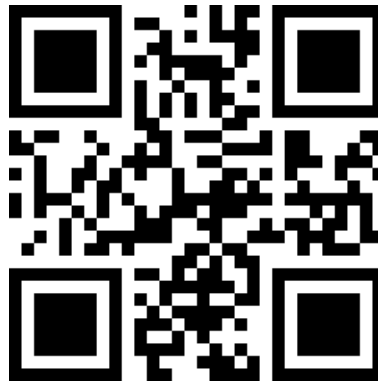


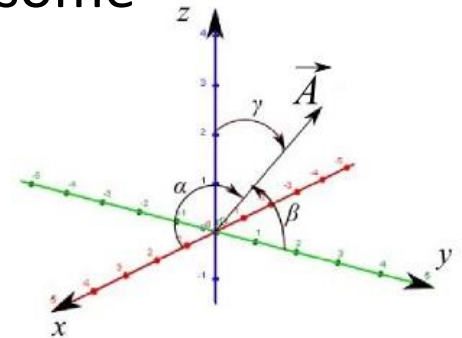
NaviCode

Symbology Designed for AGV Navigation



Essential Aspects for Navigation

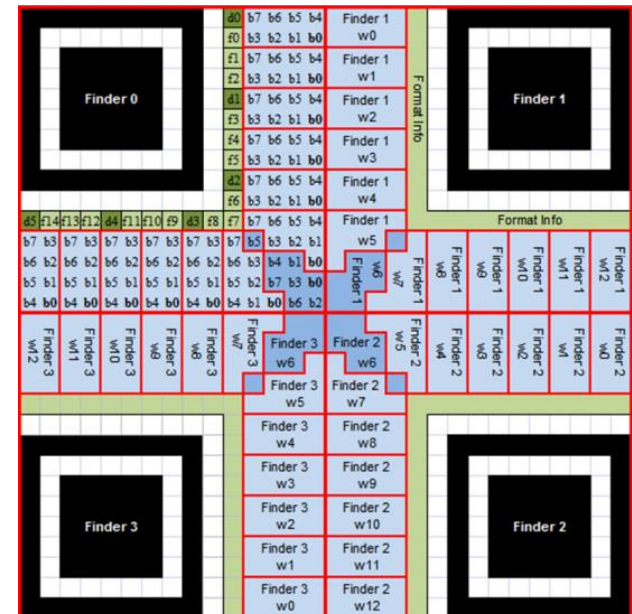
- For navigation, 3D gesture info is necessary for motion control
 - Including 3 angles & a reference point (ref. Appendix A.)
- To achieve effective navigation while moving, some measuring quality to be ensured:
 - **Precision**
 - **Speed**
 - **Robustness**
- *NaviCode* provides a specifically designed symbology structure to make sure these navigation info can be retrieved more fast, accurately, and reliably than other counterparts.



Features

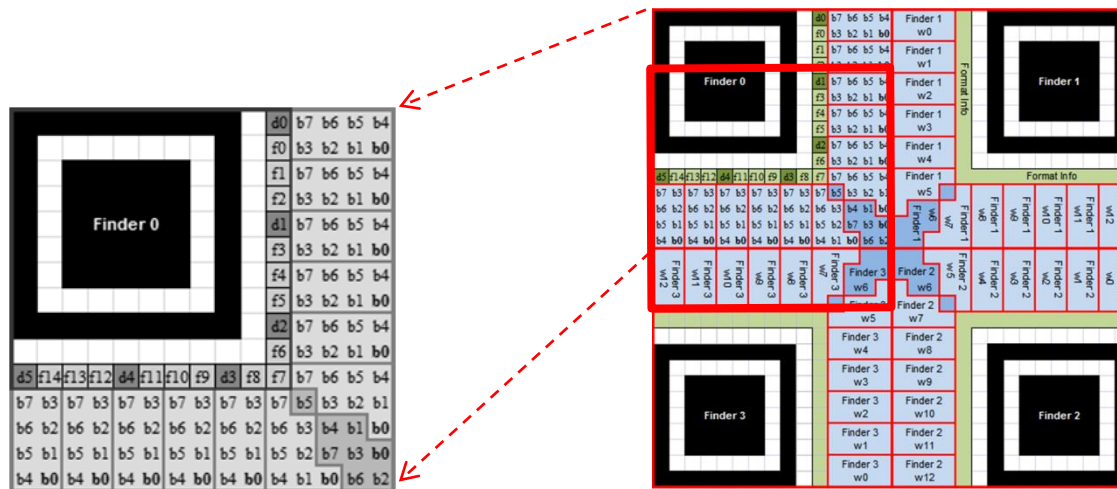
To support effective navigation, **NaviCode** features :

