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WIRELESS IMAGE APPLICATIONS AND FORMATS FOR IMAGE PROCESSING IN THE FIELD OF TRANSPORT

ABSTRACT

The work deals with the third generation of image processing services including multimedia service of messaging. Adaptation of digital images on the Internet depends on factors such as the number of Internet users, processing capacities and the bandwidth. In the context of mobile Internet, sending of images is still being developed. As the number of services and users is growing, as well as the demands for image applications, this is compared to the development of image applications in fixed Internet.

KEY WORDS

image processing format, image applications, JPEG 2000, Bluetooth, Internet

1. INTRODUCTION

Customer surveys are carried out in order to find out which types of applications they require. Apart from telephone conversations, image and textual messaging tops the list of customers' demands for future mobile applications.

Up to now, picture messages consisted mainly of images and graphics presented on the web pages. However, since images will become a natural part of mobile services, the demands for image transmission and digital processing will change.

This paper studies briefly the third generation of image processing services including MMS - Multimedia Messaging Services, which is probably one of the most important services. It analyses also some requirements which have to be met by the new applications and formats for image processing and describes JPEG2000 - the latest completed ISO/IEC standard.

2. IMAGE PROCESSING IN THE THIRD GENERATION OF MESSAGING SYSTEM

Messaging is the most important application using images.

For the customers these applications symbolise the third generation of carefree usage of technology. The path towards image processing in the third generation started with MMS in generation 2.5.

When speaking of image processing as a very important part of future applications, it has to be known that mobile phone users have to "capture" the image in a certain way. A natural way would be to integrate a digital camera into the mobile phone that would enable "capturing" and emitting images and messages from the same device. However, not all mobile phones will have integrated cameras. To adjust to different users and to enable flexible solutions means to enable mobile phones to transmit images from external cameras.

In the majority of cases image transmission will proceed through Bluetooth which has still-imaging profile, a profile that has been standardised for this purpose.

1.1. Multimedia messaging service – new generation of SMS

SMS is the most frequently used service in the second generation of mobile telephony - more than 15 million messages are sent monthly. MMS was defined and specified for the generation 2.5 and implementation of the third generation. MMS is carrying out an evolution in mobile messaging (which started with SMS), and which is a big step forward in providing the users with the possibility of becoming satisfied "producers" and satisfied consumers. This will be the first mobile application that will handle several different types of media (text, image, animation, video, audio or combination thereof) within a single message. The message content will be limited only by the "producer's" imagination.

Mobile phone users will be able to create MMS messages similarly to creating SMS messages. The big difference is in the possibility of incorporating various types of media, apart from text. As mentioned before,

mobile phones will be able to load the digital image from the digital camera. Some telephones will have installed cameras or devices as additional equipment making it possible to receive images. If video cameras are used, then videos can be recorded and added to the message. The users then add text and send the message using the telephone number as the address. Simple and easy. This type of messaging will probably be the most frequently used in MMS.

Another interesting application is when the network provider sends promotion material to users, e.g. extracts from latest musical CDs. The message can contain parts of the new CD and short videos or sound extracts enabling the users to listen to a part of CD and then to buy the whole album also using mobile phone.

1.2. Image processing by means of Bluetooth

Bluetooth linking will also form an important part of mobile future. The ability to send video or audio recordings wireless between cameras, MP3 player telephones and smartphones will enable users to expand their communication with friends and family members.

Bluetooth connection will enable friends to exchange photos and graphics which they will be able to send to other friends by means of MMS. Mobile phones will also be used for other applications regarding browsing through stored photos in the digital camera. For example, after recording the user can browse through the digital camera, select pictures s/he likes and then send them to their personal, on-line photo album. They can also use their mobile phone as remote controller for managing camera recording. By pressing a telephone button, the recorded image will be seen on the phone display. When the user comes home, the photo is transmitted automatically from the camera to PC - as long as the camera is within PC range.

2. NEW REQUIREMENTS

As the image is transmitted and the volume of mobile communications starts to include multimedia functions, new requirements appear. The photo will be exchanged between digital cameras, telephones and printers. As described earlier, the photo will also be recorded on the private photo-server or on-line photo albums on the Internet, by means of Bluetooth, MMS or WAP. It will be possible to send or exchange the photo or graphics among users (Figure 1).

