Automatic Parcel Induction and Sorting for the Last Mile

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The growing e-commerce demand requires automatic parcel handling systems. A low-cost automatic parcel induction system is being developed for the existing Prolistic eSorter. The system combines vision, neuronal networks and robotics.

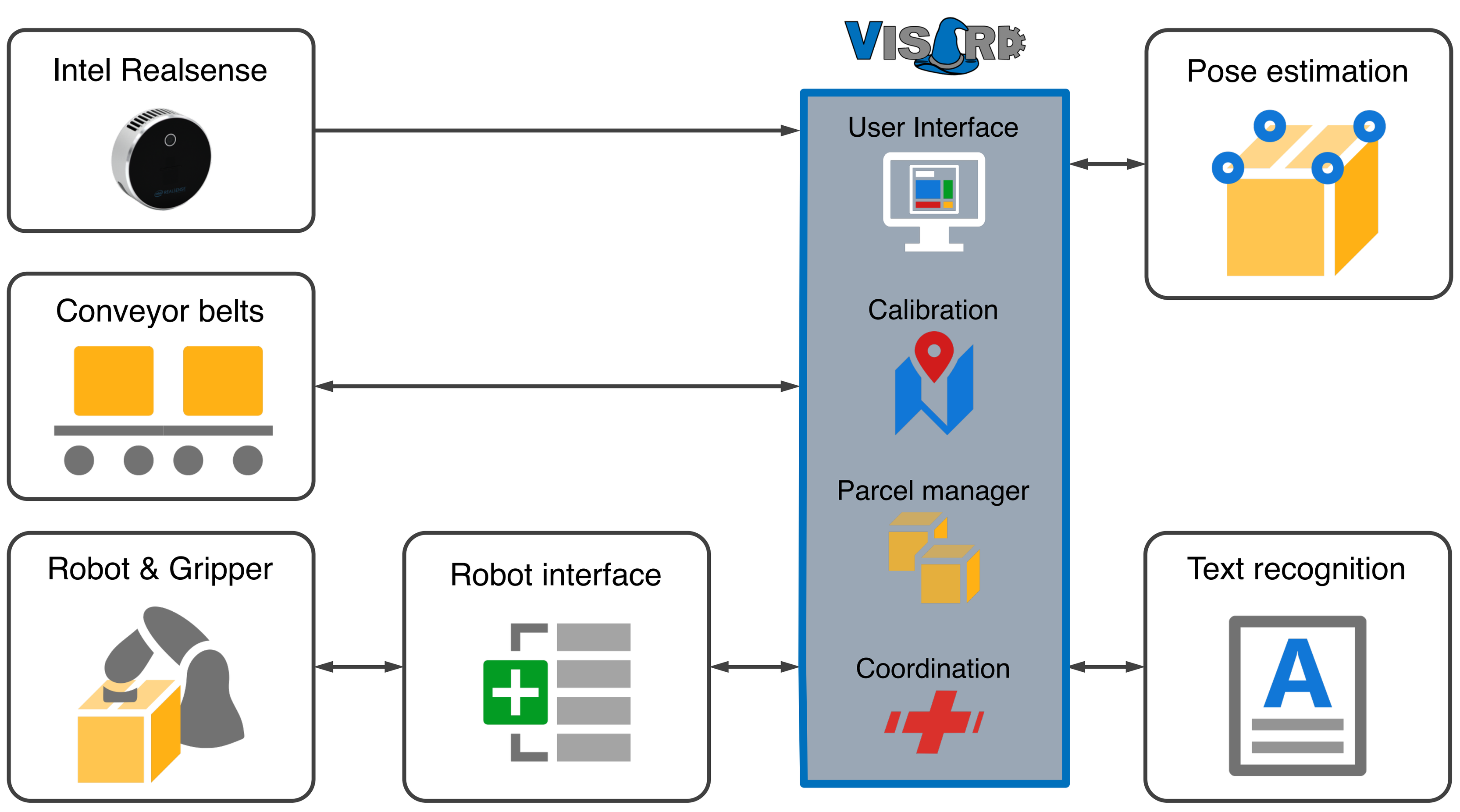
Introduction

Today, most automated parcel sorters for the last mile use manual induction. This induction is slow, tedious, and physically tiring. This project is developing an automatic induction system for Prolistic's eSorter flexible parcel sorter. Incoming parcels are dumped and channeled to a conveyor. A 3D vision system and neuronal network detects individual parcels and their pose. With this information, a robot picks each parcel individually and orients it correctly on an output conveyor.

