Importance of Human Aware Robot Navigation in High Throughput Material Handling Systems

12 December 2019
Bas Coenen | HTSC RESEARCH MEET
Airports

- Flexibility
- No human labor

Warehousing

- Scalability
- 24/7 operations

Parcel

- Redundancy

12 December 2019
HTSC Research Meet
Challenges...

> Variation of products to handle
  
  \textit{Size, weight, shape, texture, ...}

> Variation of tasks to execute

  \textit{Identify, pick, orientate, place, stack, inspect, ...}

> Human level of performance

  \textit{Reliability, speed of execution, ability to deal with exceptions, ...}

\textbf{“With an ROI that is reasonable”}
<table>
<thead>
<tr>
<th>Flow of goods</th>
<th>Work area</th>
<th>System objective</th>
<th>Robot behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goods-to-robot</td>
<td>Exclusive</td>
<td>Robot Productivity</td>
<td>Max speed</td>
</tr>
<tr>
<td>Goods-to-robot</td>
<td>Co-existence</td>
<td>Robot Productivity</td>
<td>Safe speed</td>
</tr>
<tr>
<td>Robot-to-goods</td>
<td>Collaborative</td>
<td>Human Productivity</td>
<td>Natural</td>
</tr>
<tr>
<td>Robot-to-goods</td>
<td>Co-existence/Exclusive</td>
<td>Human Productivity Robot Productivity</td>
<td>Natural</td>
</tr>
</tbody>
</table>
Autonomous Vehicle Supported Picking

System
- Central coordination
- Pick instruction by voice
- At pick location by display

Environment
- Narrow isles
- Noisy
- Worldwide application
Increasing pick density

- **Clustering**: Pick similar order (parts) simultaneously
- **Batching**: Taking two or more order per pick run
- **Overtaking**: Enable overtaking to avoid waiting and congestion
- **Multiple vehicles**: Increase the number of vehicles per picker
Considerations

Behavior

- **Comfort** is the absence of annoyance and stress for humans in interaction with robots.
- **Naturalness** is the similarity between robots and humans in low-level behavior patterns.
- **Sociability** is the adherence to explicit high-level cultural conventions.
Importance Human Aware Navigation

Human aware navigation enables

> Efficient (AV supported) picking concepts
  > Efficient execution of picks by eliminating waiting times
  > Increasing pick density
> More human comfort, can directly be linked to
  > Productivity
  > Accuracy
  > Engagement and motivation
> Safe operation
  > In vicinity of many mobile robots
  > Narrow isles
VANDERLANDE