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The Advancement of Electronic Gadgets in 21st Century

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Abstract

The 21st Century was full of innovation when it came to the Tech Sector alone, be it the introduction of the Iphone, or the launch of the big conglomerates such as Facebook and Twitter. The 21st Century gave rise to the concepts of the Curved Displays on phones and the Foldable phones. There were numerous problems which were associated with the flat screen displays, and the shortcomings have been overcome by the Curved Displays and the Foldable phones as discussed in the paper. They have revolutionized the Technological market since their launch. Many Conglomerates such as Samsung, Honor, Xiaomi have invested millions of dollars in availing this new technology. However, currently Samsung has the lead over all its Chinese competitors, and with different companies investing in the new technology, the competition is predicted to become more intense. This will surely give customers a huge variety of phones to choose from. However, this technology did not come without its drawbacks. There were multiple issues associated with the Foldable Phones such as the weight associated with the phone when folded, the tensile strength of the Foldable phones is very low, and the User Interface is not something one could get excited about. Similar issues existed with Curved Displays as well, including costly repair costs, and it is harder to get a grip on compared to the Foldable phones due to the thinning of the edges. The paper discusses in depth the shortcomings of all the types of Phones, as well as which would be the best fit for the user, along with the current trend of the users, and what the Future holds for this segment of Technology.

Keywords: Curved Displays, Foldable Phones, Gorilla Glass, User Interface (UI), User Experience (UX), Operating System (OS), Organic Light Emitting Diode (OLED), Liquid Crystal Display (LCD)

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1. Introduction

As and when technology has advanced all around the world, it has only led to an increase in competition among the major conglomerates, which does offer customers a better choice to choose from. One of the recent trends in the technological sector was the introduction of Curved Displays on Mobile Phones, along with the foldable phones. The flat screen displays have been here for a very long time. The curved display on mobile phones was introduced in the past decade itself. Samsung was the first brand to introduce a curved display on smartphones. The Galaxy Note 6 was the first phone which had a curved display, and the Galaxy S6 was the first phone which had a curved display on both its edges. On the other hand, foldable phones were launched a few years ago. The whole concept of foldable phones looked very impractical, but now, we can experience the power of foldable phones. The flat screen phones which are used all over the world are made up of hard glass, or as everyone knows it more famously as gorilla glass. This type of glass will not bend at all. So, it is obvious that to make foldable phones, some other kind of material would be used for making the screen which would be flexible, and should not break into two pieces on repetitive opening and closing of screen. The first foldable phone was launched in 2018 by a startup from China known as Royale. The phone they launched into the market was known as Royole Flexpai. This company beat all the odds to become the first company to launch a foldable phone. This paper will contain numerous sections about the Flat screen phones, the Curved Displays as well as the Foldable phones. It will also give the reader an idea about which phone type will be the best according to his or her own needs. To overcome these pressing issues, some smartphone manufacturers have entered the field of curved displays.

2. Literature Survey

Below is a list of papers we have referred to during our paper. Jihhyeon Yi Et. Al ‘s work proposed to find how the display curvature and length of hand affects the smartphone's usability, which was assessed in terms of numerous factors. The paper arrived at the conclusion that the flat display phone had provided a better grip during calling as well as texting, and the overall satisfaction was higher as compared to that of the curved display smartphone. [1]

Ashish Kumar Mishra Et Al.’s work examines potential UX problems that could result from the development of foldable phones and other gadgets. It discusses the potential drawbacks that this technology might have on the user experience and specifies the expectations and requirements that must be satisfied in order to get over these obstacles. The research also examines if adopting foldable devices is truly required and whether users will ultimately gain from it. [2] Jihun Park Et. Al’s work focused on the various advances made in recent times towards flexible and wearable displays. The paper arrived at the conclusion that the introduced technologies will play a great role when it comes to the development of flexible displays. [3]

Yushin Lee Et. Al’s work focused on finding out the relationship between the screen curvature and subjective feelings in smartphone’s usage. The paper came to a conclusion that the ideal radius of curvature of screens is 8R. Results were found to be not statistically significant when the curvature was above 8R, and hence was discarded. [4] Yushin Lee Et. Al’s work focused on finding out how displays with different radii of curvatures affected users and their experiences. For this purpose, displays of four different radii of curvature were chosen and users evaluated them subjectively based on their feelings. These experiments revealed that 8R is an ideal radius to be used on curved displays and that most users felt most comfortable using the corresponding sample. [5]