- Fully symmetric symbology
- High error-correction capability
- 4-bulleye symbology
- Better bulleye-kernel width ratio
- Data security



Fully Symmetric Symbology

- **Fast localization:** one eye registered, all eyes registered;
- Inter-block symmetry & Intra-block symmetry, for **fast data/format info retrieval;**
- 4 fully symmetric data module areas are designed to **accelerate decoding process and enhance robustness;**
- No any existing 2D symbology are fully symmetric.



High Error-Correction Capability

- Up to **44-byte data** for navigation info;
- Data region is protected by **Reed-Solomon codes w/ ECC capability up to 46%**; format info by BCH(15,5) code;
- Flat symbol sizes w/ 8 data capacity options.

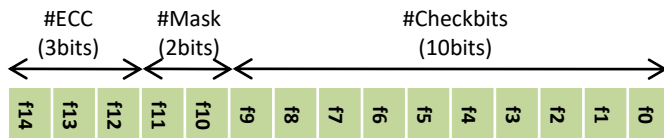


Figure. BCH code(15,5) for #ECC/#Mask information

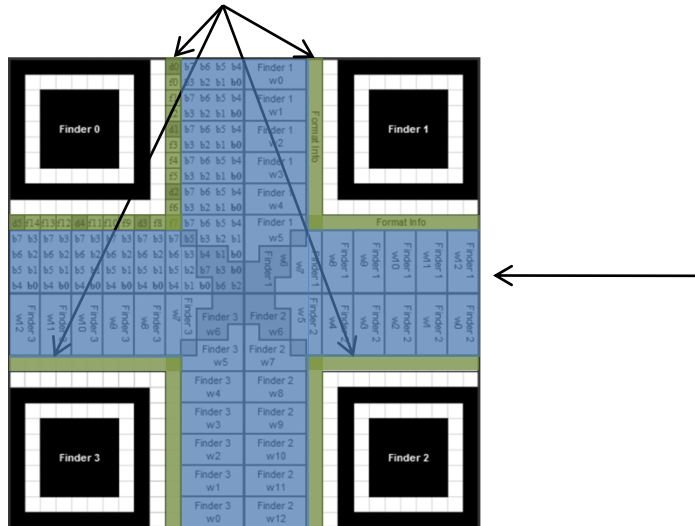


Table. Reed-Solomon Error Correction Levels and Data Capacity

ECC Level	#Data (bytes)	#Ecc (bytes)	#Codeword (bytes)	RS (c, k, r)	Max Correction
0	44	8	52	(52,44, 4)	8%
1	40	12	52	(52,40, 6)	12%
2	36	16	52	(52,36, 8)	15%
3	32	20	52	(52,32,10)	19%
4	26	26	52	(52,26,13)	25%
5	20	32	52	(52,20,16)	31%
6	12	40	52	(52,12,20)	38%
7	4	48	52	(52, 4,24)	46%

4-Bulleye Symbology

- 4 uniquely identified bulleyes to provide **higher precision** of navigation info, specifically, *NaviCode* symbol's **position & camera's inclination angles & orientation angle**;
- **Robust** to loss of part of symbols & to corrupted eyes;

