Requirement Analysis and Extending CSS3 Specification for Polar Coordinate Text Layout in Web Documents

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***Abstract*— This study extends the Cascading Style Sheet (CSS) specification in order to place the text along circles or circular sectors in web documents with CSS3 stylesheet. We propose a fan-shaped layout model and define the text layout specifications that are not in the conventional Cartesian coordinates system but in the polar coordinate system, and checked the conformity of the proposed extension specification by implementing the preprocessor that allows checking out the sample contents created by the extended CSS3 specification in the existing web browser.**

Keywords-polar-coordinate; text layout; fan model; HTML; CSS3 stylesheet.

I. INTRODUCTION

With the recent introduction of various devices with round displays, the need for circular text arrangement is increasing. Furthermore, with the advent of the age of big data, the demand of circular arrangement of information is on the rise as the data visualization field is getting attention. Also, we often see examples of text arranged in a circle or curve on logos, posters and publications in everyday life.

However, the existing web standards such as Cascading Style Sheet (CSS) and Scalable Vector Graphics (SVG), which are based on Cartesian coordinate system, are very inconvenient when placing polar-coordinate system text, since you have to separate all the letters from the text and set the coordinates of the individual letters in order to place it. Thus, a concise and standardized approach is needed to handle various cases of polar-coordinate text layout.

There was a study how to determine automatic character arrangement and orientation when placing text vertically in the existing CSS specification which became the standard module of CSS3 writing-mode [1]. New CSS3 modules of round displayed text for circular display devices [2] and 3D stereoscopic contents [3] were proposed, but the layout concept was not generalized to place any text in polar-coordinated space.

We analyzed related works in Section 2, and case studies and user requirements in Section 3. Then, we proposed a fan model and extend the CSS3 specification for the various types of text layout in polar coordinate system in Section 4. In Section 5, we checked the feasibility of the extended specification by implementing a preprocessor in the existing web browser. And we described the conclusions in Section 6.

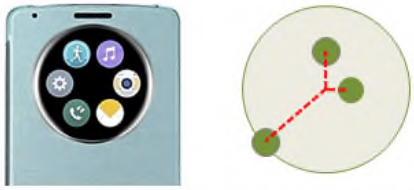
II. RELATED WORK

In the previous CSS standard, Elika J. Etemad researched an automated arrangement and orientation method for situations where there are multiple characters with different typesetting in a vertical layout [1], which became the standard module of CSS3 Writing-mode. This study shows how a CSS standard is designed: firstly, the text layout styles of different cultures are researched and the user's needs are analyzed; then the needed concept for text layout is modeled by referencing terms from the previous vertical layout; and finally, the CSS standard is expanded.

Furthermore, there is a study of expanding the CSS standard: CSS Extensions for a Round Display [2]. This study consists of multiple proposals for supporting web-based platform devices with circular display, such as a method to detect the circular screen and drawing an outline along the edge, a method to place the contents right inside of the edge, and a method to draw the outline without breaking while the contents is being rendered on the screen. As shown in Fig. 1, polar properties, such as polar-angle, polar-distance, and position, are extended, in order to use the polar coordinate for contents layout.

III. REQUIREMENT ANALYSIS OF POLAR COORDINATE TEXT LAYOUT

In order to design a standard for implementation of polar coordinate text layout on the web, various previous cases of layout were studied, then the user's need was analyzed.



```
<body style="position: polar;">
  <div id="circle1" style="polar-angle: 0deg; polar-distance: 20%"></div>
  <div id="circle2" style="polar-angle: 90deg; polar-distance: 50%"></div>
  <div id="circle3" style="polar-angle: 225deg; polar-distance: 100%"></div>
</body>
```

Figure 1. Examples of polar coordinate layout on the round display.

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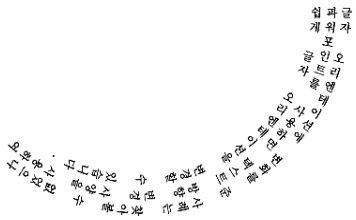
A. Case Studies of Polar Coordinate Text Layout

In the existing cases of polar coordinate text layout, there were some needs of paragraph layout, while most were a single line text layout. Fig. 2(a) shows a case of paragraph layout in polar coordinate.

