Electronic Tile for Decorating Walls and 3D Surfaces

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Keywords: e-Paper, e-Tile, wall, architecture, digital signage

ABSTRACT

Application field of Electronic Paper is now expected to expand from document displays to wall decoration and ornaments for interior/exterior. We have proposed and developed e-Tile for this kind of extended applications. A prototype of large panel model was realized by arraying e-Tile on a flat plane. Prototypes of cubic displays were also realized by constructing e-Tiles to cubic shape. Artistic display effects and 3D impression could be found in these prototypes. We hope e-Tile is a promising solution to extend the application field of e-Paper to decorative used including architectural applications.

1 Introduction

Application field of Electronic Paper is now expected to expand from document displays to wall decoration and ornaments for interior/exterior. We have been proposing and developing e-Tile for this kind of extended applications.

Figure 1 shows mapping of applications for reflective displays including e-Paper. Promising new market is expected for reflective displays especially in “large” and “public” region of this map. Because, reflective displays have advantages of energy saving and visibility under sunlight. We hope not too vivid expressions by reflective displays are ideal for keeping cityscape favorable.

Figure 2 shows concept of reflective e-Tile (Electronic Tile) and its prototype[1)-4)]. Simple display units of e-Tile, which typically consists of 100 pixels in a 100 mm x100 mm square board, enable easy construction of large wall display. Any size of large display area can be realized simply by arraying the necessary number of e-Tiles.

2 Power saving characteristics of e-Tile

Table 1 shows the specifications of the prototype e-Tile, and Fig. 3 shows the basic configuration of the e-Tile display system. One base panel accepts 25 piece of e-tiles and supply image signals received from the controller to the e-Tiles. With this display system, the power when rewriting 25 electronic tiles per second was measured to be 0.76 watts. The wattage of e-Tile was calculated to be 3 watts/m^2 when rewriting every second, since 25 pieces of e-Tiles offer display area of 0.25 m^2.

By the way, electrophoretic display method used in our e-Tile can maintain images with no power. This means that, when rewriting every minutes for instance, power saving operation with 1 second ON time and 59 seconds All-OFF time is available. This way of operation can minimize power consumption of e-Tile display system.

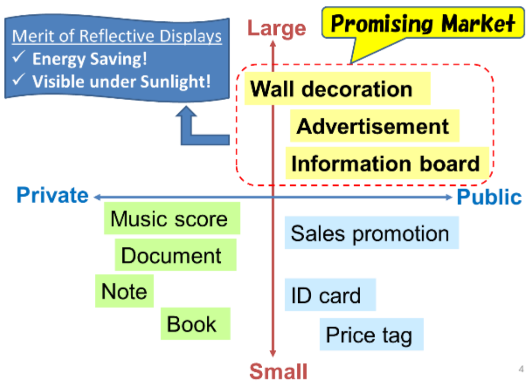


Fig. 1 Applications of reflective displays including e-Paper.

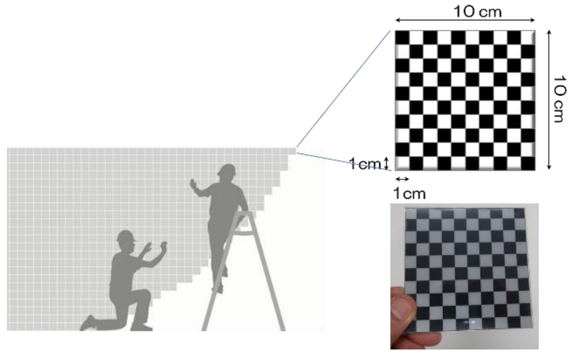


Fig. 2 Concept of e-Tile and its Prototype (10 cm square).

Table 1 Specifications of prototype e-Tile.

Item		Specs
Display method		Electrophoretic display
Dimensions		100 mm x 100 mm x 5.5 mm (42 g)
Pixel size		10 mm x 10 mm
Number of pixels		100 pixels / tile
Reflectance		36.6% (white), 3.5% (black) for D65
Contrast ratio		10.5 (white / black)
Image expression		Binary black and white
Driving method		Segmented driving
Base panel	size	500 mm x 500 mm (900 g)
	capacity	25 tiles

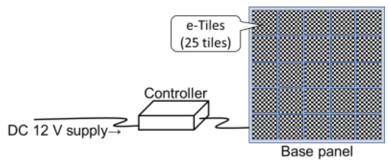


Fig. 3 Display system of e-Tile used for measuring power consumption.

Figure 4 shows the relationship between the rewriting cycle and the power consumption when the all-off state is adopted between the rewriting sequences of 1 second.

Table 2 shows estimated power consumption of e-Tile and other major display methods fit for digital signage. This table also shows the estimation results of CO_2 emission. The energy saving of e-Tile is remarkable, and CO_2 emission is naturally extremely low. This power saving characteristics of e-Tile also suggests the ability of continuing to present evacuation information by using solar cells or small batteries even in the event of a power outage by disasters.

3 Prototyping of e-Tile panels

A prototype of large panel model was realized by arraying e-Tile on a flat plane. Figure 5 shows a prototype of 1 m square panel constructed with 100 piece of e-Tiles[5]. Prototypes of cubic displays were also realized by constructing e-Tiles to cubic shape. Figure 6 shows a prototype of 30 cm cubic display constructed with 25 piece of e-Tile. Figure 7 shows prototypes of 10 cm cubic displays constructed with 5 piece of e-Tiles for each cube. Artistic display effects and 3D impression could be found in these prototypes.

