Dual Image QR Codes: The Best of Both Worlds
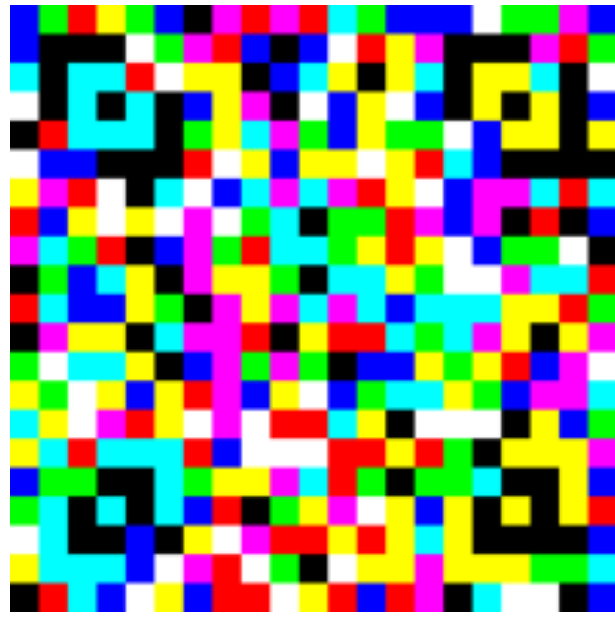
DICTA 2022

Chakrit Kammason, Yupaporn Wanna, Kannika Wiratchawa, Thanapong Intharah
Visual Intelligence Laboratory, Department of Statistics
Faculty of Science, Khon Kaen University
Khon Kaen, Thailand

Problems

- The Quick Response (QR) code was introduced in 1994 by Masahiro Hara
- Beautiful QR code can give visual hint but they can only store one set of data.
- Multi-layer QR codes can store more data but the patterns are random.
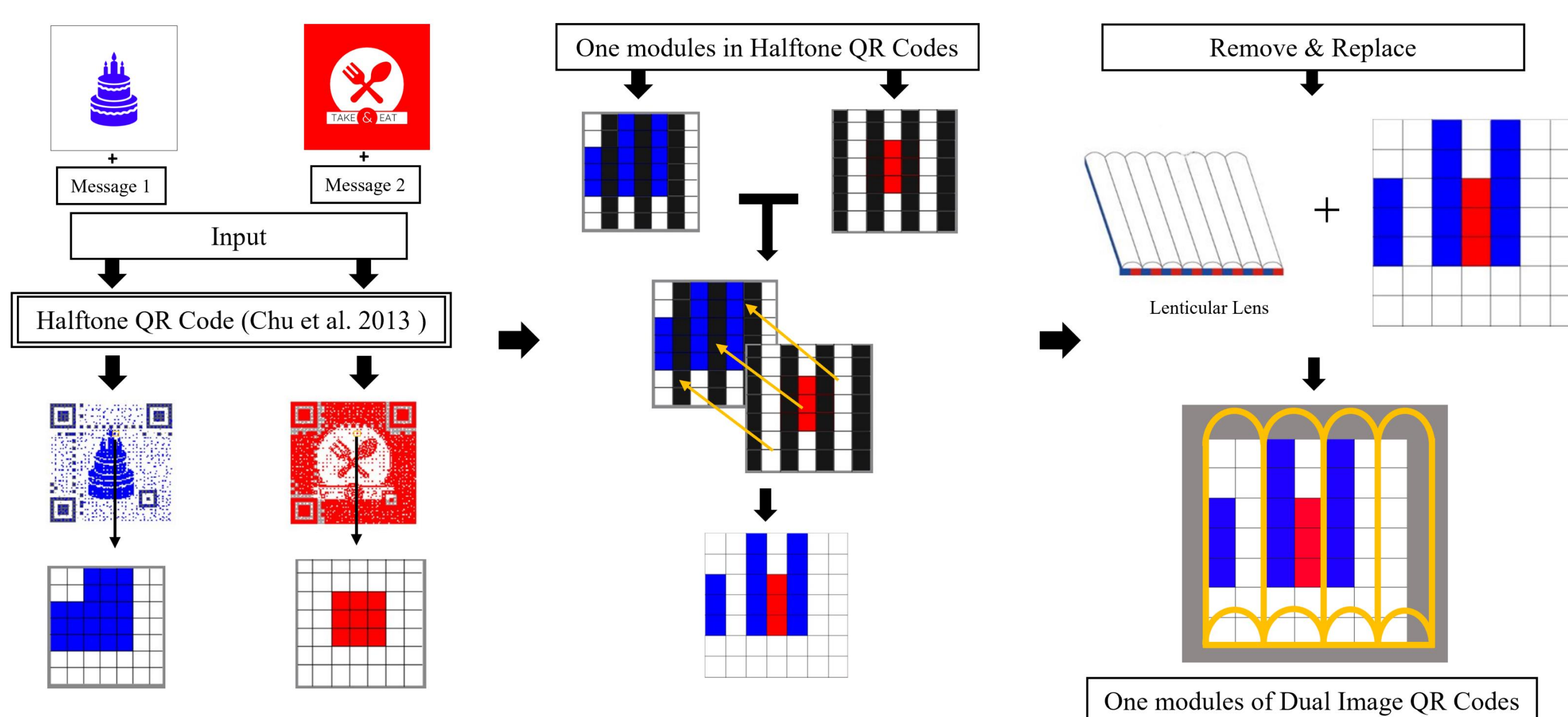