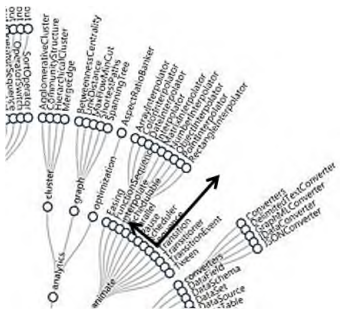
Furthermore, the direction of text layout appeared differently in polar coordinate. There were both cases where the sentences flowed in clockwise and counter-clockwise, and similar cases with inward and outward. Also, there were few cases where the character orientation was changed, instead of sentences or paragraphs, like shown in Fig. 2(b)

It turned out that a single line sentences were mostly in horizontal writing. However, in data visualizations or infographics, vertical writing was often applied to show a repeated list of data, despite the text being in a single line. Also, in vertical writing, sentences flow to inward or outward, while paragraphs were placed in clockwise or counter-clockwise direction. By contrast, in vertical writing, there were some cases of varying text orientation, as shown in Fig. 2(c), unlike in horizontal writing. .

(a) Cases of polar text paragraphs.



(b) Case of changing text orientations in horizontal writing



(c) Case of changing text orientation in vertical writing

Figure 2. Case studies of polar coordinate text layout

B. Requirement Analysis

As discussed above, in the practical cases of polar coordinate text layout, there are more varying cases than what is possible with the traditional layout. By analyzing the requirements for polar coordinate text layout, it turns out that these points have to be defined in order to place text in polar coordinate.

(1) Text Placement Area

A format model for the area in which the text block is to be placed in the polar coordinate system is needed. In the existing CSS Visual Formatting Model [4], the CSS box model is presented. However, in order to arrange text in the polar coordinate system, an area setting method for a fan-shaped layout model must be prepared.

(2) Sentence and Paragraph Layout

As a result of case studies indicated a high demand for placement of both individual sentences and paragraphs. Like the Cartesian coordinate system, the polar coordinate system requires two types of display: inline and block; see Fig. 3(a).

(3) Placing Text in Various Directions

In the Cartesian coordinate system, there are two types of sentence direction: right and left. In case of paragraph direction, horizontal text always flows from top to bottom, and vertical text flows from left to right. Directionality in the polar coordinate system is more variable and flexible than in the Cartesian coordinate system, and thus a new model is required for polar coordinate system text directionality; see Fig. 3(b).

(4) Placing Text in Vertical Writing

Compared to that of the Cartesian coordinate system, orientations in the polar coordinate system are more variable. According to the CSS3 Writing-mode module, in the Cartesian coordinate system, the sentence directions are either left to right or right to left, and the paragraph directions are always top to bottom for horizontal writing, and either left to right or right to left for vertical writing. Furthermore, the text orientation is limited to top, left, or right. However, in the polar coordinate system, the text could be flipped, or have a varying orientation depending on the degree within the coordinate. Therefore, orientation in the polar coordinate system is more complex than that of the Cartesian coordinate, thus text orientations should be modeled accordingly; see Fig. 3(c).

(5) Placing Text in Different Coordinate Systems in the Same Area

Since general documents assume the use of the Cartesian coordinate system, the polar coordinate system element is located in the Cartesian coordinate system. Conversely, in the case of Fig. 3(d), the Cartesian coordinate system is located within the polar coordinate system. As in this case, it is necessary to define a standard for element arrangement when the two coordinate systems are mixed.

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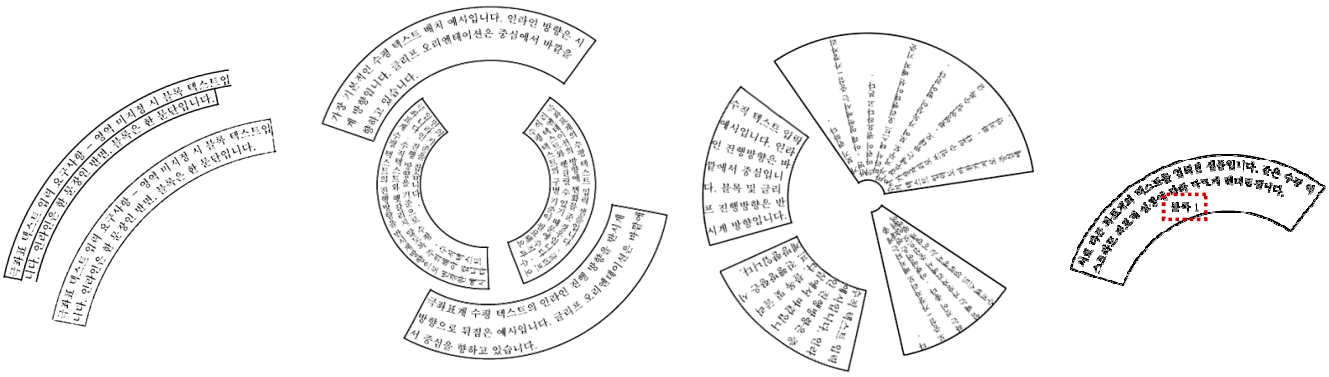