As new multiservice networks open up many different customers (telephones and smartphones, home workstations, play consoles and TVs) will be able to access the contents of the Internet and mobile Internet (Figure 2). Convergence of services and networks has changed the needs for the future image formats. In order to enable image communication, image formats need to be widely used - which means that the majority of applications and users have to accept them. New requirements will have to be met by multimedia services and applications because different customers with different capabilities will share the same contents. This results in the need to adjust the content to the user. Traditional adjustment of images to customer's capabilities was not a priority, since the majority of customers accessing Internet had similar capabilities. The trend in new image formats is that they are designed so as to be easily transcoded and adjusted to the customer's capabilities.

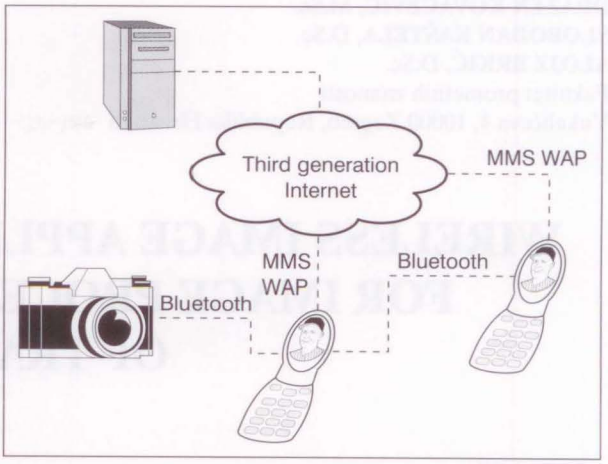


Figure 1

In order to illustrate the need to adjustment, let us consider the on-line photo album service. Imagine you have taken a photo of your favourite car with a digital camera and you have copied it into your on-line photo album. On the web page for on-line service the photo can be accessible in the following formats:

- low resolution (160 x 120 pixel) – e.g. adapted to mobile devices,
- medium resolution – for presentation on PC or TV screen,
- high resolution – for high-quality prints. Many today's photo album services offer high-quality prints from the closest print-shops.

For this scenario the content providers have to be able to deliver also three different versions of the same photo.

The simple solution is to store three separate photos with different resolutions, but this then increases the need for storage memory.

Another solution is to store one, high-quality version and then to adjust the photo to the customer's needs using media portal in the network. Operations in the portals could be calculation complex if the image format was not properly designed for this type of application.