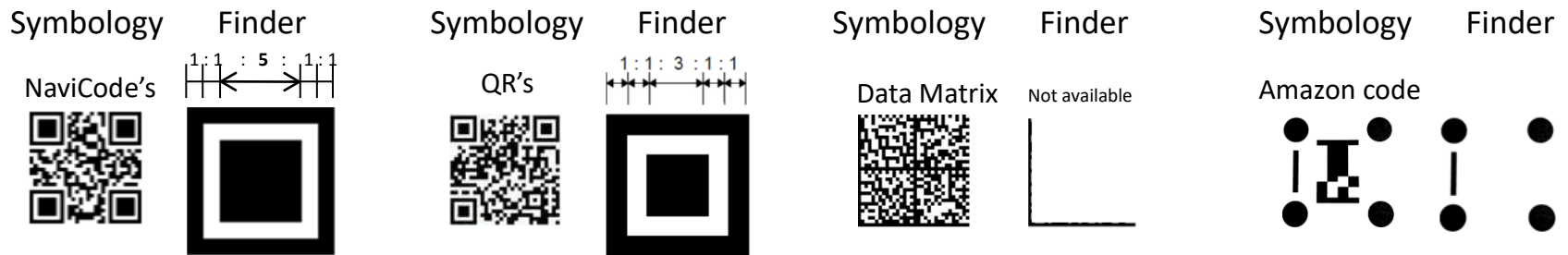
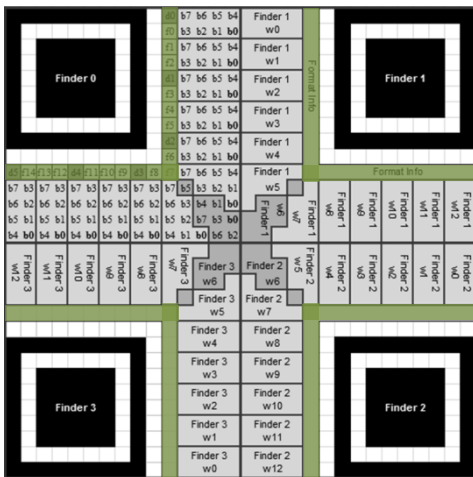


Figure. Popular symbologies for navigation applications

Data Security

- Incompatible w/ any existing 2D codes;
- **Higher error correction ability** to enhance robustness (as high as ~46%, comparing to that of QR/DM ~30% and of Amazon code ~0%);
- 4 copies of ECC protected format info to support, in worst case, single bull eye decoding;
- **Data encryption** with user-specified keys.



