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FLEXIBLE DISPLAY STATE RECOGNITION AND ICON DISPLAY

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ABSTRACT

Flexible displays like OLEDs, flexpads etc are emerging display technologies that enables beautiful and efficient displays and lighting panels. Owing to the advanced technology of flexible electronics, flexible touch screens have become a reality and could by widely deployed on various devices such as mobile phones, wearable devices, and hand-held tablets. Flexible displays uses plastic substrates and plastic electronics for the display backplane.

Flexible touch screens not only realize the concept of multi-foldable devices but also significantly change the user experiences due to its flexibility. In fact, electronic flexible displays are being used to make curved phones and televisions. This is possible because while the display may be "flexible", the internal components remain fixed.

1. INTRODUCTION

The demand for ubiquitous and easy-to-use displays as human interfaces is increasing. One of these interfaces are lightweight, flexible display that can be rolled up or folded. The technology growth in past few decades has made the flexible touch screens/displays much more mature. With the extensive effort devoted by various manufacturers, the flexibility and picture quality of flexible touch screens are improved extensively. It has also become apparent that the advent of flexible display systems will have a significant impact on the market, not only because of the ubiquitous and convenient systems that could be supported, but also because of the potential to provide unconventional visual effects that are not possible with conventional systems. Due to this technology, it might be possible to carry a large home display device simply by rolling it up for anyone. Figure 1 shows a recently launched Samsung phone that has flexible display.

Fig1. Samsung Infinity Flex Display

But, before the flexible touch screens gained its popularity, foldable devices usually consisted two or more individual rigid screens. For instance, Huitema et al. [1] proposed a flexible displays device composed of a discontinuous front plane and a continuous backplane. On the other hand, Sony also proposed a two-panel display foldable Tablet P. However, in recent years, due to the evolvement of flexible touch screens, the concept of building foldable mobile devices with a single flexible touch screen is proposed by many tablet manufacturers. However, few studies or user interface designs have considered the usage scenarios when flexible touch screens are folded.

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2. BACKGROUND

Flexible electronic paper (e-paper) based displays were the first flexible displays conceptualized and prototyped. It was developed in 1974's by "nicholas k sheridon" at Xerox palo alto research center[2] . Flexible electronic paper uses plastic substrates and plastic electronics for the display backplane. There is ongoing competition among manufacturers to provide full-color ability. An ideal e-paper display can be read in direct sunlight without the image appearing to fade. Though this form of flexible displays has a long history and was attempted by many companies, it is only recently that this technology began to see commercial implementations slated for mass production to be used in consumer electronic devices.

Khalilbeigi et al.[3] presented a novel device concept that features double-sided displays which can be folded using predefined hinges. However, the device is not flexible. Trying to develop a flexible device, Steimle et al.[4] proposed an interactive system called Flexpad that combines a depth camera and a projector to transform sheets of plain paper or foam into the flexible, highly deformable, and spatially aware handheld displays. Furthermore, the authors in [5] and [6] also used a projector to transform sheets of plain paper or foam to simulate the flexible devices. Nevertheless, the proposed devices are not real flexible devices.

To develop a real flexible device, Gallant et al. [7] presented a combination of a 3D GUI with windows imbued with the physics of paper and the Foldable Input Devices (FIDs), but the foldable input devices cannot display anything. Therefore, users cannot directly interact with foldable input devices. In addition, Tarun et al.[8] proposed Snaplet, a wearable flexible E Ink display augmented with sensors that allow the shape of the display to be detected. At the same year, Lahey et al.[9] present an evaluation of the effectiveness of various bend gestures in executing a set of tasks with a flexible display. In [8] and [9], the authors implemented their solutions on a flexible hand-held device with a real display. However, the above solutions have not solved the interactive problem for the display of the folded area.

Figure 1 shows a diagram of the layers in different types of displays. Samsung refers to their flexible OLED display as FAMOLED.

