Interactive Spiral
A Radial Visualization for Mobile Devices

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ABSTRACT

We propose an interactive radial visualization of tabular data optimized for mobile devices. Our visualization employs a spiral layout, making it suitable for small handheld touchscreens. Users can view an overview of the data, search for specific data, and access details as needed. We hope this visualization technique will encourage users to interact with data rather than just looking at them passively.

Keywords: Well-ordered sets, Mobile Application Development.

Index Terms: Human-centered computing → Information visualization; Mobile devices; Touch screens

1 Introduction

We propose a spiral-based visualization that is suitable for mobile touchscreen devices. Our visualization presents only a subset of the data at any given time. Users can access more data by rotating the spiral. Our goal is to improve users' desire to interact with data.

The *Hundred Family Surnames* contains one hundred of the most common Chinese surnames. As we search on the internet, the surname data is often presented in a tabular format. The 10 by 10 table (Table 1) presents the most common surnames in China today.

1	王	2	李	3	张	4	刘	5	陈	6	杨	7	黄	8	赵	9	吴	10	周
11	徐	12	孙	13	马	14	朱	15	胡	16	郭	17	何	18	林	19	高	20	罗
21	郑	22	梁	23	谢	24	宋	25	唐	26	许	27	邓	28	韩	29	冯	30	曹
31	彭	32	曾	33	肖	34	田	35	董	36	潘	37	袁	38	蔡	39	蒋	40	余
41	于	42	杜	43	叶	44	程	45	魏	46	苏	47	吕	48	丁	49	任	50	卢
51	姚	52	沈	53	钟	54	姜	55	崔	56	谭	57	陆	58	范	59	汪	60	廖
61	石	62	金	63	韦	64	贾	65	夏	66	付	67	方	68	邹	69	熊	70	白
71	孟	72	秦	73	邱	74	侯	75	江	76	尹	77	薛	78	闫	79	段	80	雷
81	龙	82	黎	83	史	84	陶	85	贺	86	毛	87	郝	88	顾	89	龚	90	邵
91	万	92	覃	93	武	94	钱	95	戴	96	严	97	欧	98	莫	99	孔	100	向

Table 1

We have applied our spiral visualization model to the Chinese surnames to verify the model's usability, and with this app, we hope to present Chinese culture to the world. (Note: names in some other languages such as English will not apply to this model because they are elongated).

The remainder of this paper is organized as follows: First, we review some related work (Section 2) in the areas of radial visualization and mobile app development. Then, we discuss the interactive design (Section 3) of our visualization, followed by section 4, the algorithms we used for the spiral layout and animation. Finally, we present some suggestions for future work (Section 5) and our conclusions (Section 6).

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2 Theory

Our research combines two areas of work that historically have seen little overlap: radial visualization and mobile visualization.

2.1 Related Work

Information visualization researchers have traditionally focused their efforts on large visual displays. However, there has recently been increased attention on the need to bring information visualization to small-screen, daily-use mobile devices [1]. As such, Jin et al. [4] and Delai et al. [3] proposed visualizations designed natively for mobile platforms. However, their approach compromises the "overview first" aspect of the Visual Information-Seeking Mantra [2] in that they only display snapshots of the data at specific time intervals rather than the entire data set.

The first application of a spiral UI to mobile devices of which we are aware is SpiraList [5]. SpiraList employs a spiral widget to allow one-handed navigation of a user's contacts list on a touchscreen phone.

Although we could have rendered this data using a series of parallel straight lines, this would reduce our visualization to a simple table. We believe the radial approach is more visually appealing and will thus entice users to spend more time exploring the data.

3 Interactive Design

Figure 1

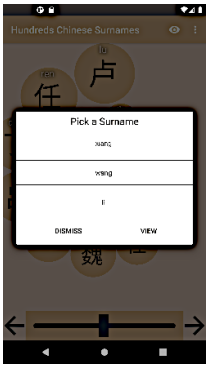

Figure 2

Figure 3

We chose a logarithmic spiral for our visualization. A logarithmic spiral grows exponentially with the radius. Therefore, the size of the icons increases gradually.

As a proof of concept of this spiral visualization scheme, we have implemented the *Hundred Chinese Surname*s mobile app. It is currently available on Google Play and Amazon Appstore.

3.1 Layout

The display is divided (Figure 1) into two areas. The largest is the spiral visualization itself. Just below the visualization is a slider with a knob (called a "thumb") that the user can drag left or right.

The spiral view is the main view. Each circular icon represents one surname. Approximately 60 surnames are presented at one time, but only about twenty are large enough to show the details;

these are the focus. The remaining icons are smaller in size and are placed close to the spiral center. They are presented for an overview.

3.2 "The Visual Information-Seeking Mantra" adapted to small screens

Although Shneiderman's "Visual Information-Seeking Mantra" [2] is still adhered to by most researchers in Information Visualization, Jin et al. argue that the "overview first" approach is simply not feasible with the small screens inherent to phones and tablets [4].

