

A Efficient Multidimensional Real-Time Image Signal Processing Method for Mobile Communications

Ye LIANG

Department of Computer Science, Beijing Foreign Studies University, Beijing, China
E-mail: liang_ye@sohu.com

Abstract. As the development of mobile communication technique, portable radio communication equipment is used widely in military and commercial field. So, a lot of traditional applications such as multidimensional image signal processing are implanted on portable radio communication equipment platform. But how to balance the low-performance of portable radio communication equipment and the high demand for hardware of the traditional application becomes a hot field. Through analyzing the difficulties about combining multidimensional image signal processing and portable radio communication equipment, we put forward a displaying control technique of mobile geography information, which is based on measurement of use's location, to reduce the cost for hardware. At the same time, we do serials of experiment on BREW platform to validate it in this paper.

Keywords: Mobile Real-Time image, Multidimensional signal processing; Partition technique; The displaying control technique; Index technique; Location querying

1. Introduction

Although portable radio communication equipment have been known from the beginning to be capable of generating 2D images involving simple lines, images and polygons in real-time, the creation of multidimensional computer images and the speed necessary for generating fast.

One interesting aspect of real-time computer images is the way in which it differs from traditional off-line rendering systems. On the other hand, in the case of real-time images, the system has less than 1/30th of a second per image. Thus, real-time images are oriented toward providing as much performance as possible for the lowest quality possible for a given class of hardware. Most video-games and simulators fall in this category of real-time images. As mentioned above, real-time images are currently possible due to the significant recent advancements in these special hardware components called images processing units. Although the gap in quality between real-time images and traditional off-line images is narrowing, the accuracy is still far below the accuracy of offline rendering. [1, 2]

Another interesting difference between real-time and non-real-time images is the interactivity desired in real-time images. In the case of real-time interactive equipment images, usually a user is in control of what is about to be drawn on the display screen; the user typically uses an input device to provide feedback to the system. In a way this is justified due to the immense difference between the infinitesimal response time generated by a human-being's motion and the very slow perspective speed of the human-visual system; this results in significant advancements in computer images, whereas the advancements in input devices typically take a much longer time to achieve the same state of fundamental advancement, as these input devices have to be extremely fast in order to be usable. [3, 4]

In practical applications, the soldiers want to be given the geography information about them all the time through the equipped portable radio communication equipment, in order that they can draw a conclusion that

how to kill the enemy. In our lives, we also always want to know the geography information about us using our mobile telephone, which is a kind of portable radio communication equipment when we are out.

It is well known that portable radio communication equipment has smaller screen and low-performance disposing capability comparing with personal computer, however the traditional multidimensional image signal processing depended on high demand for memory size, processor speed and other hardware can not be used for portable radio communication equipment directly. So the mobile multidimensional image signal processing, which realizes combining multidimensional image signal processing and portable radio communication equipment, need to be designed to fit for mobile computing environment.

2. Introduce for Multidimensional Image Signal Processing

Signal processing is an area of electrical engineering and applied mathematics that deals with operations on or analysis of signals, in either discrete or continuous time, to perform useful operations on those signals. Signals of interest can include sound, images, time-varying measurement values and sensor data, for example biological data such as electrocardiograms, control system signals, telecommunication transmission signals such as radio signals, and many others. Signals are analog or digital electrical representations of time-varying or spatial-varying physical quantities. In the context of signal processing, arbitrary binary data streams and on-off signaling are not considered as signals, but only analog and digital signals that are representations of analog physical quantities.

Image signal processing applications involve large multidimensional signals which have to be stored in memory modules. In application-specific architectures for real-time multidimensional signal processing, a significant cost in terms of chip area and power consumption is due to these background memory units. The multidimensional signals are usually modeled in behavioral descriptions with array variables. In the algorithmic specifications of our target applications, many of the array references cover large amounts of scalars. Therefore, the efficient handling of array references in the specifications for image and video processing is crucial for obtaining low cost memory allocation solutions.

Multidimensional image signal processing is a system, which could process geographical spatial data. Geographical spatial data includes various data types and levels, with a large quantity of geographical information data. To mobile multidimensional image signal processing, it is so huge that only the geographical information of a campus could not be saved in the memory of portable radio communication equipment at one time.

Through analyzing users' demands and customs of querying geographical information on portable radio communication equipment in mobile computing environment, we can draw a conclusion that people don't want to obtain geographical information once as much as possible, but want to get the useful information observably shown on screen. So the geographical information data is cut into levels and blocks, and is indexed in serialization order. Every block of a level could be fit for the memory of portable radio communication equipment. They are the partition technique and index technique for mobile multidimensional image signal processing. But in order to save the limited memory, it is not enough to only have partition technique and index technique. Because the memory of portable radio communication equipment is divided into two parts, one for calculation, and the other for show on the screen. The techniques could only save the memory for calculation and reduce the quantity of querying result data. So in order to save displaying memory, we put forward the displaying control algorithm of mobile geographical information.

3. Displaying Control Algorithm

There are three steps to achieve the aim of displaying control.

First, the user's state such as situation is detected by mobile support station (MSS) to get the detailed moving parameter when the user sends out querying requirement of geographical information, and then, the result of measurement is transformed into the standard format of mobile multidimensional image signal processing.

Second, the transformed result of measurement is regarded as condition to query database of mobile multidimensional image signal processing. If some geographical information object or a part of it need be

displayed on the screen, the geographical information object will be downloaded and saved in portable radio communication equipment memory so as to process it in the next step.