4 Conclusions

1） Remarkably low power consumption of e-Tile was confirmed by measured values.

2） Prototype of 1 m square panel formed with 100 e-Tiles were demonstrated.

3） Prototypes of 30 cm and 10 cm cubic displays were demonstrated as an expanding application of e-Tile.

We hope e-Tile is a promising solution to extend the application field of e-Paper to decorative use including architectural applications. Our results show that e-Tile can be expected as the third alternative for large area display system, after LED and LCD, as a power saving and modest expression reflective medium. We are now preparing 2 m square panel constructed with 400 piece of e-Tiles for demonstrating applicability as wall displays.

References

[1] Makoto Omodani, Shoki Ishi, Yuma Adachi, “Concept of e-Tile and its Prototyping”, SID 2018 Digest, pp.1601-1603 (2018).

[2] Makoto Omodani, Yuma Adachi, Hirohito Shibata, “Prototyping of e-Tile”, Proceeding of IDW ’18, pp. 1248-1251(2018).

[3] Makoto Omodani, Taiga Masuyama, Hirohito Shibata, “Prototyping of Practical e-Tile and Estimation of its Image Impression from Distant Observers”, SID 2020 Digest, pp. 726-729 (2020).

[4] Taiga Masuyama, Makoto Omodani, “Prototyping of Practical e-Tile and Evaluations of Joint Gap Area Effect”, Proceeding of IDW ’20, pp. 757-760(2020).

[5] Makoto Omodani, Hiroyuki Yaguchi, “Concept of e-Tile for Wall Decorations and its Prototyping”, Proceeding of ICFPE 2021, 2Rm104-08-01(2021).

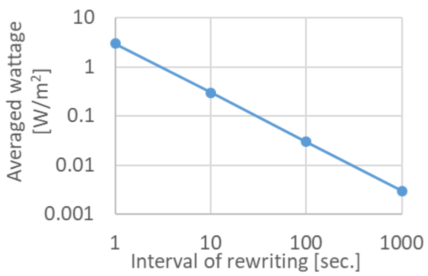


Fig. 4 Averaged wattage of e-Tile per 1 m^2 area when all-OFF state is inserted between rewriting timing.

Table 2 Power consumption and CO_2 emission of displays.

(per 1 m^2 display area)

Display methods		Wattage	Power consumption[1]	Expense[2]	CO_2 Emission[3]
		W/m^2	kWh/m^2	$ /year	kg/year
LED[4]		600	2,600	650	1,300
LCD[5]		500	2,200	540	1,100
e-Tile	Rewriting every sec.	3	13	3	6
	Rewriting every min.	0.05	0.2	0.05	0.1

1) Supposed operation: 12 hours×365 days
2) Supposing 27 Yen/kWh (110 Yen/dollar)
3) Supposing 0.5 kg/kWh
4) Calculated from a typical LED: NEC LED-SD100AB（96 cm Square）：540 Watt
5) Calculated from a typical LCD: SONY GXD-L52H1（52 inch）：380 Watt

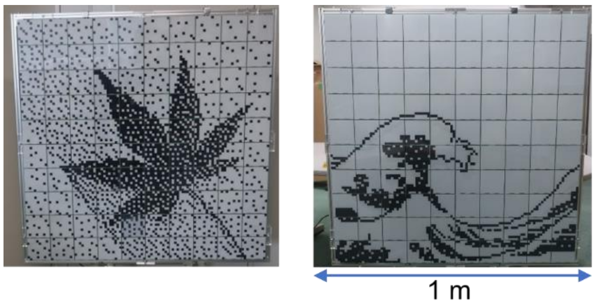
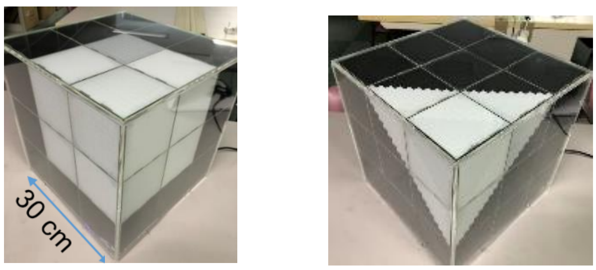
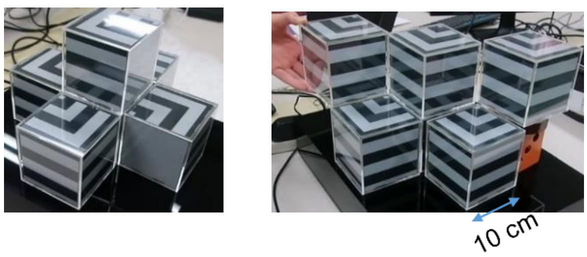


Fig. 5 Prototype of 1 m square panel formed with 100 e-Tiles.



(a) Floating white cube (b) Floating trigonal pyramid

Fig. 6 30 cm cubic display formed with 25 e-Tiles.



(a) Masonry blocks (b) Bumpy wall

Fig. 7 10 cm cubic display formed with 5 e-Tiles for each cube.