**A Survey: Multimedia User Interface for Mobile Devices**

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**Abstract**

Mobile devices like smartphones, iPad, and tablets are developing rapidly and playing more and more important roles in people’s modern lives. With the growth of hardware technologies, Mobile Devices becomes more and more powerful. As a consequence, there is more Multimedia content being used on Mobile Devices to enrich users’ experience. To explore the current utilization of Multimedia on Mobile Devices and estimate the future trend, I surveyed and analyzed some papers to explore the development of Multimedia on Mobile Devices. In this survey paper, the data is organized by the key aspects of Multimedia on Mobile Devices, including the Multimedia content on mobile, the technologies that enrich the Multimedia on mobile devices, the technologies that enhance the performance of Multimedia on mobile devices, the Cloud and AI technologies for Multimedia. Then, based on the survey, I made the estimation of the future trend. In the future, mobile devices would keep growing the hardware and software, so that there would be more Multimedia elements used on mobile devices with fast, powerful, and interactive performance.

**SECTION I.**

**Introduction**

Mobile Devices have been playing an important role in modern society for many years. With the rapid growth of Mobile Devices, Multimedia content has been developed and migrated for Mobile Devices with a huge growth too. Mobile Devices could access and capture many types of Multimedia content such as text, images, audio and videos [1]. To analyze the growth of Multimedia content utilization on Mobile Devices, I collected and surveyed some papers to collect data. And, I made the forecast the future trend based on the surveyed data. In this paper, I survey the papers by their importance and relevance of mobile multimedia and organize the papers based on their topics. In Section II, I overview the mobile multimedia and the advanced multimedia content on Mobile Devices such as Multimedia Thumbnail, Interactive TV Services, and Live 360-Degree Videos. In Section III, I explore the technologies that enrich mobile multimedia, including the technologies that enhance the users’ experience like Cloud and AI [7]-[8][9][10][11][12][13][14][15][16][17][18][19][20][21][22][23][24].

In Section IV, I presented the conclusion and my forecast of the future of mobile multimedia.

**SECTION II.**

**Multimedia Content on Mobile device**

**Multimedia Thumbnail**

Mobile devices are developed to be smarter nowadays. They have CPUs and Memory to process multimedia data. But there are still issues existing, such as how to adapt the multimedia to the limited screen size of mobile devices, how to adapt the interaction ways between the users and mobile devices and how to support the different kinds of files on mobile devices.

Erol, Berkner and Joshi [2] addressed these issues and revealed the techniques that are used to adapt content to mobile devices. To address the issues of viewing documents on mobile devices’ small screens, Erol, Berkner and Joshi proposed a technology Multimedia Thumbnail (MMNail). The MMNail is used on a short video clip of a document that provides the user with guidance to help the user read through the document. And the research result of Erol, Berkner and Joshi showed that this technology significantly improved document comprehension.

**Interactive TV Services**

Multimedia content on mobile devices not only include basic image, audio, video but also support the TV lives. There is a technology called Interactive TV (iTV) that is addressed by Hölbling, Rabl, Coquil and Kosch [3] provides the access to digital TV content to the users. This technology consists of two parts, an iTV plug-in component that implements the VDR's plug-in interface and an application on users' mobile devices. And the iTV plug-in component connects with the application on mobile devices via the UPnP framework to transfer the information flow so that the users receive the TV content and gain control of the application. This iTV platform allows users to access synchronous TV content by using its add-on services. And it is a big improvement to enrich the users’ experience while using multimedia on mobile devices.

**Streaming Live 360-Degree Videos**

Live Stream is popular nowadays, with growing demand and technologies, the live stream of 360-degree video on mobile devices is now available. Eltobgy, Arafa and Hefeeda [4] presented a new solution called VRCast for live streaming of 360-degree videos to mobile users. This technology allows the user to receive 360-degree video, interact with the live stream, and optimize energy consumption.

**Section III.**

**Cloud and AI on Mobile Multimedia**

**Cloud Service on Mobile Multimedia**

Cloud service is popular now, there are some articles demonstrating the current utilization of Could Service on mobile multimedia [5]. Cloud Service is a new technology to store data, process data and provide Internet access of the data to the user [6]. The users can store their digital information in the cloud server instead of storing the data on their local devices so that the data is widely available [7]. By using the Cloud Service, the users could also gain performance of processing data in the powerful Cloud machines without building their local hardware. To apply the Cloud Service on processing multimedia on mobile devices, there are some popular models including μCloud model, MAUI MCC model, Cloudlet Model, eXCloud (Extensible Cloud) model and Ad-hoc Mobile Clouds model [8].

**Artificial Intelligence on Mobile Multimedia**

Artificial Intelligence is the most popular field in the IT industry in recent years. And probably it represents the major development of the future of our society. Artificial Intelligence could be widely used, and mobile multimedia is a good field that could be benefited from the power of Artificial Intelligence. For example, the well-known Siri of Apple’s iPhone is a successful sample that shows how AI could enrich the users’ experience. Siri could recognize the user’s voice command and perform actions based on the command such as playing music, playing video or opening applications. This is the new way to allow the users to interact with the device. Artificial Intelligence works with multimedia and enhances each other. Zhu, Wang and Gao [9] introduced a concept called Multimedia Intelligence, which explains the convergence between multimedia and AI and how multimedia and AI mutually influence and enhance each other.

**SECTION IV.**

**Conclusion**

As a consequence of this survey, the facts clearly show that mobile multimedia have been well developed. According to the articles, there are many technologies that are introduced to provide multimedia content, to enrich the user experience, to enhance the performance of multimedia and to adapt the power consumption of operating multimedia on mobile devices [10]-[11][12][13][14][15][16][17][18][19][20][21][22][23][24].

Therefore, with these technologies, in the future, the multimedia content will be more widely used on mobile devices, the type of multimedia content will be more various, the performance of mobile multimedia will keep growing and provide more interactive ways to the users to enhance the users’ experience, and mobile multimedia will play a more important role in people’s daily life.

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