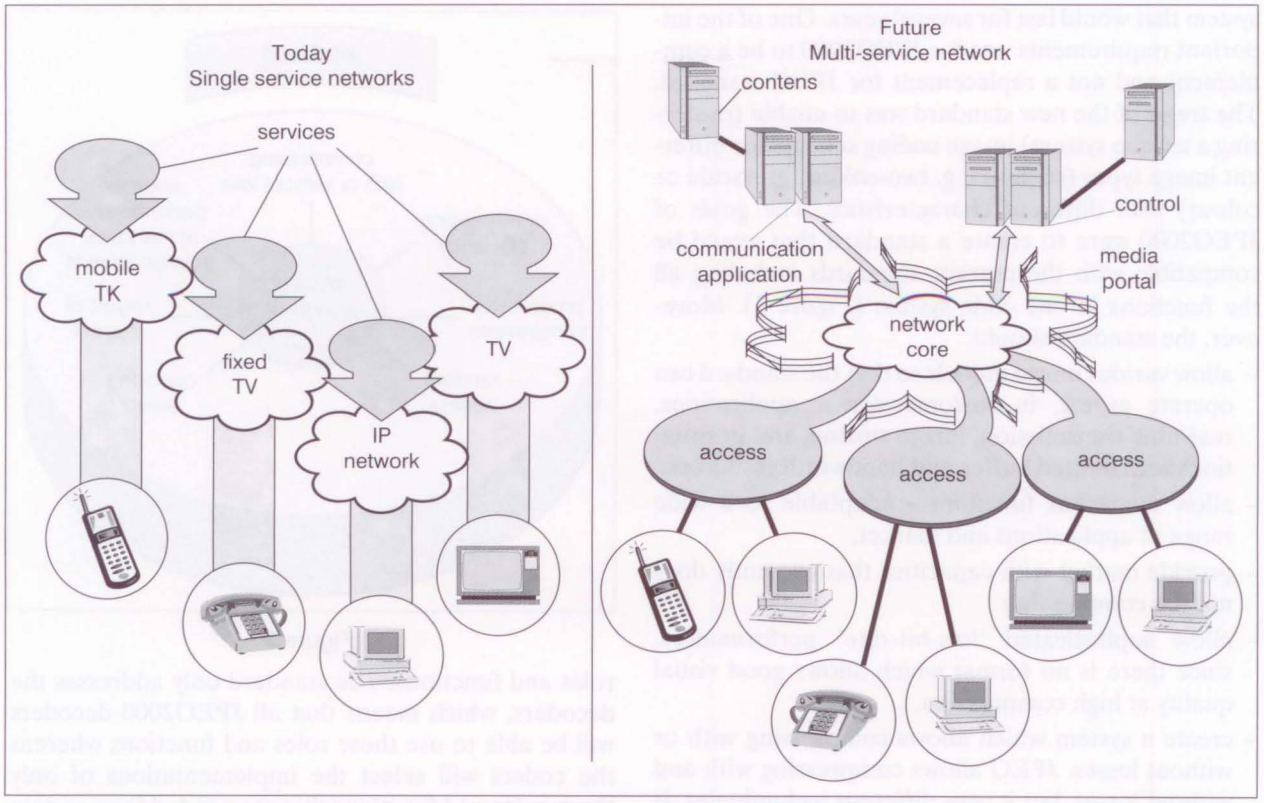


Figure 2

2.1. Image processing formats

Adjustment of digital images to the Internet depends on factors such as the bandwidth, processing capacity and the number of users connected to the Internet. In the context of mobile Internet, sending of picture messages is still in the development phase. As the number of services and users is growing the adjustments and requirements for image applications will grow - which is compared to the evolution of image applications in the fixed Internet. There are several different image formats at present.

- GIF87 and GIF89 are the most frequently used formats for graphical compression and computer-generated images,
- JPEG is used for compression of photos.

Some new formats (such as PNG) are gaining popularity. Traditionally image formats have been designed for specific types of images such as e.g. graphics or photos. Up to now, no single format could cover various types of images by means of the same compression engine. However, the new standard, JPEG2000 leads into the new area of image formats. Standard:

- enables the same systemic solution for any image application and the existing image type,
- represents a way into compressing graphics and photos with the same compression engine,
- enables the functions such as 'random access' for image 'code-stream' and allows the customer-server applications to use the fact that the users have an unlimited viewing space, but want to access full resolution of the recorded image through instructions such as e.g. image zooming and pan. Information required from the customer can be sent directly from the server;
- enables different progressive modes, top compressed efficiency and 'region-of-interest' capability. It will also provide simple transcoding with low calculation complexion allowing adjustment to customer's capabilities of simple comparison with other existing formats.

3. JPEG2000

Since 1997 Ericsson has been actively involved in JPEG2000 standardisation. As part of this initiative, the Ericsson Research staff has taken several positions such as e.g. JPEG2000 co-editors, JPEG2000 editor of the verification model and the chairman of the region-of-interest subgroup.

3.1. Requirements

At the start of working on JPEG2000, the objectives of the new standard were high. The "task group 1" wanted to design and create a flexible image coding

system that would last for several years. One of the important requirements was for JPEG2000 to be a complement and not a replacement for JPEG standard. The trend of the new standard was to enable (preferring a unique system) image coding scheme for different image types (such as e.g. two-colour, greyscale or colour) with different characteristics. The goals of JPEG2000 were to create a standard that would be compatible with the current standards including all the functions in one code system (Figure 3). Moreover, the standard should:

- allow various image models so that the standard can operate as e.g. in customer-server applications, real-time transmission, image storing, and in situations with limited buffer and bandwidth resources,
- allow numerous functions - adaptable to a wide range of applications and market,
- provide market with capacities that currently does not use compressing
- allow sophisticated 'low-bit-rate' performances, since there is no format which allows good visual quality at high compression.
- create a system which allows compressing with or without losses. JPEG allows compressing with and without losses, but it uses different technologies. It is not possible to decompress an image with losses with JPEG mode without losses. The image formats (such as e.g. GIF and PNG) support only compressing without losses;
- allow good compressing of photo and computer generated images and other types of images such as e.g. medicine or highly sensitive ones;
- create a flexible image code system for wireless environment which is strongly in contrast to noisy channels;
- allow random access to image file and various types of progressive transmission (important requirements and tools) – this allows the image format to be used in the maximum number of applications.