(a) Examples of paragraph layout (b) Examples of various directions (c) Text layout in vertical directions (d) Mixed coordinate system

Figure 3. Examples for requirement analysis

IV. EXTENDED CSS SPECIFICATION FOR POLAR-COORDINATE TEXT LAYOUT

In the existing CSS, all HTML elements are placed in a rectangular area, in a so-called the box model. In this paper, we propose a fan shaped layout model in polar-coordinate system as shown in Fig. 4, which is called a fan model. According to the CSS visual style model definition [4], the box layout following the CSS box model [5] is defined by box type, box area, position method etc. Likewise, we designed the fan model to be described with fan type, fan area, and position type.

The types of the fan model are divided into fan-block and fan-inline that correspond to block and inline elements of the box model. The positioning method uses the position attribute same as in the box model, because the fan model also specifies the element positioning within the Cartesian coordinate system. The difference is that the box area is placed based on its left-top corner, while the fan area is placed from a reference point, which is the center of the fan shape. Fig. 4 shows the detail attributes of the fan model.

The CSS3 writing-mode module has properties that describe the inline direction, the block direction, and the glyph orientation. While box model has left to right (ltr), right to left (rtl), and top to bottom (tb) directions, the fan model has directions of clockwise (cw), counter-clockwise (ccw), outward to inward (inward), and inward to outward (outward). Therefore, the horizontal writing and vertical writing in fan model can be described as in Fig. 5.

As shown in Table 1, the fan-shape layout specification is divided into three parts: fan model setting, direction setting, and typographic setting, where the prefix '-fan-' is used to distinguish extended attributes. The basic information for the fan model setting is display type, width, and height. The direction setting attributes include sentence direction, paragraph direction, and text orientation. The typographic setting attributes contain indentation, spacing, horizontal alignment and vertical alignment.

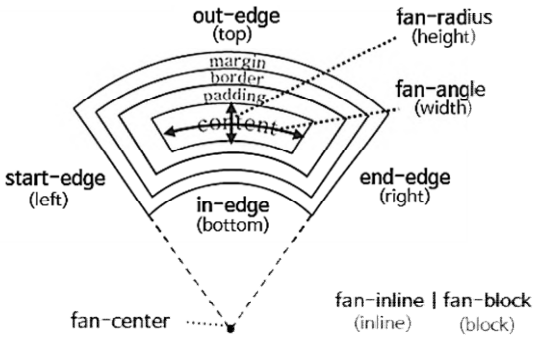

Figure 4. Definition of the fan model

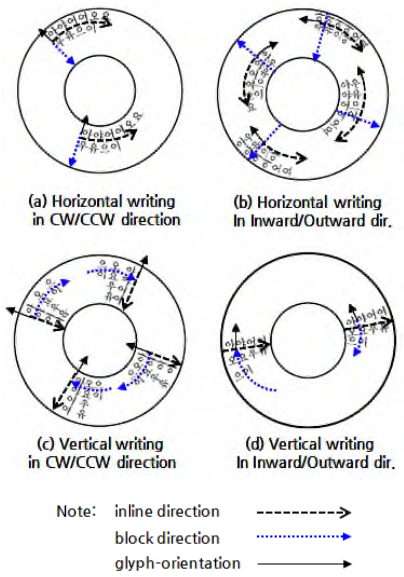

Figure 5. Definition of directions in polar coordinate system

TABLE 1: SPECIFICATION OF CSS3 FAN SHAPE LAYOUT

Category		Extended CSS Specifications
Fan Model Setting	display type	`display : -fan-inline | -fan-block`
	width	`-fan-angle : <angle> | auto`
	height	`-fan-radius : <number> | auto`
Direction Setting	sentence direction	`-fan-direction : cw | ccw | v-inward | v-outward`
	paragraph direction	`-fan-writing-mode : horizontal-auto | v-cw | v-ccw`
	text orientation direction	`-fan-text-orientation : upright | sideways-cw | sideways-ccw | sideways`
Typesetting Properties	indentation	`-fan-indent : <length>`
	alignment	`-fan-align : start-edge | end-edge | center`
	white-spacing	`-fan-white-space : normal | pre-wrap | pre-line`
	vertical-alignment	`-fan-vertical-align: <length> | <percentage> | baseline | sub | super | text-top | text-bottom`

