3D MAPPING and LOCALIZATION

-an application to UV-C disinfection robots-

HU-MATHS-IN
Hungarian Service Network for Mathematics in Industry and Innovations

H2020 SOCIETAL CHALLENGES

Health and wellbeing, smart and integrated transport

The industrial problem tackled in this project is the 3D mapping, accurate vision-based localization and position tracking of an UV-C disinfection robot, that can quantise the irradiance on the surrounding surfaces.

AUTONOMOUS SYSTEMS TRANSFORMING ICT, ROBOTICS

Research group

Faculty of Informatics --- MPLab

UNIVERSITY of DEBRECEN

SZTAKI

Machine vision and perception

Company

B+N Referencia Zrt.

Healthcare cleaning and disinfection

SZÉCHENYI 2020
MAGYARORSZÁG KORMÁNYA
Európai Unió
Európai Strukturális és Beruházási Alapok
BEFEKTETÉS A JÖVŐBE

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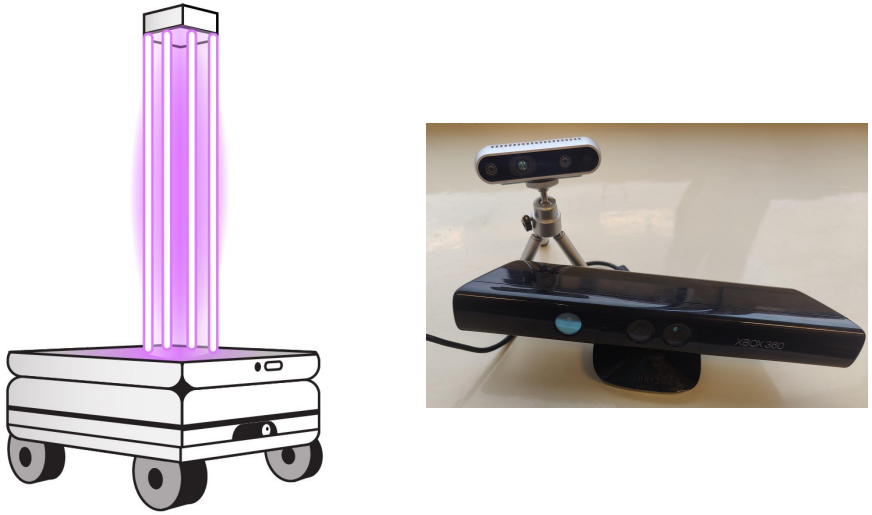
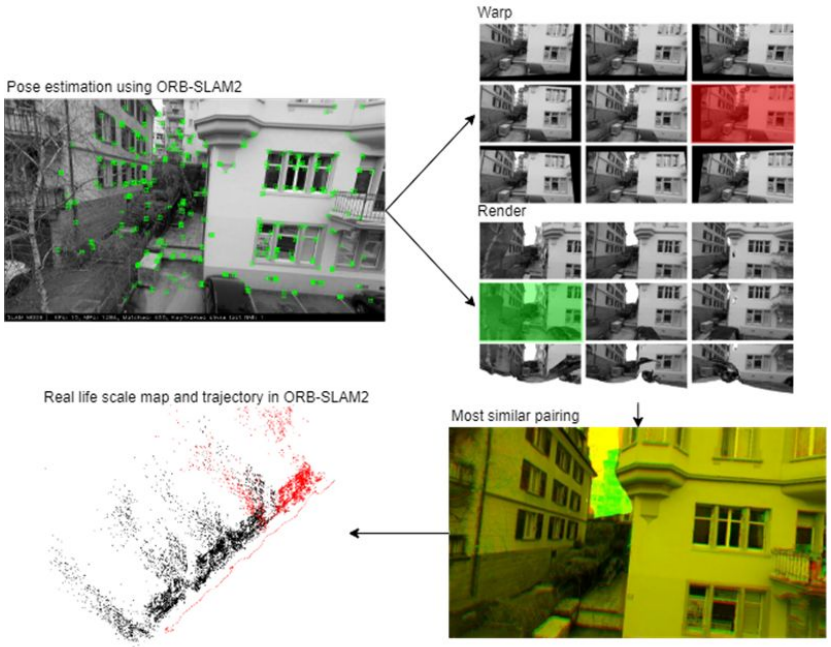
Challenges & Goals

- To develop a 3D mapping algorithm using RGB-D sensors
- To quantise the UV-C irradiance on the surrounding surfaces
- To investigate the accurate mono-camera localization in 3D maps and point-clouds
- To compute the relative position between consecutive robot positions
- To achieve near real time operation



Sketch of the UV-C robot (left), and the RGBD sensors used in the experiments (right)



Overview of the proposed localization algorithm (applied in outdoor environments to localize an MAV)

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Mathematical and computational methods and techniques applied