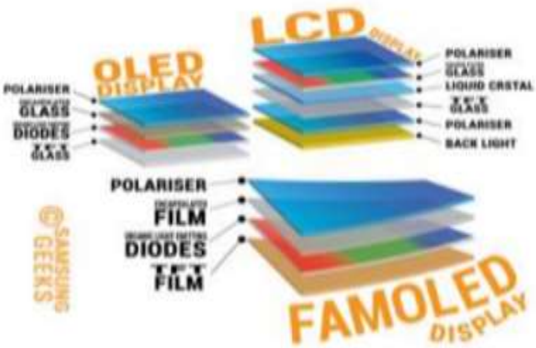

Fig 1. Layers in different displays

3. WORKING

The main idea behind the flexible display is to identify folding types by calculating the bending angles between two adjacent panels. The coordinate system is firstly defined for each section of the touchscreen, as shown in Figure 2. With the defined coordinate system, the angle between two adjacent panels can be denoted as $\theta 1 - \theta 2$.[10]

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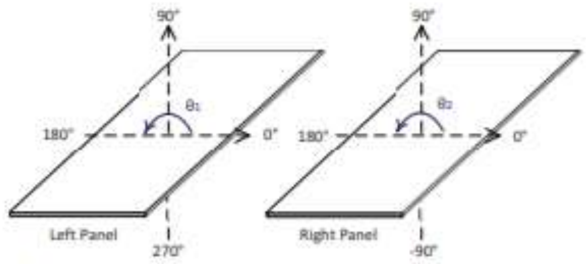

Fig.2 Co-ordinate system for panels

To enhance the interaction of user interface in a flexible display, the auto-adjusting icon interface is proposed to relocate icons or widgets on the bended area of the screen when the flexible display is folded by the user.

Figure 3 shows the flow for launching the interface. To improve user interaction with flexible displays, the proposed interface changes the displayed layout from default icon display to auto-adjusting icon interface display when user bends the flexible screen.[11]

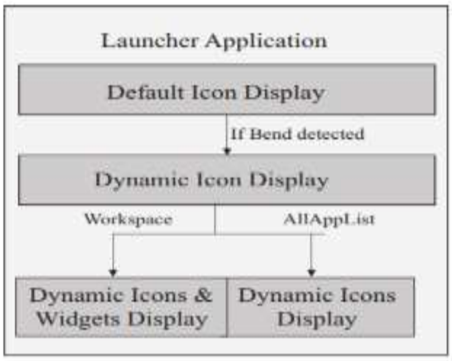

Fig3. User Interaction Flow

4. ADVANTAGES

Some benefits of flexible displays are better durability, lighter weight, thinner dimensions, and unique software commands.

The use of a plastic substrate and the ability to flex locally when dropped makes the device less likely to crack, saving the users the trouble of having their screen replaced or being forced to buy a new device.
Flexible devices will also be lighter and thinner than their rigid counterparts because they use plastic instead of glass.

The ability to deform the device may allow the user to access a set of commands in their devices user interface.

5. LIMITATIONS

There are still challenges to overcome before truly flexible devices hit the market, as the machinery behind the display is not meant to be bent. While plastic has its advantages, it is not as good as glass when it comes to encapsulating the thin-film transistor and other components from moisture, oxygen, and other unwanted particles. Phone technology need to become tough enough to handle the stress of daily flexing over an extended period of time. Another barrier of a flexible device is the battery. Batteries are typically rigid in nature and until these batteries can be manipulated to flex, the notion of a bendable phone is unlikely. Similar to the battery, the silicon circuit board and its components are also not malleable. Device manufacturers will have to find cost effective alternatives to these problems before these new gadgets hit the shelves.

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6. CONCLUSION

Researchers have found that this technology can provide mobility and easy of information flow. Flexible display seems to fit right into the mould for the future. Flexible electronic displays have the opportunity to revolutionize the industry. The flexible electronics in future will play a part in field of security, entertainment and may lead to innovative applications.

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