Edzer Huitema’s work focuses on the different applications, along with alternatives and the current status of the world of technology for foldable phones. The paper gives a better understanding of foldable phones, and the different technologies it uses, as well as the different problems solved by it. [6]

Alam A Et. Al’s work focuses on the implementation of a fan-out packaging of CMOS dyes on an elastomeric substrate instead of using large ultra-thinned dyes. The paper found out that bending of large thinned dyes leads to degradation in performance. However, using a daisy-chain linked arrangement of smaller dyes solves the problem. The proposed system is more flexible and also more reliable thus improving performance. [7]

Ha MH Et. Al’s work discusses replacing the conventional colorless polyamide (CPI) films for ultra-thin glass (UTG) to be used as a cover window for the display. The paper guarantees that using CPI films does not guarantee the best experience as it tends to crease and reduce visibility. UTG on the other hand does not crease despite a bending radius of 1.5R and is reliable against cracks too. An optical clear adhesive (OCA) substrate is used to relieve the UTG of the bending stress to further increase bendability. [8]

Sun N Et. Al’s work reviews the working of flexible OLEDs under mechanical strain. Further, it also discusses the various hurdles that prevent the widespread use of flexible OLEDs along with potential use cases in the future. It starts by describing OLED technology and its methods of preparation. It also describes various substrates that can be used and their pros and cons. Further it also discusses the various parameters of OLEDs such as performance, emission spectrum, luminous spectrum and many more. [9]

Jang DH Et. Al’s work discusses an improvement to an alternate technology that can be used to replace the use of OCA for the bonding of the flexible OLED panel with the bending cover window. This improved model increased the strength and uniformity of the bending OLED display. The paper concludes that the lamination method using silicon improved on the OCA lamination but was still prone to degradation of the panel. The newly proposed hybrid silicone material is uniform and shows excellent results for compression strength tests without leading to any degradation in image quality. [10]

Ma L Et. Al’s work focuses on optimizing the wiring in the FOLED (flexible organic light emitting diode) conducting layer in the bending area. Due to the repeated bending, the wiring in this area tends to degrade faster than the wiring in other areas. It proposes changing the resin ply thickness and also using different routing schemes. [11]

Lee SM Et. Al’s work aims to investigate how a-IGZO TFTs perform electrically under mechanical stress. After conducting dynamic mechanical stress tests and TCAD Modelling scheme and experiment, degradation proportional to bending radius and bending direction is observed. From these experiments it was observed that TFT devices can be made more reliable. [12]

Chen Jt Et. Al’s work aims to design a novel green approach to create a glass substrate of optimum thickness through the use of a bonding and separation method to produce thin panels. The paper concluded that using the proposed method, a glass substrate of 0.1mm thickness is produced. This cannot be produced by conventional methods without lowering the quality. If implemented in factories and manufacturing plants, this method can save time, costs, and avoid pollution to significant extents. [13]

P. Boher Et. Al’s work focused on how factors such as radius of curvature and spot size affected display distortion in curved displays. The angles were measured using typical systems. The paper determined the effect the curved shape and out-of-focus issue of a screen has on the viewing angle measurements, either by using a standard goniometer or a Fourier optics viewing angle system. [14]

Sari Kujala Et. Al's work proposes that the method can serve as an uncomplicated tool for comprehending the reasons behind the enhancement or degradation of User Experience over time with product usage as well as their connection to customer loyalty. The paper concluded that the participants summarized the factors that had altered their relationship with the mobile phones. Qualitative and statistical analyses were conducted to view the relationships between the various trends observed. [15]

Hai-Wei Chen Et. Al's work mainly focuses on the heated topics LCD and OLED displays, which includes a systematic as well as a comparative study of the two display technologies. The paper conducted a succinct examination of the recent advancements in LCD and OLED Technologies, and both technologies have their own advantages and disadvantages. It is our belief that the rivalry between LCDs and OLEDs will continue for a long time. [16]

J Yi Et. Al's work focused on the influence the curvature of screen and hand size has on smartphone versatility in different tasks. It was observed that no single curvature of the screen was optimal for all smartphone usability measures considered. The paper also suggests that a combination of curvatures instead of a single screen curvature is needed to enhance the overall usability. [17]