Four copies of format info

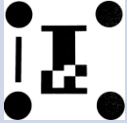





NaviCode decodable worse-case



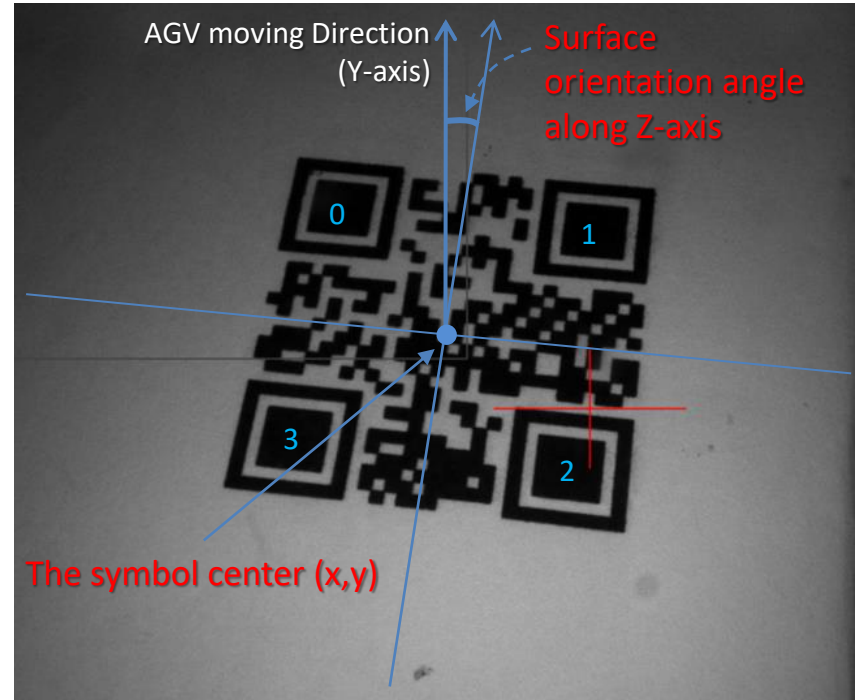
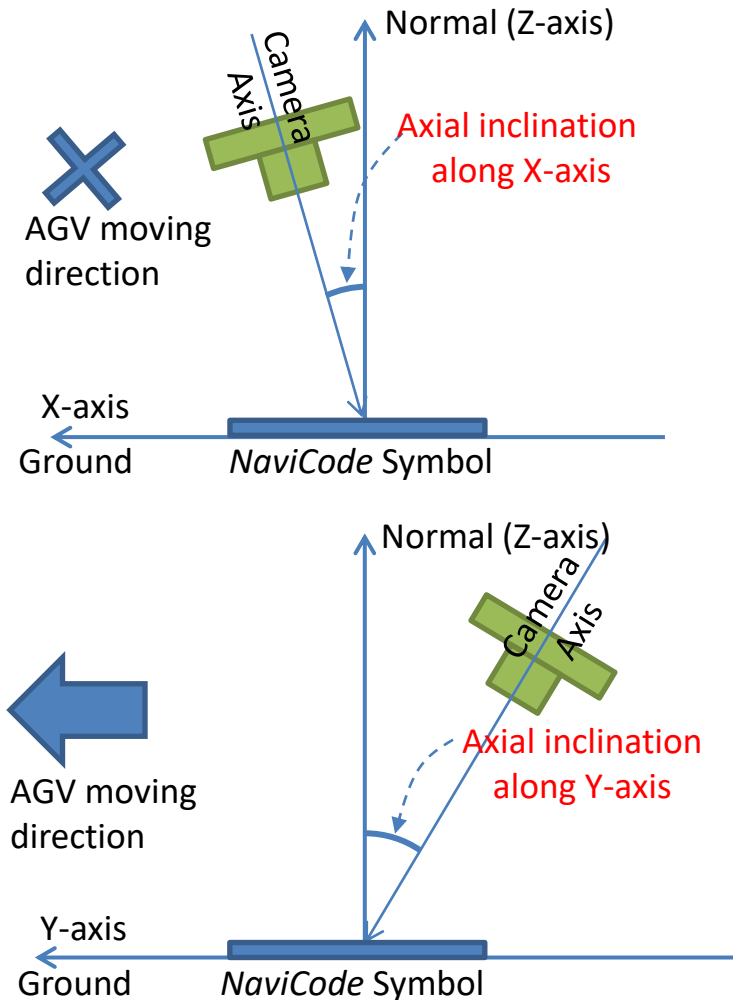
QR decodable worse-case

Comparisons among common 2D codes, Amazon Code and NaviCode for Navigation

	Amazon AGV code	QR Code (v. 3)	Data Matrix (32x32)	NaviCode
Symbologies				
Data contents	3.5 bytes ✓	70 bytes ✓✓✓✓	60 bytes ✓✓✓✓	44 bytes ✓✓✓
ECC capability & data security	0% ✓	30% ✓✓✓	30% ✓✓✓	46% ✓✓✓✓
Easy to locate	✓✓✓	✓✓✓	✓✓	✓✓✓✓
Reading speed	✓✓✓✓	✓✓✓	✓✓	✓✓✓✓
Intrinsic precision for navigation info	✓✓	✓✓✓	✓✓	✓✓✓✓

Appendix A

Gesture Info – 3 Angles & a Reference Point



Evaluation kit – MIR8N

Dimension (mm) : 52 W x 66 L x 21.2 H

Field of view: 80° x 57° (W x L)