We likewise compromise on the "overview first" approach by only displaying a subset of all the surnames on-screen at any time rather than the entire set. However, our design does offer multiple ways to interact with the data, as explained in the following sections.

3.2.1 "Zoom and Filter"

Slider: Users can activate the motion by dragging the slider thumb in either direction. Dragging the slider thumb towards the left will rotate the spiral clockwise, causing the largest icons to slide away from the spiral at the top of the screen and each remaining icon in the spiral to increase slightly in size.

Buttons: Another way to activate the motion is by pressing the buttons located on either side of the spiral. Pressing the left button removes the largest icon from the visualization, thus rotating the spiral a few degrees clockwise.

Direct manipulation: Users can also activate the motion by "drawing circles" on the screen with their fingers. In this case, spiral motion is intuitive: sliding the finger clockwise causes a clockwise rotation in the spiral and vice versa.

Search by name: By tapping the "Search" button on the toolbar, the user can search for a specific surname by scrolling through a list of available names. (Figure 2). Once the user selects a surname, the spiral rotates to bring the selected surname into the outermost ring of the spiral.

3.2.2 "Details on Demand"

Users can tap on any on-screen icon to view the surname in a larger font (Figure 3). In addition, the app also displays a Wikipedia article about the surname. The user can also hear an audio recording of the surname. On the same screen, tapping the "famous people" button reveals a list of famous people with that surname, adding an extra layer of hierarchy to explore if desired.

4 Algorithm

Circles are positioned along a spiral line, with the diameters increasing gradually from the center. As the user adjusts the slider progress, the positions of the current on-screen surnames are updated accordingly. Below is a discussion of how we compute the spiral as well as the location and size of the surname icons.

4.1 Spiral Calculation

In the Cartesian coordinate system, the formula for drawing a logarithmic spiral can be represented by the equation:

$$x = a\cos(\theta)e^{b\theta} \quad y = a\sin(\theta)e^{b\theta}$$

To adapt different screen sizes:

- We initialize θ to approximately -5.73π radians and increase it just over 5.57π radians.
- For a, we use $w/10$, where w is the width of the screen in pixels.
- For b, we use the inverse tangent (cotangent) of 1.48π radians.

4.2 Size Calculation

To ensure all circles in between rings do not overlap, we use the gap distances between spiral rings as the factor for sizes of circles.

4.3 Position Calculation

We hold constant the radial distance between the circular icons on the spiral. As the radius increases, however, the same angular distance covers a larger linear distance (see Figure 4). Thus, the space allotted for each icon increases naturally as we move away from the center of the screen.

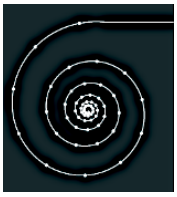

Figure 4

5 Future Work

We believe the visualization metaphor described in this paper can be readily applied to other forms of data. Possible applications could include:

- History of an organization, such as a business, university, or country
- The succession of heads of state (i.e., kings, presidents) of a country
- List of scientific discoveries in a given domain.
- An alternative representation of the periodic table of elements.

Since most mobile screens are rectangular, one possible area of future work would be to use an elliptical spiral, rather than a circular spiral, to make better use of available screen real estate.

6 Conclusion

In this paper, we have presented a technique for visualizing well-ordered sets on a handheld device. Previous work by Jin et al. [4] limited the number of on-screen icons to approximately 15 at a time. By rendering the data as a continuous stream rather than at discrete slices, our approach can accommodate many times this amount. Although the majority of the icons are admittedly too small to interact with, these provide useful context for the larger icons along the outer rings of the spiral.

In addition to *Hundred Chinese Surnames*, we have also implemented a few other mobile apps (*Temples Timeline* and *BYUH History*) as practical demonstrations of this visualization strategy. It is our hope that this model will enable more users to visualize and interact with their data on the computing platforms they use every day, that is, mobile devices. We also hope that our work will inspire visualization researchers to create many more mobile-first visualization systems for a variety of data sets and purposes.

References

[1] B. Lee, M. Brehmer, E. K. Choe, P. Isenberg, R. Langner and R. Dachselt, "Data Visualization on Mobile Devices," in ACM CHI, Montreal, 2018.

[2] B. Shneiderman, "The eyes have it: A task by data type taxonomy for information visualizations," in Proceedings of IEEE Symposium on Visual Languages, Denver, Colorado, 1996.

[3] I. Delai, M. Jin and G. Draper, "Visualizing Time-Variant Sets on a Handheld Device," in Proceedings of the 9th International Symposium on Visual Information Communication and Interaction (VINCI 2016), Dallas, Texas, 2016.

[4] M. Jin, I. Delai and G. M. Draper, "Visualizing Apostolic Succession," BYU Studies Quarterly, vol. 55, no. 2, pp. 115-126, 2016.

[5] S. Huot and E. Lecolinet, "SpiraList: A Compact Visualization Technique for One-Handed Interaction with Large Lists on Mobile Devices," in NordiCHI, Oslo, Norway, 2006.