S Lee Et. Al's work focused on creating ergonomic design principles for present-day rigid smartphones as well as upcoming devices with flexible displays, while also considering factors such as user-perceived grip comfort, personal preference etc. The paper found that the participants in the study preferred to unroll the rollable screen with a shorter pulling motion that resulted in higher muscle activation, over a longer pulling motion that involved less muscle activation. These results provide ergonomic design recommendations for both flexible and rigid devices. [18]

S Lee Et. Al's work aimed to explore design form factors for smartphones by examining the impact of hand size and device dimensions such as edge roundedness and thickness apart from the usual height and width. The paper concluded that the width of the phone played a major role in influencing grip comfort as well as design appeal. The dimensions helped in contributing to high comfort and design attractiveness. [19]

Ju-Te Chen's work presents a new approach for attaching and detaching the glass and carrier substrates which involves inserting gas between the substrates which helps in separating them. The method also effectively eliminates chances of formation of flaws in the edges of the glass substrates that might occur due to the detachment process. The paper came to a conclusion that the method used in the paper can be used for efficient detachment of the laminated glass substrate. [20] Kai Takeuchi Et Al.'s work aimed to gain a better understanding on the bonding and detachment mechanism of Silicon and glass. The paper observed that glass containing absorbed water molecules created gaps in the bonding and hence reduced the bond strength enabling easier detachment. [21]

Hsu Tsi-Hsuan Et Al.'s work aimed to develop the next generation AMOLED display technology to be used in the manufacture of foldable and curved edge displays. The paper emphasizes on the importance of low takt time and high accuracy for the mass production of narrow border displays. It also describes a new methodology to laminate curved displays. [22]

Kao Shan-Chen Et Al.'s work aimed to discuss the challenges in the development of flexible OLED displays and to provide solutions for mass production. The paper concludes by referencing problems associated with LTPS thin film encapsulation and preparation of flexible substrate. [23]

Cho Doo-Hee Et Al.'s work aimed to design a less expensive process for fabricating flexible integrated OLED substrates. The paper successfully reports the fabrication of flexible substrate OLED devices. It also revealed that these devices have electro-optical properties comparable to those of conventional glass substrate OLED devices. [24]

Ke Tsung-Ying Et Al.'s work aims to find a method for transferring an OLED display, which was formed on glass substrates using a 620°C LTPS TFT and touch sensor, to non-PI flexible substrates using a weak bonding method. The paper reports successful transference of the display without any compromises in both viewing and touch input experiences. [25]

Cho Hyun Wook Et Al.'s work addresses the problem of visible horizontal line defects that occur in flexible OLED touch sensors when high voltage driving is used to improve performance of the touch sensor. The methods proposed by this paper to fix these line defects include selecting appropriate frequency bands and tuning the start time of the touch sensor signal. [26]

Wang Shuang Et Al.'s work describes the design and implementation of a touch sensor for foldable OLED modules with reduced thickness. The paper reveals that using a metal-mesh touch sensor with a Manhattan pattern compared to traditional ITO touch sensors produces comparable performance results to that of rigid modules. [27]

Kamada Taisuke Et Al.'s work describes the development of a display that integrates an organic image sensor with OLEDs. A prototype display was fabricated at the end of the research. This display used side-by-side patterning to incorporate the organic image sensor. [28]

Watanabe Kazunori Et Al.'s work aimed to fabricate high performance small to medium sized displays for wearables. The display thus created employs a metal-mesh pattern to hold the sensor electrodes. Furthermore, touch detection functioned properly even after 100000 folds with a 5mm radius of curvature.

[29] Jeong Hyun-Jun Et Al.'s work aimed to investigate effects caused by mechanical strain on characteristics of TFTs and to study the ambient instability. It was observed that with decreasing bending radius the on-current of the TFTs decreased due to an increase in resistance. Also, as mechanical stress increased, reliability of the devices decreased due to ambient effects and changes in density of state. [30]

Song Jiaqi Et Al.'s work describes flexible InGaZnO thin-film transistors (TFTs) and the recent advances in their development. The paper introduces flexible InGaZnO TFTs and their superiority over rigid counterparts. The fabrication process of these TFTs is explained, along with the recent advances in their electrical performance and mechanical flexibility. The paper also discusses the mechanisms behind the bending-induced instability. [31]

Prevatte Carl Et Al.'s work aimed to describe a framework for manufacturing versatile, high-performance displays using a hierarchical assembly strategy. [32]