The work on requirements resulted in identification of the markets and image applications for the Internet, mobile communications, digital photography, e-business, digital library, printing, scanning, medicine, facsimile and traffic.

3.2. Properties and functions

After developing a plan of requirements, the group for standardisation worked in order to improve many roles and functions without sacrificing the compressing performances and increasing the algorithm complexity.

The final compressing algorithm offers very competitive compressing performances for various image types while still having kept an offer of a wide range of

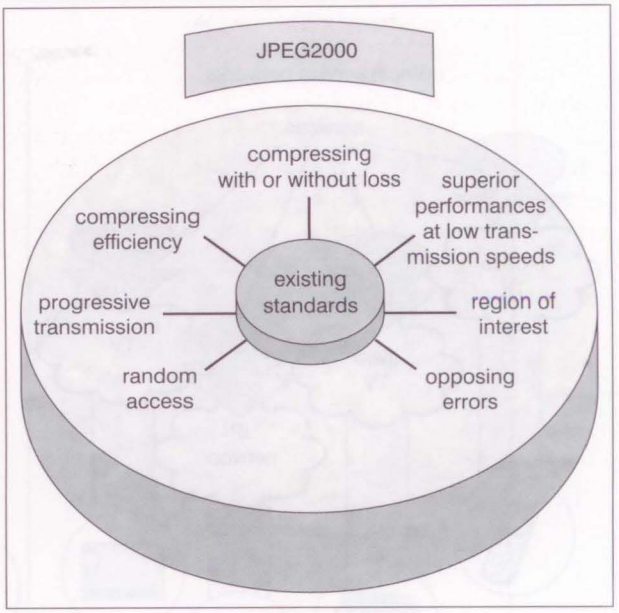


Figure 3

roles and functions. The standard only addresses the decoders, which means that all JPEG2000 decoders will be able to use these roles and functions whereas the coders will select the implementations of only those roles and functions that are needed for a certain application. The main JPEG2000 roles and functions of the JPEG2000 standard are:

- compressing efficiency;
- with or without losses;
- progressive transmission;
- opposing errors;
- coding according to region of interest;
- random access.

3.2.1. Compressing efficiency

The most important role in image compression signals is their compressing efficiency. The more images can be compressed with keeping the acceptable quality of image, the faster they can be sent and more easily stored. One of the goals of JPEG2000 was to improve the performances of JPEG at high compression. Anyway, it will probably be possible to design a system for compressing which will be superior to JPEG2000 for some types of images, JPEG2000 is currently the leading standard in the majority of image types.

3.2.2. With or without losses (Lossy or lossless)

JPEG2000 can be used for compressing images with or without losses in information. Lossless capabilities are very important for compressing in medical or satellite images. However, when digital camera is used for informal photos it may be sufficient to store these in an acceptable quality - higher compression allows the user to store more images in the camera.

3.2.3. Progressive transmission

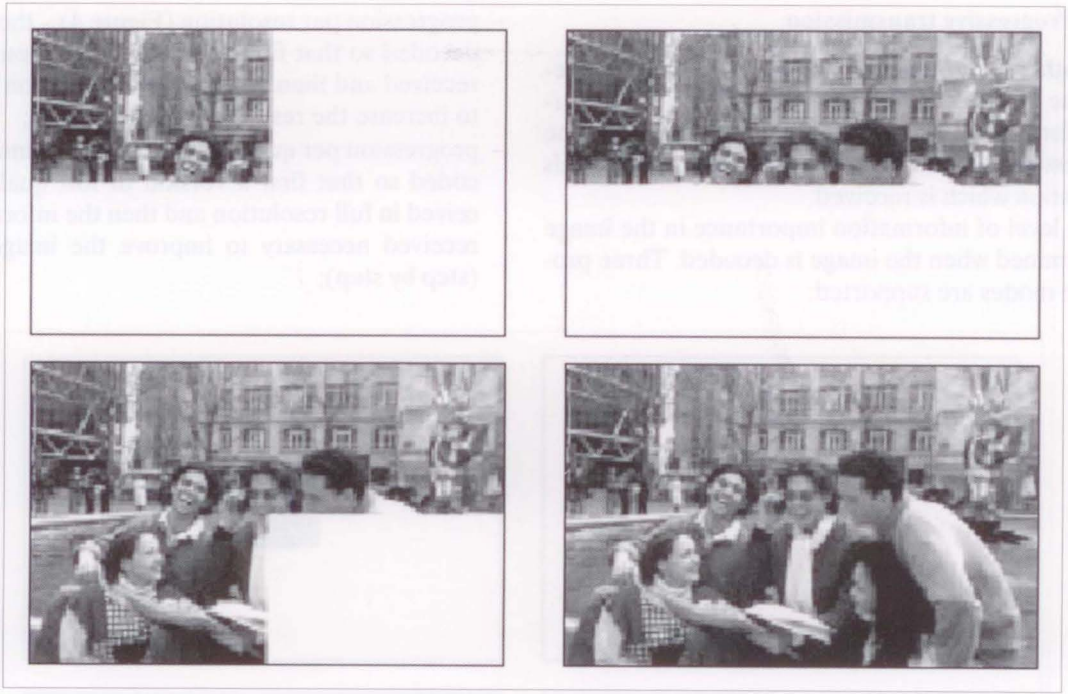
Another important role of JPEG2000 is to integrate the nature of the compressed file. Very important information is that the image is set first in the compressed file. When the image is sent, it is first this information which is received.

