Blender Simulation for Camera Placement Optimisation

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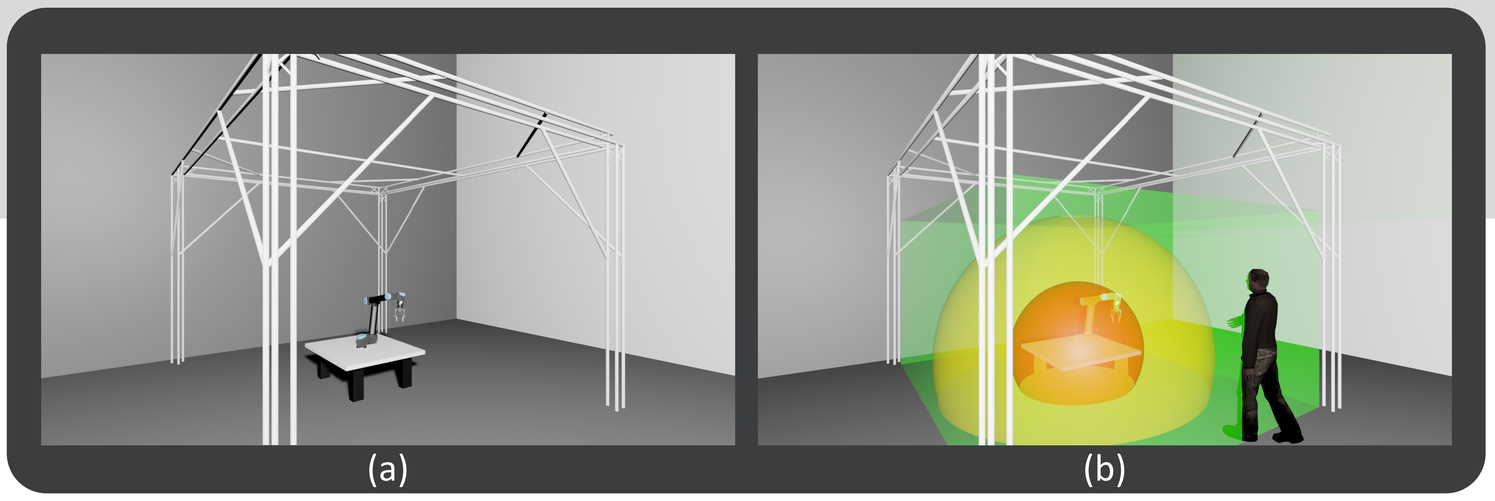
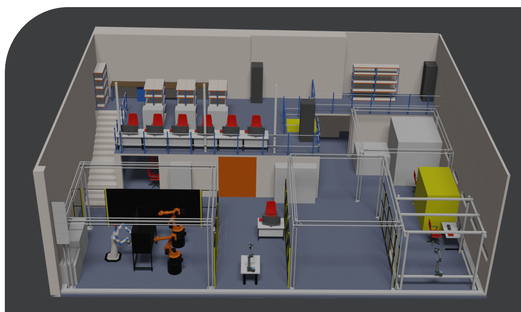
Enabling safe work zones for human-robot-collaboration requires enhanced tracking capabilities. This work introduces a simulation based approach in Blender for optimising the placement of a stereo camera network to improve measurment robustness, minimising the effect of occlusions, ensuring coverage and angular intersection between cameras within complex user-defined environments. A Blender add-on has been produced to assist non-expert users in achieving this goal. In addition to the simulation work, we also evaluate the repeatability and accuracy of a Zed2 camera. This allows for the integration of hardware-based performance into the simulation pipeline.



(a) Simulated robot workspace; (b) highlighted robot working zones: interaction zone (red), warning zone (yellow), safe zone (green).