Ke Tsung-Ying Et Al.'s work describes the method of separating flexible electronics from a rigid carrier glass for flexible OLED display production. The method involves using a weak bonding method and mechanical de-bonding with a protection film assistance. The paper also demonstrates the advantages of not using a PI substrate in flexible OLED display production. [33]

María Rodríguez Fernández Et Al.'s work aimed to help us understand primary display production technology especially those with minimal power consumption. Energy usage of these displays was observed. Even though significant progress has already been accomplished in this area, industry strategy objectives and research group lines of inquiry still have this goal as their primary purpose. [34]

Danny Ziyang Huang Et Al.'s work describes the history and characteristics of folding mobile phones before elaborating on their effects on human society. The paper came with observations that People strive for the highest level when people and technology are combined. Life is altered by technology. Both the engineering and the user interface of the folding screen phone carrier are first-rate. [35]

Shanshan Wang Et Al.'s work aimed to investigate and contrast the current research on picture retargeting in order to suggest an improved integrated content-aware image retargeting system that outperforms competing ideas. The paper's important topics, which should contain items and their surroundings, are the main emphasis of the essay. An importance map is used in an image retargeting system to express the significance of specific pixels within the image. [36]

Li-Wei Kang Et Al.'s work aimed to describe probable causes for image distortion on foldable displays. A portion of a displayed image on a mobile device may be squished when the device is folded to a specific extent. [37]

Peng Fei Bai Et Al.'s work helps us understand multiple paper-like technologies with a focus on the current state and potential trends in the future. It was observed that the driving waveform was essential to the electrophoretic display and it greatly affected various aspects such as refresh rate, image quality, flicker, etc. Continued advancement of electrofluidic display technology may be a promising option for displaying video in a manner akin to paper. [38]

Zhiyuan Zhao Et Al.'s work discusses various advancements in display technology from thick electronic tube technology. It was observed that flexible displays have certain distinct advantages over traditional rigid displays, like being lightweight, having an ultrathin construction, consuming less energy, and having a higher mechanical deformation tolerance. [39]

Kim Do-yoon Et AL.'s work conveys the fact that displays are essential for conveying visual data and information across various media platforms. Reflective displays, which differ from emissive displays in certain ways, are becoming more prevalent among screens. In order to create flexible reflective displays, we have examined a number of fabrication methods. Every component of the flexible display should be replaced with stretchable material for optimal performance. The creation of stretchy materials and reflecting screens, however, has undoubtedly made some small but significant strides. [40]

3. Background

This section of the paper mainly focuses on the history of the flat phones, the problems it ran into over the years along with an added insight into curved displays and foldable phones.

The concept of flat, or “slate” smartphones started with the introduction of the Apple’s iPhone by the cofounder of Apple Steve Jobs in 2007. The Apple iPhone initiated the trend of flat smartphones with the introduction of a touch-screen device which can execute multiple instructions just like a computer. Other firms also followed suit, and then launched their own versions of smartphones, each with unique features, which then resulted in the widespread popularity and acceptance of the flat phones. Over the years, there have been numerous developments to these flat phones, making them powerful, slim, and containing loads of features. Now, even though the flat phones are quite popular these days, they do come with their own sets of problems. Flat phones have several shortcomings which include difficulty in handling mainly because of the size, glare and reflections on the screen, and limited viewing angles.

The introduction of curved displays surely did create a lot of “buzz” in the technological sector, with Samsung being one of the first companies to introduce curved displays. After Samsung, a lot of companies such as Realme, Google, OnePlus, Vivo, Xiaomi and many others followed suit to take a chunk of the market share. In recent years, these curved displays have gained popularity, with the most premium phones having the curved design. There are more benefits than which meets the eye. These smartphones include enhanced aesthetics, improved grip and better handling, along with ease of typing and pressing buttons. Research also shows that there is a reduction of screen reflections as well as the glare to the human eye. Not to mention, these phones have a very eye-catching look. The curved part of the display helps in giving the user a more immersive experience while streaming High Definition (HD) videos and video games. These phones, however good they are, have their set of limitations. These include a high price point, Reduced Screen Area, and Image Distortion because of the curvature of the edges.

But, despite these challenges, these curved displays continue to maintain their popularity in the smartphone market, mainly due to the benefits they offer when it comes to aesthetics, handling, comfort and grip.

