic understanding of where they are hidden
Real-time Processing	The program needs to be able to process what it sees in real time and present its data as it sees it.	• The environment is constantly changing and needs to able to output real time results • Its important that the output displays real time results because it is important that the robot is able to constantly adapt to the environment
Be able to capture PCD from the sensor	The program uses PCD data to identify a human in the present environment	• This data needs to be collected properly so that it can be processed • Without this data the program/robot will not be able to properly detect the humans
Be able to analyze PCD files	The program should be able to analyze PCD files that are uploaded rather than captured in real time.	• Controlled scenarios could be easily tested to ensure proper results and also allow for specific configuration

3 Stretch Goals

Goals	Explanation	Importance
Detect Humans Fully covered in clothing	When a human is fully covered their skin color is no longer visible which would make it more difficult to detect the person.	• In more dangerous scenarios it would be highly likely that some humans may be wearing full body suits for protection • Also this would allow for a system that isn't solely dependent on skin color to detect humans
Mapping the environment	Being able to identify other objects that are present within the environment	• Being able to identify objects would allow for a better understanding of the environment and where the person is hidden
Humanoid Outline	Creating a realistic outline that shows a humanoid figure in a 3D plane	• Creating a more humanoid outline will give proper dimensions to the person hidden in the frame • This would allow for more accurate detection and human depiction

4 Challenge Level and Extras

The challenge level of the project is considered to be general. The project consists of topics already covered within previous year courses. Majority of the project fits into the group's domain and should be achievable. However, there is a learning curve with the computer vision aspect of the program. 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.