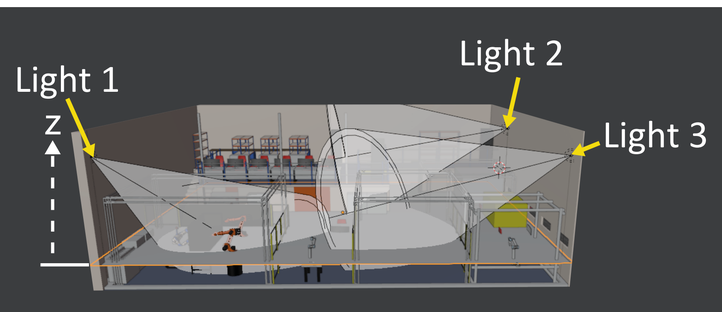
Simulation Methodology

Model creation in Blender → Camera simulation → Space voxelization → Data analysis: Holistic Algorithm or Genetic Algorithm

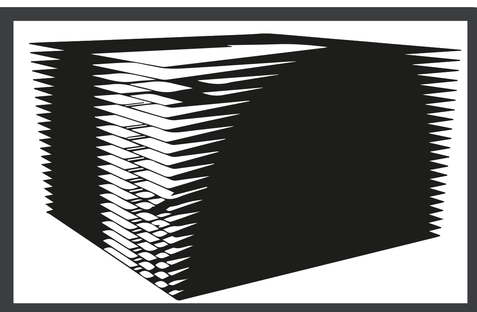


Simulated complex environment in Blender

Camera simulated as light. Line of sight determined using ray tracing



A plane is translated through the volume and baked at each position



Group of binary baked planes showing voxelised light distribution

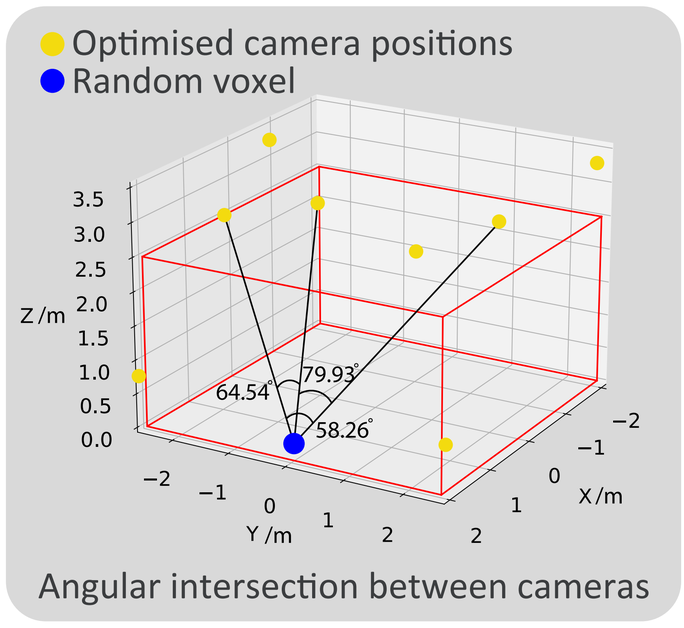
Optimisation

Camera position optimised such that:

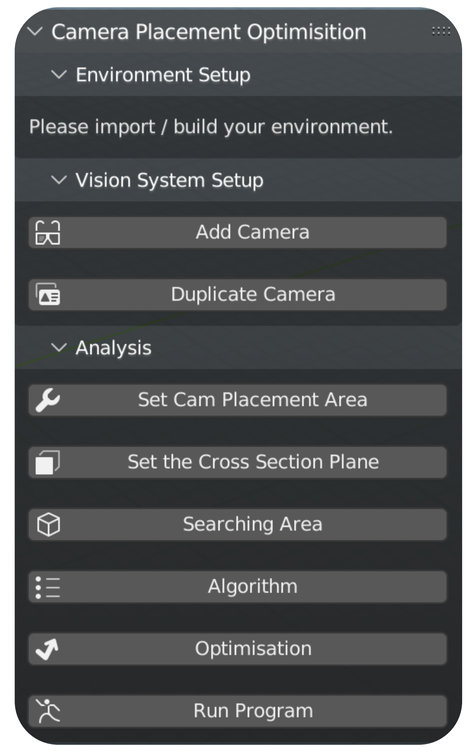
- Each voxel can be viewed by ≥3 cameras.
- The angle between the cameras can be set as a desired angle range.