The level of information importance in the image is determined when the image is decoded. Three progressive modes are supported:

- progression per resolution (Figure 4) – the image is decoded so that first a version of low resolution is received and then follows the information required to increase the resolution (step by step);
- progression per quality (Figure 5) – the image is decoded so that first a version of low quality is received in full resolution and then the information is received necessary to improve the image quality (step by step);

Figure 4

Figure 5



Picture 6

– progression per position (Figure 6) – the image is decoded in order of the 'scan' line so that first the upper left area of the image is received in full quality and resolution, and then other parts are received from left to right and from top to bottom.

At any moment the receiver can choose to stop receiving the image and decompress the information received up to that moment. For instance, a device with a small display that received an image compressed according to progression per resolution mode can choose to stop receiving information when the desired resolution is received.

3.2.4. Opposing errors

In JPEG2000 files there are several ways of increasing opposition towards wrong bits that appear in the image. There are also several ways of restarting the decoder at certain intervals, in order to prevent the influence of error in one part of the image on the other parts while the image is being decoded. It is possible to collect the most important information, such as e.g. captions, data in a part of the file. This information can then be protected during transmission.

3.2.5. Coding according to region of interest

One of the requirements for JPEG2000 was the decoding capability of different parts of the image in different qualities. Another requirement had been previously set, that the information in a compressed file is located in the part of the image with higher quality (region of interest). Both functions have been implemented into the JPEG2000 algorithm. Thus, when JPEG2000 image that contains information about the region of interest is received, the important parts of the image will be received before the rest of the image. (Figure 7)

3.2.6. Random access

When JPEG2000 image is compressed, it is divided into several levels of subdivisions. Every subdivision is separately coded and can be easily found within the file. It is then easy to extract and decode only the desired part of the image.

4. STANDARD FOR THE FUTURE

As described above, JPEG2000 standard is planning to become the standard for the future. It is unlikely that it would replace the existing standards, but it will supplement them by great possibilities and functions. Due to its flexibility and performances, JPEG2000 can become a candidate for the future use in wireless applications for images and the next generation of image processing.

5. CONCLUSION

Images will be a component of the future mobile service. MMS will probably represent the most important service in the third generation systems. The use of digital image processing will change as multiservice networks develop - which sets new requirements for the future image formats. Since many different cus-

Figure 7

tomers will access images, the new format needs to be flexible in order to be adjusted to different customer's possibilities. One such format, JPEG2000 has just been completed at ISO/IEC. JPEG2000 - one of the first formats that can accommodate various types of images and image applications is a good candidate for the future use in wireless image applications.

SAŽETAK

BEŽIČNE SLIKOVNE APLIKACIJE I FORMATI ZA OBRADU SLIKA IZ OBLASTI PROMETA

U radu se obrađuje treća generacija usluga obrade slika uključujući multimedijsku uslugu prometa porukama. Prilagodba digitalnih slika na Internetu ovisi o faktorima kao što su broj korisnika na Internetu, kapacitet procesiranja i širina kanala. U kontekstu mobilnog Interneta, slanje slikovnih poruka još je u razvoju. Kako će rasti broj usluga i korisnika, kao i zahtjeva za slikovnim aplikacijama to se komparira s razvojem slikovnih aplikacija u fiksnom Internetu.

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