Building Consistent Laser Scan Maps

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Basic Idea
Approach

- Rotational shift
- 1st translational shift
  - Coarse shift (1/10 resolution)
  - Fine shift (0.5° or 1 cm)
- 2nd translational shift
- Projection filter
- Line segmentation
- Generation of histograms
- Histogram correlation
Projection Filter
Rotational Shift

Σ length

-90°  0°  90°
1\textsuperscript{st} Translational Shift

\begin{align*}
\Sigma \text{ length} & \\
1\textsuperscript{st} \text{ main direction} & \\
-90^\circ & \quad 0^\circ & \quad 90^\circ
\end{align*}
2nd Translational Shift

Σ length

1st main direction

2nd main direction

±20°
Odometry vs. Scan Matching

- **Odometry**
  - Stringing together small offsets
  - Each error affects all successive positions

- **Scan Matching**
  - Stringing together small offsets
  - Each error affects all successive positions

- **But:**
  - The offset can be significantly larger, and therefore a smaller number of scans is required (reference scans)
  - Using a map, the errors can be corrected when returning to a known area
Map Building & Self-Localization

- insertion of predecessor into map
- selection of reference scan
- determination of shift
- position correction & error distribution
- distribute rotational error
- distribute translational error

Priorities:
- old
- large projection
- close
Distributing the Errors

Correction of Rotation

Correction of Translation
Example 1

- **Scans**
  - Recorded: 9403
  - Processed: 4208
  - Stored: 122

50 m
Example 2 – Environment

- Building: MZH
Example 2 – Environment

- Building: NW 2
Example 2 – Environment

- Buildings: IW + BIBA
Example 2 – Environment

- Building: MZH
- Total Length: 2176 m
Example 2 – Odometry
Example 2 – Laser Scan Map
Laser Scans & Glass
Conclusion & Outlook

- **Scan Matching with Histograms**
  - Projection Filter
  - Line Segmentation
  - Correlation of Histograms with different Resolutions
- **Map Building**
  - In Real-Time (at 84 cm/s)
  - Automatic Selection of the required Scans
  - Distribution of Errors
- **Outlook**
  - Tests in Populated Environments
  - More Robust Line Segmentation
  - Probabilistic Approaches