Multi-layer QR Code   Halftone QR Codes (Chu et al., 2003)

Dual Image QR Codes

- Use Halftone QR Code (Chu et al., 2003) to beautify the code.
- Use the lenticular image technical to fuse two images into one for increasing capacity of the QR code.
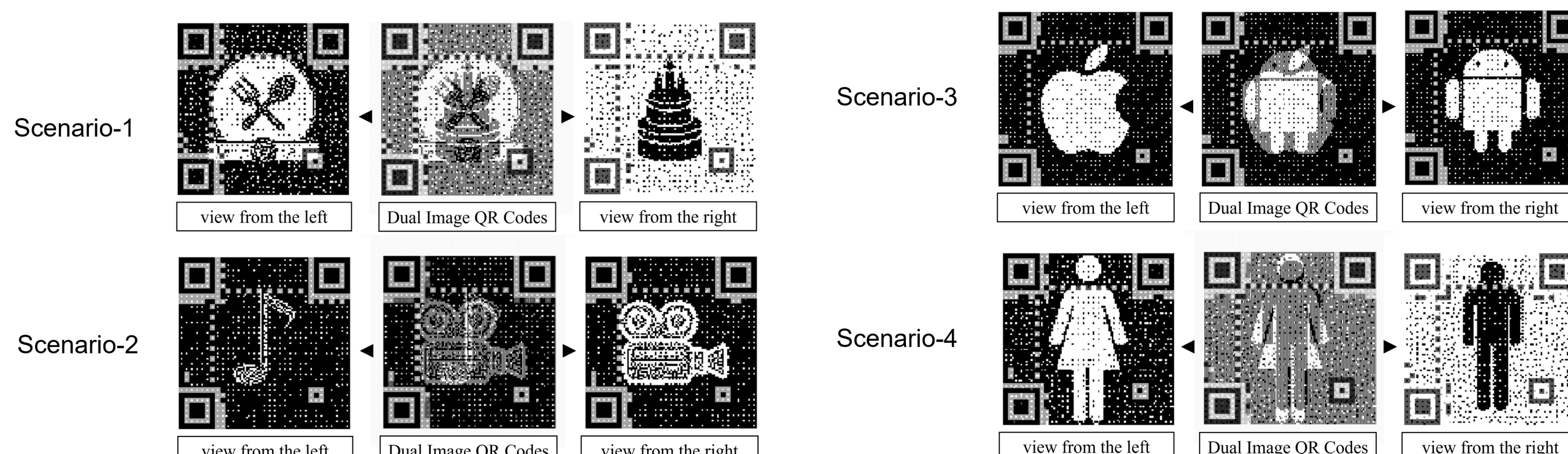
The generation steps are as follows

