AdVanScan

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Introduction

Royal Mail is a public company responsible for the delivery of postage in the UK, and faces a huge logistical challenge to deliver their service, with 50 million letters and packages a day delivered by 45,000 vans to 24 million addresses. Optimisation of local delivery routes and schedules is made difficult due to a lack of data on the initial and real-time fill level of the van.

Currently, Royal Mail relies on post-delivery questionnaires completed by drivers after completion of their route to gain an estimate on van fill levels, however, such methods are subject to low uptake rates and bias.

We present here two complementary approaches to estimate and relay van-fill levels, both before distribution and in real time during the delivery route.

3D Camera

One method used a 3D camera to estimate the volume. The Intel RealSense camera was used to extract a point cloud reconstruction of the interior of the van. Images were taken from various angles in order to maximise information about the internal structure. The point clouds were merged and then a surface mesh was constructed from the resulting merged point cloud. The volume was then calculated by integration.

Ultrasound Depth Sensor Array

One system applied a 3×5 ultrasound depth sensor grid on the roof to sample the van fill level in discrete partitions. The 15 sensors were connected to a Raspberry Pi through two 16:1 multiplexers, which allowed individual sensor selection. The sensors are sequentially fired, to avoid interference, and the fill level is estimated using a 4th order polynomial fit or given as a percentage fill relative to a baseline empty measurement.

Experimental Results

- A prototype delivery van was constructed out of cardboard in order to perform experiments to evaluate the approaches.
- 8 different van fill configurations were used with known percentage fill based on the measured volumes of all items placed in the van.
- Ordered and disordered item configurations were used for each percentage fill, as shown in the images in Fig 1.
- The measurement results obtained by each approach are presented in the chart below:

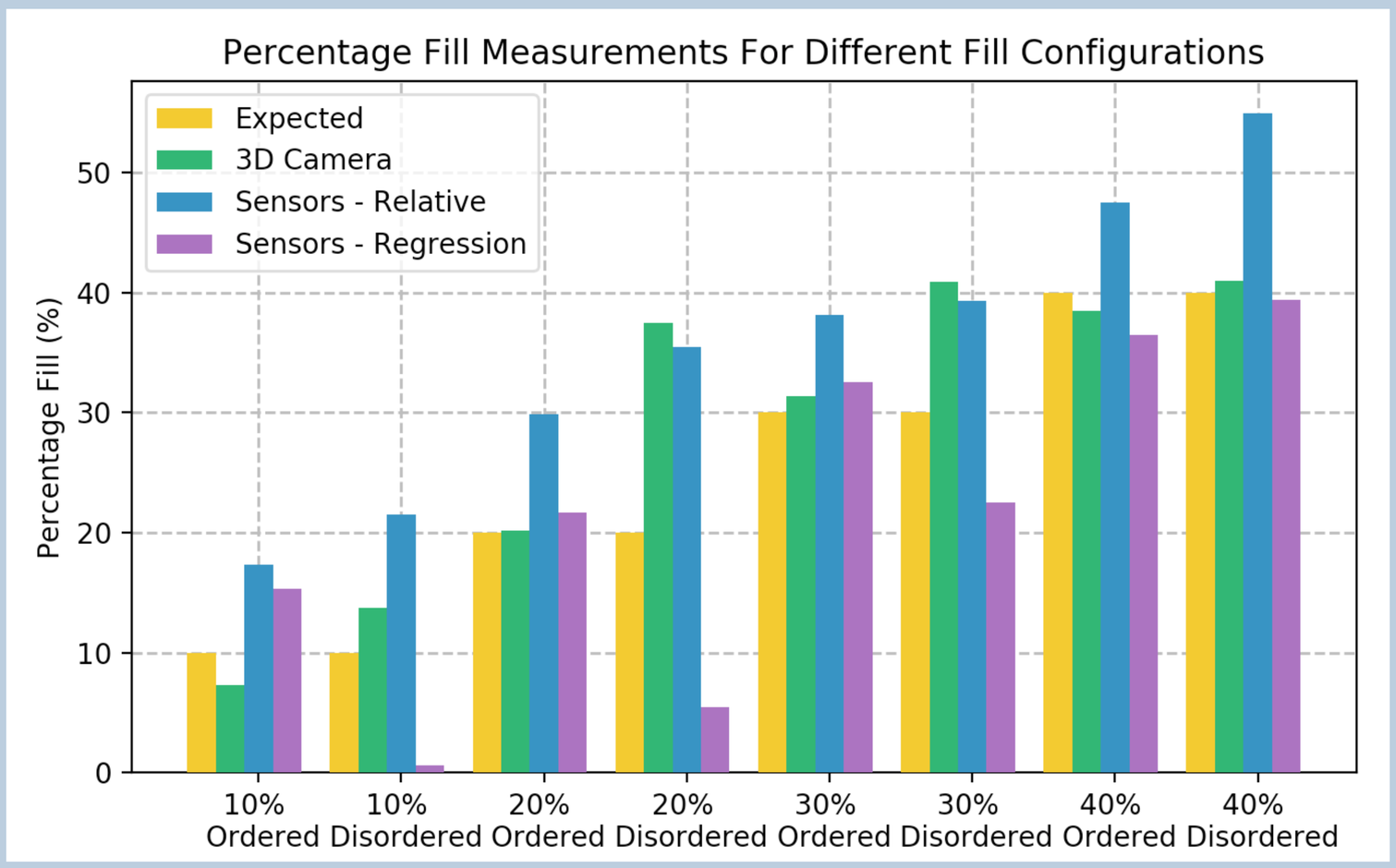

Figure 1: Left: Experimental measurements, Right: Van fill configurations for 20% ordered (top) and 20% disordered (bottom)

Approach Comparison

3D Camera	
Pros	**Cons**
Most accurate method	Dependent on picture quality
Can deal with non-uniform fill	Can miss gaps at back of van
No installation in van	Requires more computation

Ultrasound Depth Sensors	
Pros	**Cons**
Real-time	Interference
Affordable	Errors with uneven surfaces
Sufficiently accurate	Errors for non-uniform fills
	Inaccurate for low percentage fills

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