The next turning point in the Technological Sector was the introduction of the foldable phones. The Selling point of these phones is evident in the name, i.e., phones which could be folded into a smaller device when compared to the original device. These phones could be smaller than the typical phones which exist these days in the market. These phones can transform into a large tablet-like form factor when needed. This allows the user to take advantage of a larger screen for multiple tasks such as gaming, streaming HD videos and movies while retaining the simplicity and the form factor of a smartphone. The first commercially available foldable phone was the Samsung Galaxy Fold, which was released in 2019. Since Samsung's launch, many other companies followed suit such as Microsoft, Xiaomi, Oppo, Motorola among many others. The launch of foldable phones was met with a lot of excitement and skepticism, mainly because of its underlying technology still being in the early stages as well as the challenges that lie ahead of it. One of the biggest advantages associated with the foldable displays is that with a foldable device, you have twice the space in the underlying hardware, so it's possible that you could have a battery with more capacity or even a more powerful processor. Where normal phones usually have a camera island at the back and then a separate selfie camera at the front of the phone, this is not necessary with the foldable displays. This gives manufacturers the opportunity to pay more attention to just that camera island. Even though the foldable displays enjoyed a lot of attention, they had their own set of limitations with them. Some customers found the phone very thick and tougher to handle. One of the major question marks for the companies were to include a single Operating System (OS), or a dual Operating System (OS). The Hinge mechanism that allowed the phone to fold and unfold was very prone to wear and tear over time, and this affected the longevity and reliability of the phone. These phones were usually very expensive to own, and very few in a number, and hence, they were not widely available in the phone markets.

But, despite these drawbacks, these foldable phones are seen as a new and an interesting development in the phone industry, and they are expected to gain more popularity and users over the years as the technology progresses and improves.

4. Technology behind the Curved displays and advantages compared to flat phones

Living in the digital era, we have all heard about the concept of curved displays, but seldom do we know about the technology behind creating these curved displays. This section of the paper will discuss exactly that, so the readers will have a better understanding of how curved displays are manufactured. The technology behind curved displays involves the use of flexible display panels, such as OLED (Organic Light Emitting Diode) or LCD (Liquid Crystal Display). These can be bent into a curved shape. These panels are made up of different layers of multiple light-emitting diodes or liquid crystals that are sandwiched between two pieces of glass. The bending of the panel is achieved by mounting it on a flexible substrate, such as a plastic or metal frame. Now, the curvature of the display panel can then be tailored according to one's specific requirements, which allows for a customized viewing experience.

Curved displays offer many more competitive advantages than the traditional flat displays, which also includes a more immersive viewing experience attributed to a wider field of view, and reduced reflections and glare due to the curvature of the panel. Research also shows that because of the curvature of the display, eye strain as well as fatigue can be reduced by providing a more uniform viewing distance to the eyes, along with a more aesthetically pleasing appearance. Curved Displays are also known to be easier to handle compared with the flat phones providing a comfortable grip.

5. Technology behind Foldable Displays and advantages compared to Flat phones

There are various technologies that are used by foldable displays to achieve the best performance and ease of use. As foldable displays are supposed to "fold", various issues such as creasing, breaking, discolouration and many more arise. One way to increase foldability is by using a fan-out daisy-chain linked packaging style. This was originally used for CMOS dyes on an elastomeric substrate. As large thinned dyes were prone to degradation on bending, multiple smaller dyes were linked together in a fan structure to enable safe bending. This can be applied effectively to OLED and micro-LED displays. Recently with the introduction of other substrates such as plastic, UTG (Ultra-thin glass), metal, etc. foldable displays are becoming more and more of a reality. Ultra-thin glass can be a suitable substitute for the cover window of the display. It is hard and more flexible than glass (does not break or crease even at a bending radius of 1.5R and is reliable against cracks). Another technology that can be used to laminate the bendable cover window on a foldable display is to use a multi-hardness silicone pad. Conventionally, the cover window is laminated with OCA (Optically Clear Adhesive) but it has been found to cause degradation of the display panel due to the technology used in the lamination process. This method of using a hybrid silicone pad has shown to have excellent compression strength and uniformity without causing any degradation. Apart from the physical integrity of the cover window and substrate, the wiring in the conducting layer can also be optimized by using suitable routing schemes. This ensures that the wiring in the layer does not suffer from degradation. There are also recent improvements in the manufacturing process of the thin glass to be used in the display also. Conventional methods require the use of chemicals and grinding thick glass down to the required thickness. A novel green method has been proposed that employs a bonding and separation method to create thin glass of optimal thickness.