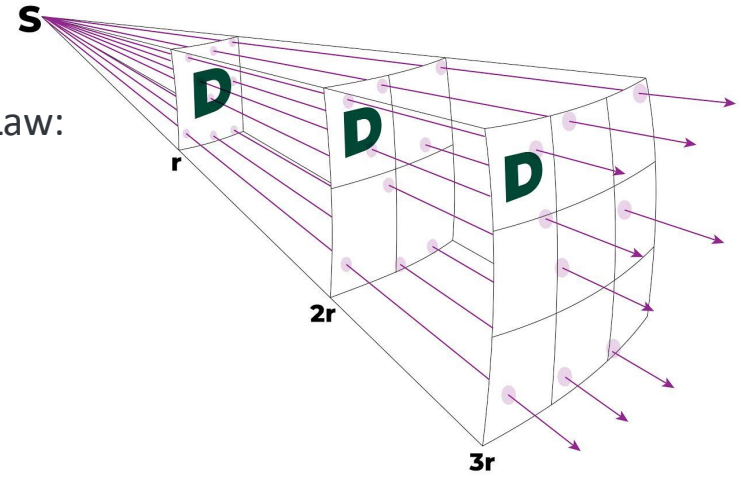
- Irradiance depends on:
  - Distance from the light source – Inverse Square Law:

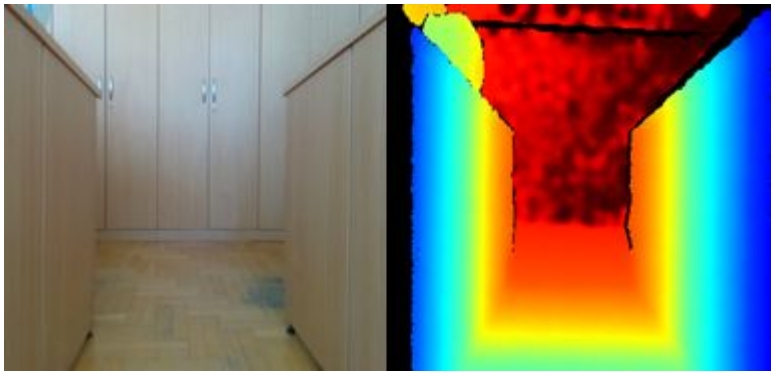
$$I(r) = \frac{k}{r^2}$$

  - Angle of incidence – Lambert's Cosine Law:

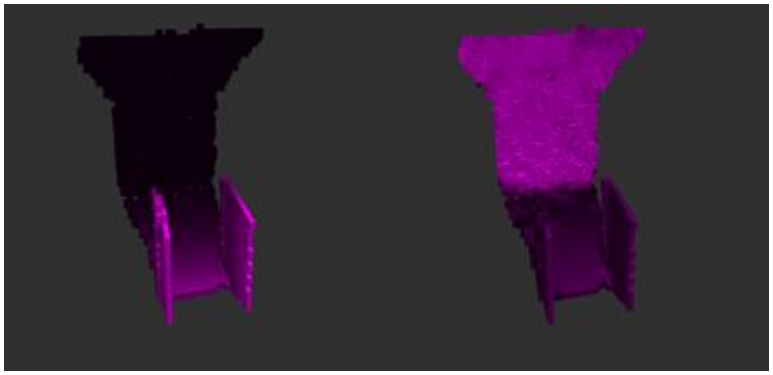
$$I(\Theta) = I_{dir} \cdot cos(\Theta)$$

  - Time of irradiation





Snapshot of the of the test environment: RGB (left) and Depth (right) images



Irradiance computed with respect to: distance (left) and angle of incidence (right)

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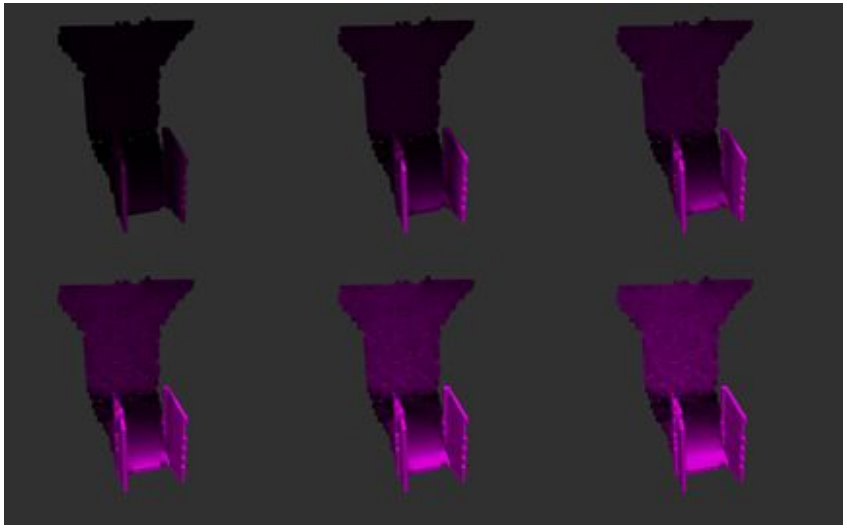
Results & Benefits to the company

- Results:
  - Voxel based algorithm to reconstruction of the environment
  - New method to solve the relative pose between two robot positions from deep learned depth and a single affine correspondence
  - Accurate appearance-based mono camera localization system in 3D maps
- Benefits:
  - Intelligent 3D irradiance estimation in near real time operation
  - Accurate and fast robot localization



Dynamic simulation of irradiation computed from both distance and angle of incidence over time

The project advanced the state-of-art in computer vision and intelligent mobile disinfection robotics