Specification

The system combines vision, neuronal networks and robotics and shall:

- Handle parcels up to 10 kg weight and 400 x 300 x 200 mm^3 volume
- Manage any packaging material
- Move at least 4000 parcels per hour
- Identify parcel pose to ± 5 mm and $\pm 20^\circ$
- Identify the address label and read it



The system architecture is modular and allows many robot units based on the desired throughput. Modules communicate with gRPC/protobuf. CSEM's Visard builds the user interface and controls the whole process.

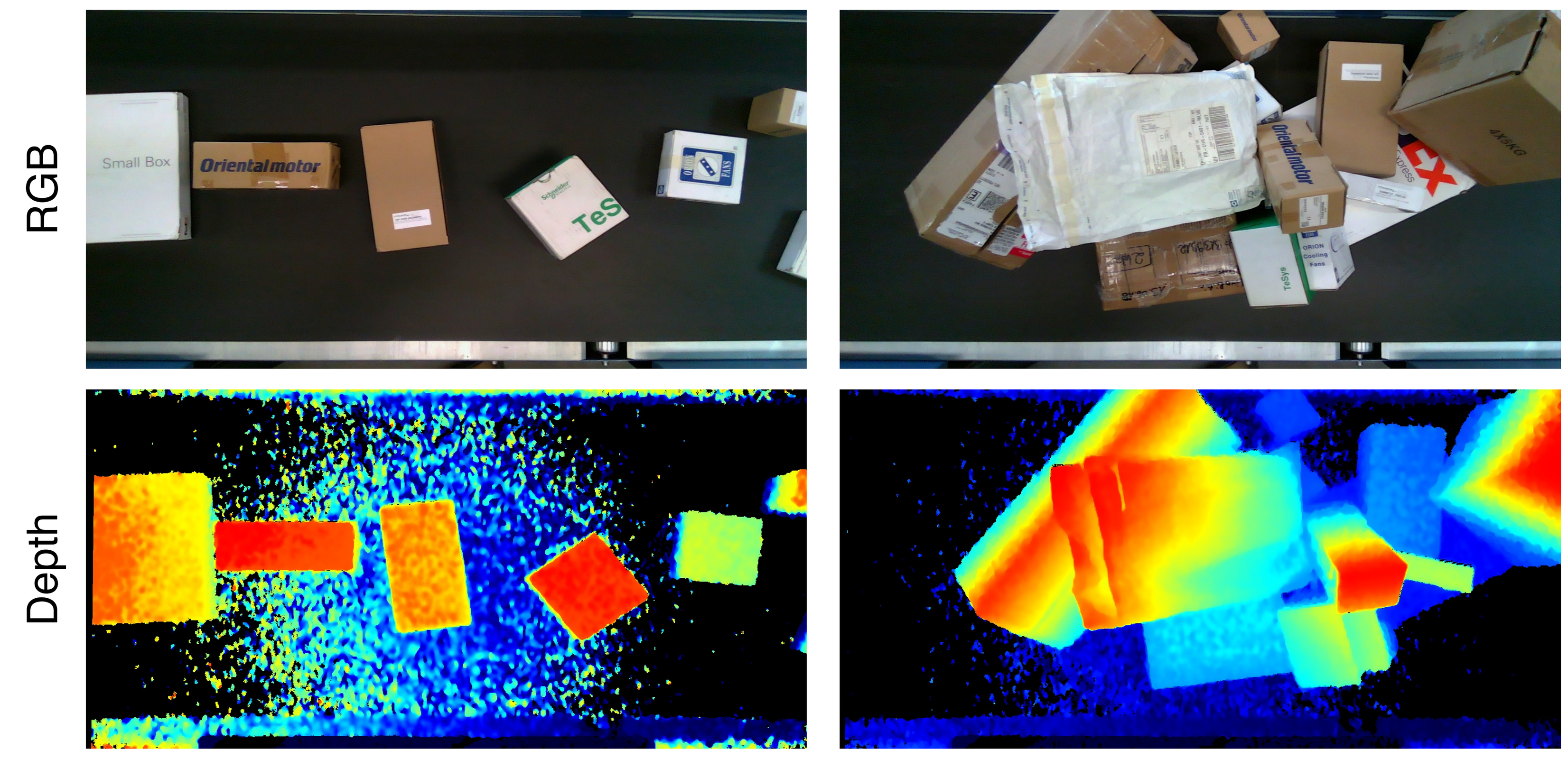
Gripper

A 3D-printed vacuum gripper was developed. The gripper has multiple gripping zones, combines suction cups and sealing foam, includes a blow-off function. This allows manipulating parcels of varied size, weight and packaging material.
Camera-robot calibration uses a gripper plate with CCTags. Calibration data is generated by moving the plate with the robot under the camera.

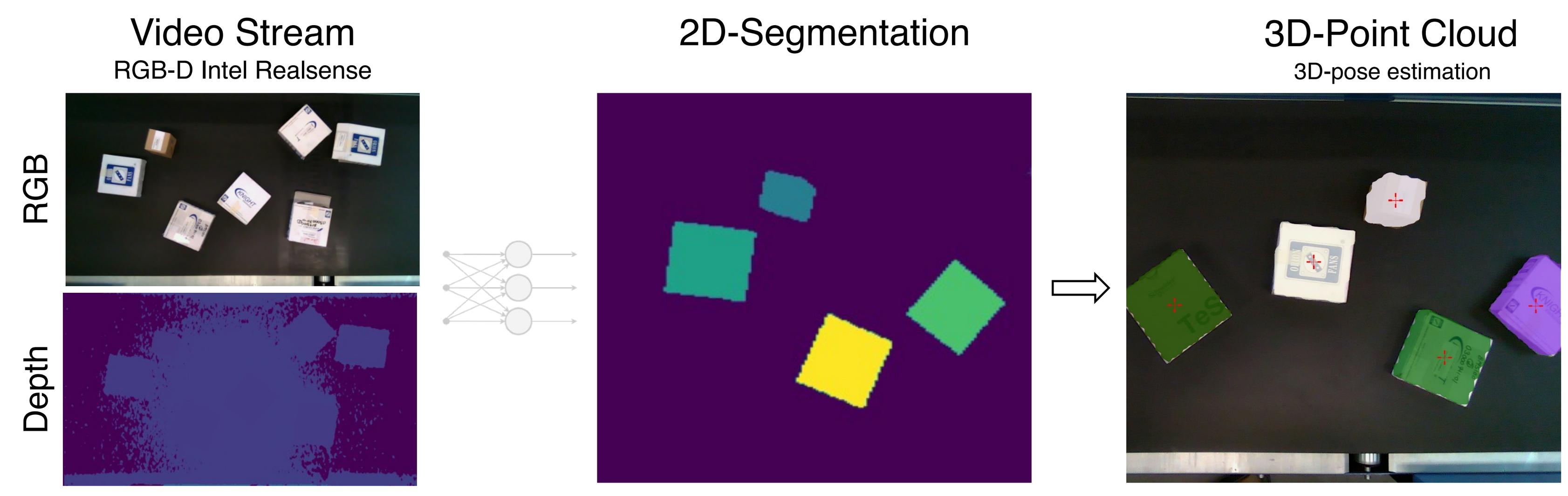
The 3D-printed vacuum gripper developed uses a combination of foam and suction cups with multiple gripping zones. Camera-robot calibration is achieved with an adapter plate with CCTags on the gripper.

Vision & Image Processing

Vision uses an RGB-D lidar (Intel Realsense). A neuronal network detects the parcels. The network is trained using photo-realistic synthetic data, enabling access to all scene information (parcel dimensions, pose, materials) as well as fast and unlimited amount of training data. The network training is supported by real data to close the simulation-reality gap. The 3D pose estimation of the bounding box is calculated and sent to the robot parcel handler.



Data from the Intel Realsense Lidar RGB-D camera.



Overview of the image processing. First the parcels are segmented by a neuronal network. Then the 3D pose is estimated and sent to the robot.

Robot and Path Planning

A low-cost robot is used. An interface to the robot was written to facilitate its system integration. An intelligent path-planner includes different gripping strategies for the gripper zones and collision avoidance.

eSorter induction system: A robot isolates parcels from an incoming conveyor.

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