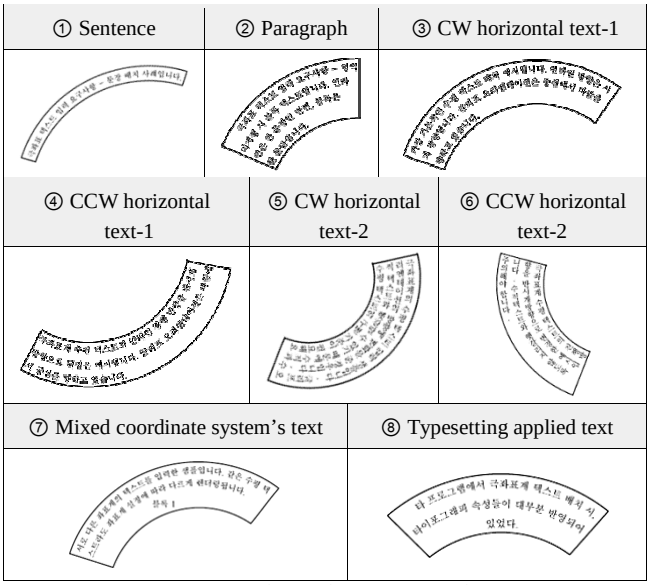

Figure 6. Sample text for the feasibility test of CSS3 extension

V. FEASIBILITY TEST

Since the proposed CSS3 extension is not working in the current web browser, we developed a preprocessor [6] to translate the extended CSS3 specification into the current CSS3 properties. Using the preprocessor, we evaluated the feasibility of the CSS3 fan model specification whether the extension can efficiently represent the polar-coordinate system text.

For the feasibility test, we developed PowerPoint sample contents that can cover the various cases of polar coordinated text layout as in Fig. 6. Then we compared the results from the code described with our CSS3 fan model with the results from the code using JavaScript library CssWarp.js [7]. From the results, we found out that the results from our CSS3 extension were the same as PowerPoint results, but some of them were not able to be represented with the CssWarp.js library(⑤⑥ in Fig. 6).

Also, we counted the number of tokens in the sample codes, and compared those written in CssWraps.js and CSS3 fan model. While the average number of codes in CssWraps was 78.0, the average in CSS3 fan model was 20.5 where the reduction rate is 26.3%. Therefore, we assessed that we could express the user requirements for polar-coordinate text layout well by using the CSS3 fan model specification proposed in this study.

VI. CONCLUSION AND FUTURE WORK

In this study, we proposed a CSS3 extension in order to place text in a polar-coordinate system in web documents expressed in HTML. This allows the text to be placed in a polar-coordinate system by only using the CSS3 stylesheet in the HTML standard documents. The proposed CSS3 fan model can place sentence and paragraphs, text in multiple directions, and vertical text in polar-coordinate system.

The future plan is to implement the extended CSS3 module as a Javascript library to be easily imported by general users, and to standardize it as a regular W3C CSS3 specification module so as to be implemented eventually within the existing web browsers.

ACKNOWLEDGMENT

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REFERENCES

[1] E. J. Etemad, "Robust vertical text layout," The 27th Internationalization & Unicode Conference, 2005, pp. 15-16.

[2] S. Han, H. Song, and J. Hong, "CSS Round Display Level 1," W3C WD 22, Dec. 2016. [Online] Available from: http://www.w3.org/TR/css-round-display-1/ (accessed 10 April 2018)

[3] S.B. Lim, H.J. Lee, W.Y. Jin, and S.M. Shim, "CSS3 extensions for setting web content in a 3D view volume and its stereoscopic 3D display," Computer Standards & Interfaces. vol.50, pp. 65–75, Feb. 2017.

[4] B. Bos, T. Celik, I. Hickson, and H. Lie, "Cascading Style Sheets Level 2 (CSS 2.1) Specification-9 Visual formatting model," W3C Recommendation, June 2011, [Online] Available from: http://www.w3.org/TR/CSS21/visuren.html (accessed 10 April 2018)

[5] B. Bos, "CSS basic box model," W3C Working Draft, 9 August 2007, [Online] Available from: http://www.w3.org/TR/css3-box/ (accessed 10 April 2018)

[6] S.M. Shim, "CSS3 Extension for Polar-Coordinate Text Layout and its Preprocessor,". Master Thesis. (in Korean) Sookmyung Women's University, Feb. 2016

[7] D. Weber, "CSSWARP, CSS Text to Path Generator," 2011 [Online] Available from: http://csswarp.eleqtriq.com/ (accessed 10 April 2018)