Illumination: white light LED x 6

Output Interface: 1.5m USB , VCOM or UART

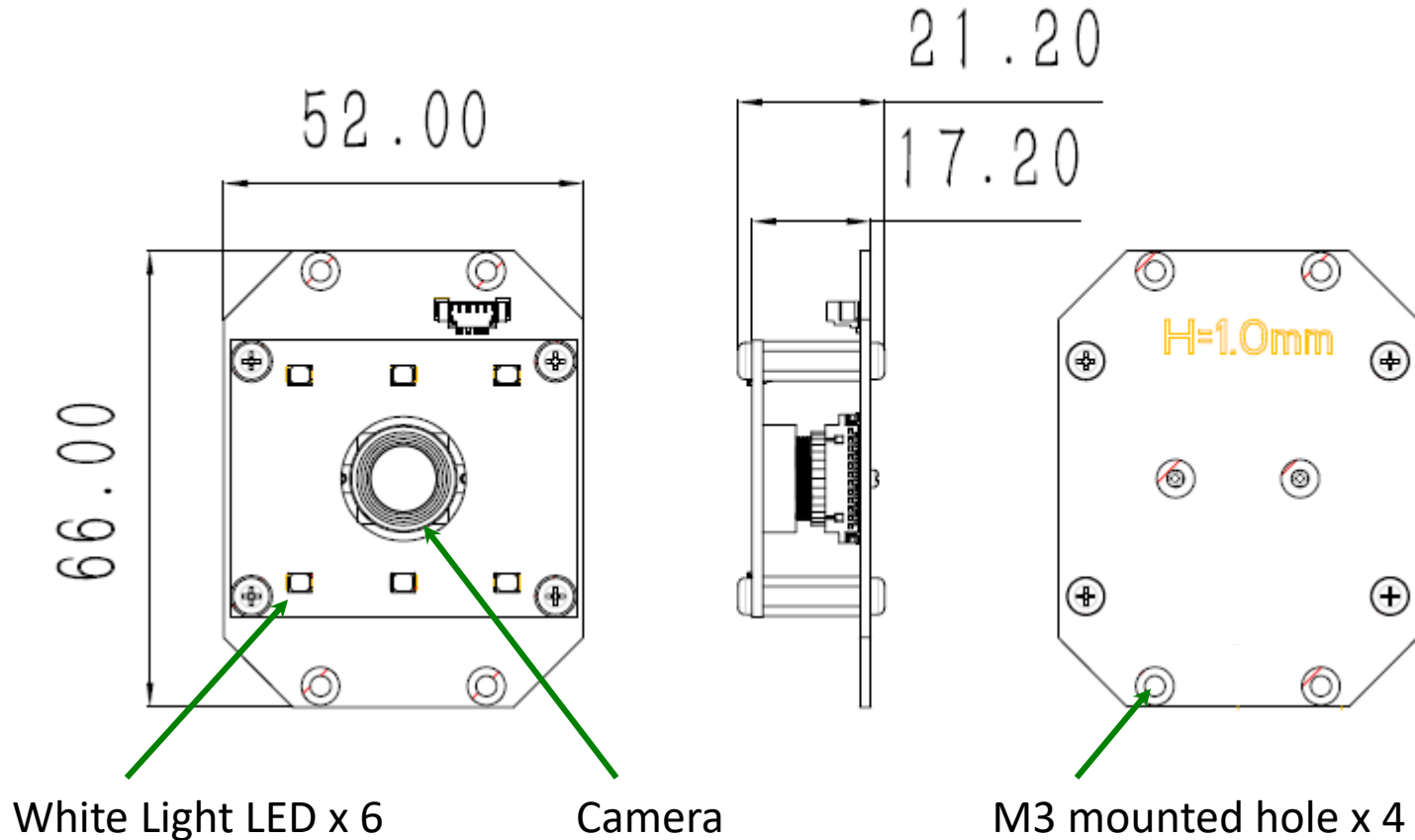
Power: 5V/0.5A

Command **SDK** and document



Evaluation kit – MIR8N

Dimension: mm



Evaluation kit – MIR8N

Field of view: $80^{\circ} \times 57^{\circ}$ (W x L)