The above-mentioned technologies are just a fraction of many more innovative technologies and approaches to make foldable displays reliable and easier to use.

6. Technical Challenges associated with curved displays and suggestions on overcoming them

This section discusses primarily about the different technical challenges associated with the curved displays, and it will also suggest ways we can overcome these challenges for effective utilization. Some of the Technological Challenges include:

1. Display Flexibility: A Flexible substrate is needed in order to build the curved shape of the display, which is not the easiest task when it comes to manufacturing.
2. Mechanical Strength of the Phone: The curved shape of the display makes the phone more fragile and hence more prone to damage.
3. Touch Sensitivity: The touchscreen technology may not work as effectively on the curved displays, which leads to difficulties in touch accuracy.

There are ways in which we can overcome the above challenges. Display Flexibility of the curved screens can be increased with the help of flexible substrate materials, such as either plastic or flexible glass. Research has been ongoing into flexible materials such as graphene which reduces the risk of damage during manufacturing and use and hence thereby increasing the display flexibility.

The most common way to increase the mechanical strength of the curved display is to use a tempered glass, but other than that there are many ways to go about increasing the mechanical strength of the displays. Lamination of the display with stiffening materials, such as Polymer films or metal layers will reduce the risk of damage by a significant amount and hence even increase its Mechanical Strength. Even the use of high-strength substrate materials will help increase the mechanical strength of the curved displays. When it comes to the touch sensitivity, we could use improved touch sensors which will have better accuracy. These improved touch sensors will be able to detect with good accuracy if the touch is accidental or not. We could use multiple touch sensors around the curved displays as well to improve touch accuracy and address touch sensitivity issues.

7. Technical Challenges associated with Foldable displays and suggestions on overcoming them

There are a few technical challenges associated with foldable displays as well, which is precisely what the section covers. The section will also cover sound strategies on addressing these issues. Some of the problems faced by the foldable displays include:

1. Integration with Hardware: Integration of the foldable display with other hardware components such as the battery, storage and the processor can be a very difficult task. It must be done very carefully in order to ensure high performance and reliability.
2. Touch Screen Accuracy: Touch screen might not work that effectively in foldable phones, which reduces the accuracy of these touches.
3. Software Optimization: The foldable phones require software optimization to ensure a seamless as well as a consistent User Experience, particularly when the device is folded and unfolded time and again.

There are a few ways in which we could overcome these above challenges in order to enjoy the benefits of the foldable phones. To avoid the Hardware Integration issues, manufacturers need to take care of multiple things such as the Hinge design, which was discussed earlier in the paper. The hinge mechanism of the foldable phone should be able to endure the frequent opening and closing of the device, as well as should ensure that unwanted materials such as dust and debris do not enter. We could as well use flexible materials for manufacturing the foldable phones which would be resistant to scratches and cracks. We could improve the touch screen accuracy by integrating the phone with a high-resolution display. This allows for smaller touch points on the screen. We could as well reduce the display thickness of the phone, as it would have a major impact on the touch accuracy of the phone, as these thicker displays have trouble recognizing inputs from the user

When it comes to software optimization of the phone, we could collaborate with different software developers, to ensure that the software which is running on the foldable display is optimized or not for the underlying hardware. Managers should also test the software as thoroughly as possible on the prototypes of foldable phones, which will help to identify and fix any issues that might affect its performance, reliability or touch accuracy.

8. Conclusion

This survey study paper has examined the emergence of curved and foldable displays as well as their prospective market impact. Both technologies have the potential to completely change how we use our gadgets and create new user experience possibilities. Foldable displays have the advantage of having more screen space in a portable design, which might make multitasking more effective and fun. Moreover, new use cases and applications might be created as a result of foldable displays. Apart from potentially reducing screen glare and offering a broader field of view, curved screens offer a more immersive viewing experience. This might be very helpful in virtual reality and gaming applications. In the future, the adoption of these technologies will be determined by a variety of factors, including cost, durability, and consumer demand. However, as manufacturers and developers seek to differentiate themselves in an increasingly crowded market, we can expect to see continued innovation and development in both areas.

Overall, foldable, and curved displays are exciting developments in display technology that have the potential to improve how we interact with our devices and consume content. It will be interesting to see how these technologies are adopted and integrated into our daily lives as they continue to mature.

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