Visual Perception Test

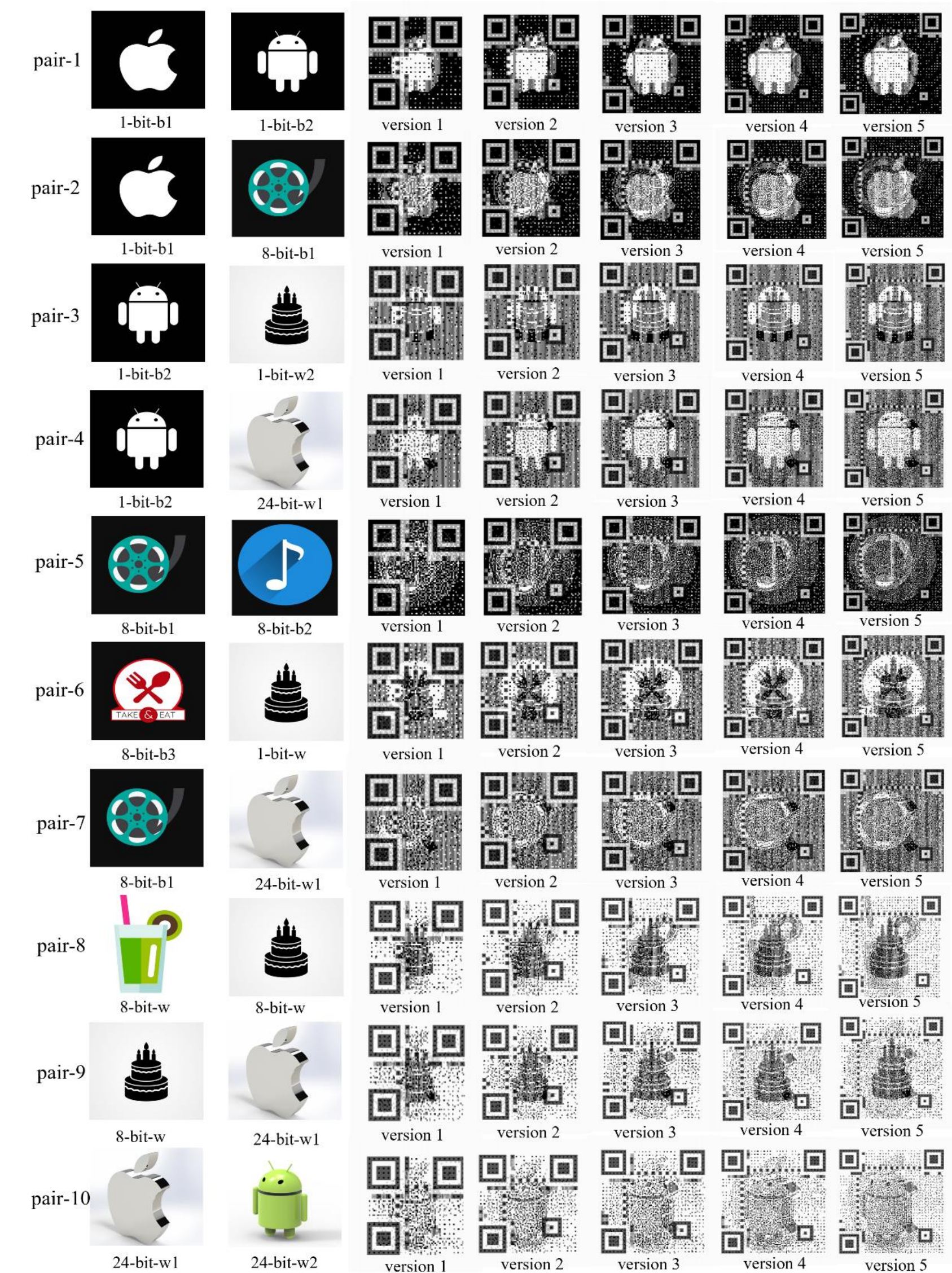We investigated the visual cue of the dual image QR codes with the 13 participants in four simulated scenarios

1) as a menu in the restaurant
2) as an entertainment platform promotional flyer
3) as a mobile app advertisement card
4) as an information signpost in a fashion shop