Results for angle range of 45˚ to 120˚:

- Genetic algorithm solution: 93% effective coverage.
- Equally spaced installation solution: 0.03% effective coverage.



Angular intersection between cameras

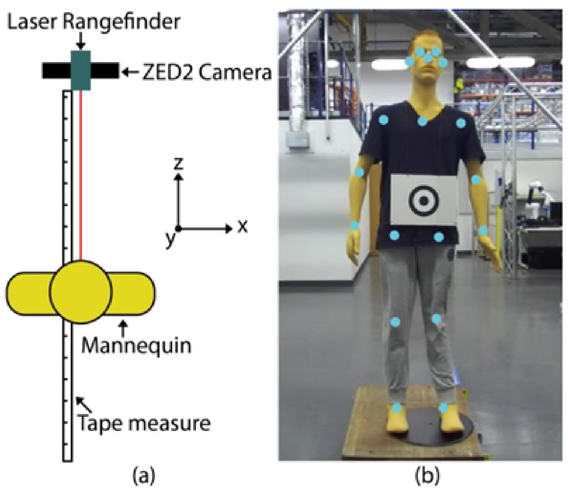


Blender camera optimisation add-on GUI

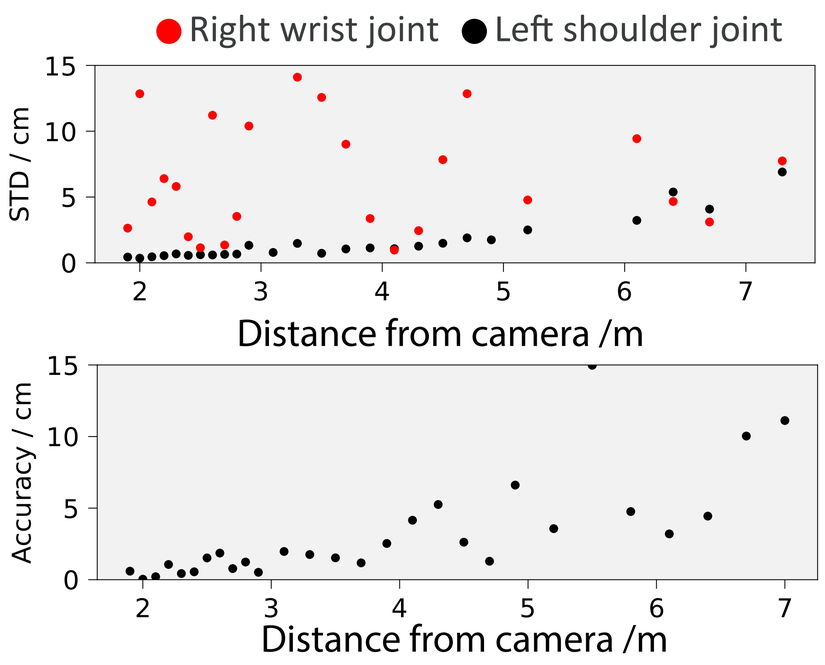
Add-on Design

- **Add camera:** Customise the camera FOV size and operating distance.
- **Duplicated camera:** Add more cameras into the network.
- **Set cam placement area:** Set available placement area for cameras.
- **Set the cross section plane:** Set voxelization plane step size through the volume.
- **Searching area:** Customise the region of interest.
- **Algorithm:** Set optimisation approach: Holistic or Genetic algorithm/ set parameters.
- **Optimisation:** Only available when using Genetic algorithm method - Set the viewing angle between cameras.

Hardware Evaluation



(a) Experiment setup; (b) Mannequin with captured skeleton labelled as blue dots



Conclusion

- Demonstrated simulation approach for camera placement optimisation using Blender in complex environments.
- Simulation outperforms equally spaced camera network distribution.
- Created a Blender add-on to allow non-expert users to optimise camera network.
- Enhancement of simulation investigated by experimentally characterising the repeatability and accuracy of a Zed2 camera.

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