- The participants could easily describe images in scenarios-1, 3, and 4 correctly.
- The music note image in scenario-2 had low visual quality.
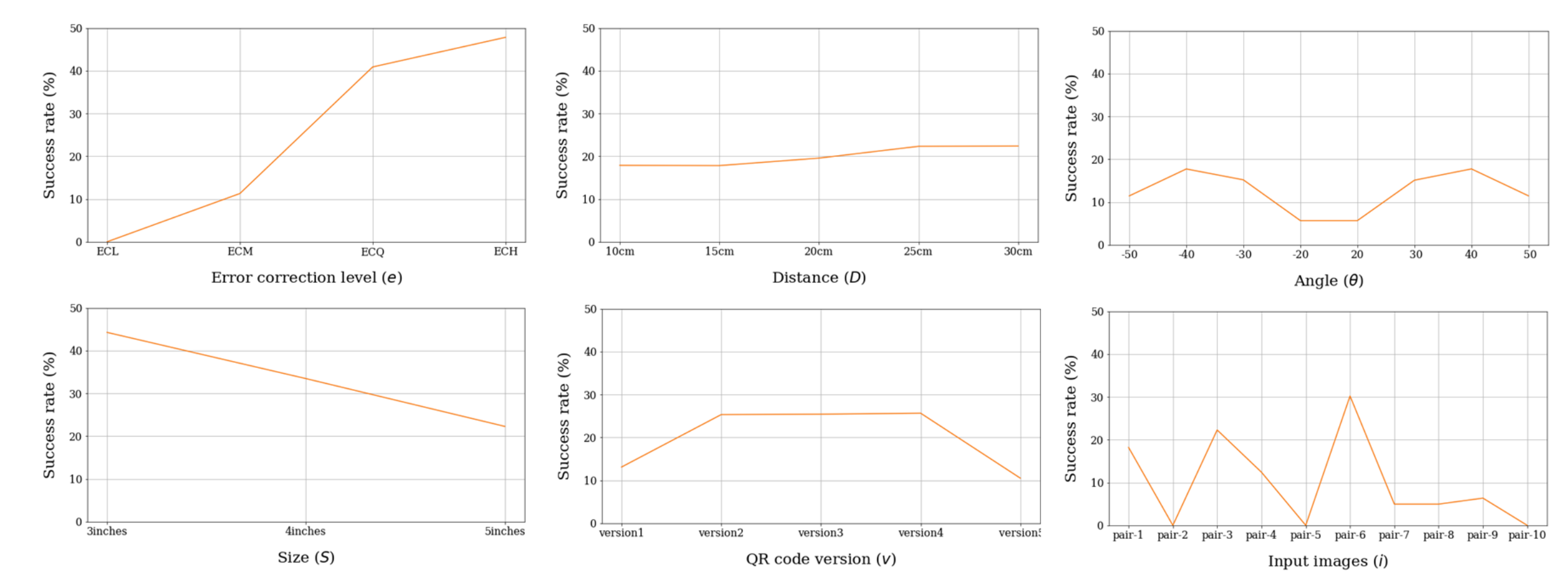- For the visual hinting, most of the participants correctly guessed the encrypted messages.

Robustness Test

- Dual image QR codes aim to improve both beauty and capacity aspects while preserving the ability to scan by standard QR code readers.
- We tested on 10 Dual Image QR Codes.

We evaluated 6 parameters which make 24,000 combinations and found 3,714 combinations that of 100% success rate.

Image	QR Code Version	Error correction Level
• 1-bit white background • 1-bit black background • 8-bit white background • 8-bit black background • 24-bit white background • 24-bit black background	• Version 1 • Version 2 • Version 3 • Version 4 • Version 5	• Low • Medium • Quartile • High

Size	Distance	Angles
• 3 inches (3x3 inches) • 4 inches (4x4 inches) • 5 inches (5x5 inches)	• 10 centimeter • 15 centimeter • 20 centimeter • 25 centimeter • 30 centimeter	• -20° left or 20° right • -30° left or 30° right • -40° left or 40° right • -50° left or 50° right

Error correction level (e)	ECH 47%		ECQ 39%		ECM 12%
QR code version (v)	version4 26%	version3 24%	version2 23%	version1 14%	version5 11%
Input images (i)	pair-6 32%	pair-3 24%	pair-1 20%	pair-4 9%	pair-7 pair-8 pair-9 4% 4% 4%
Distance (D)	30cm 26%	25cm 24%	20cm 23%	10cm 14%	15cm 11%
Angles (θ)	40 17%	-40 17%	-30 15%	30 14%	50 -50 -20 20 11% 11% 5% 5%
Size (S)	3inches 44%		4inches 33%		5inches 22%