At last, displaying control technique is used to cut down the needless displaying parts in the querying result image, so the image that will be drawn is just the parts, which could be shown in the screen. In order to meet the requirement, we design a displaying control algorithm. The process is: First, get the points at which the extending lines of four edges of the rectangular plane limited by the sides of the portable radio communication equipment screen intersect with the geographical information object, and insert the points into a singly linked lists in serialization order; And then the points lying on the extending lines of four edges of the rectangular plane limited by the sides of the portable radio communication equipment screen are moved to the tops of the angle of the rectangular plane limited by screen; Last, the points lying out of the rectangular plane limited by screen are deleted. During the process, if any two neighboring points have the same value, they should be combined into one point. Using the algorithm, we could realize the displaying control technique of mobile geographical information based on measure of user's location.

In order to explain the algorithm in detail, we put forward some definitions and regulations.

Definition 1: The point lying on the sides of screen or out of screen is the out point.

Definition 2: The point lying on the sides of screen or in the screen is the useful point.

Definition 3: The point, which has no use for drawing the result image in the screen, is the useless point.

Regulation 1: The useless points decision regulation

- If there are three out points to be connected together and the middle one is not useful point, then the middle point is the useless point.
- If both the beginning point and the next point are out points, and the beginning point is the useless point, the beginning point is the useless point.
- If both the ending point and the previous point are out points, and the ending point is the useless point, the ending point is the useless point.

Regulation 2: The adding points regulation

Let the rectangular plane limited by screen be rectangle A, and let the needed displaying object be polygon B. Let the four edges of the rectangle A lie on straight line a, b, c, d separately. Get the points at which straight lines a, b, c, d intersect with polygon B, and then insert them into the linked lists at corresponding positions.

Regulation 3: The moving points regulation

If the obtained point through the adding points regulation lies on the extending line of four edges of the rectangular plane limited by screen, the point should be moved to the vertex of the screen, which is nearest to the point.

Regulation 4: The combining points regulation

If the neighboring two points in the linked lists have the same value, they should be combined to one point.

Regulation 5: The deleting points regulation

Use the useless points decision regulation to find the useless points in the linked lists, and delete them from the linked lists.

4. Explanation and Example

Now, we explain how to control the displaying of geographical information objects using the given definition and regulation above. Suppose that the polygon ABCDEF is a geographical information object, which need be displayed on the screen, and the rectangle A'B'C'D' is the control rectangle limited by screen. Let edge A'B' lie on straight line a, edge B'C' lie on straight line b, edge C'D' lie on straight line c, and edge D'A' lie on straight line d.

At the beginning, according to Figure 1, we know that, the original linked lists is:

$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow A$

If we want to show geographical information object ABCDEF by linked lists method. Obviously, we need the displaying control technique, which we talk about above. In an other word, we should get the part of

geographical information object ABCDEF showing in the screen A'B'C'D'. These steps could make the aim become reality:

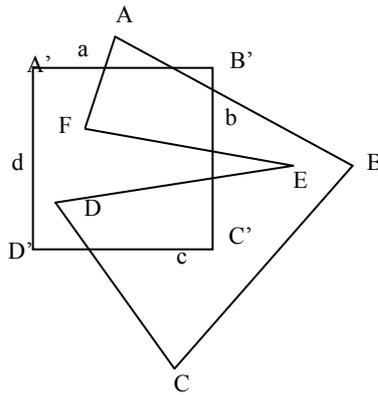


Fig.1. The original picture.

Step 1: Use the adding points regulation to seek the points at which the lines a, b, c, d intersect with the geographical information object ABCDEF, and then insert them into the linked lists. The process is detailed below:

a) At first, the points at which the line a intersect with segments of line AB, BC, CD, DE, EF, FA need be gotten: By calculating, line a intersects with segment of line AB at point 2, and line a intersects with segment of line FA at point 1; There are no joints between line a and other segments of line, so we don't calculate them. Because of point 2 lying between point A and point B, point 2 is inserted into linked lists between point A and point B. The same as point 2, point 1 need be inserted into linked lists between point F and point A. Now, the linked lists turns into:

$$A \rightarrow 2 \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow 1 \rightarrow A;$$

b) Next, get the points at which the line b intersects with segments of line A2, 2B, BC, CD, DE, EF, F1, 1A and get the joints: point 5, point 6, point 7, point 8, and insert them into the linked lists. Now, the linked lists turns into:

$$A \rightarrow 2 \rightarrow 3 \rightarrow B \rightarrow 6 \rightarrow C \rightarrow D \rightarrow 5 \rightarrow E \rightarrow 4 \rightarrow F \rightarrow 1 \rightarrow A;$$

c) Then, get the points at which the line c intersects with segments of line A2, 23, 3B, B6, 6C, CD, D5, 5E, E4, 4F, F1, 1A and get the joints: point 5, point 6, point 7, point 8, and insert them into the linked lists. Now, the linked lists turns into:

$$A \rightarrow 2 \rightarrow 3 \rightarrow B \rightarrow 7 \rightarrow 6 \rightarrow C \rightarrow 8 \rightarrow D \rightarrow 5 \rightarrow E \rightarrow 4 \rightarrow F \rightarrow 1 \rightarrow A;$$

d) At last, seek the points at which the line d intersects with segments of line A2, 23, 3B, B7, 76, 6C, C8, 8D, D5, 5E, E4, 4F, F1, 1A. By calculating, there are no joints between line d and these segments of line, so the linked lists need not change;

The Figure 2 shows the result after adding points.

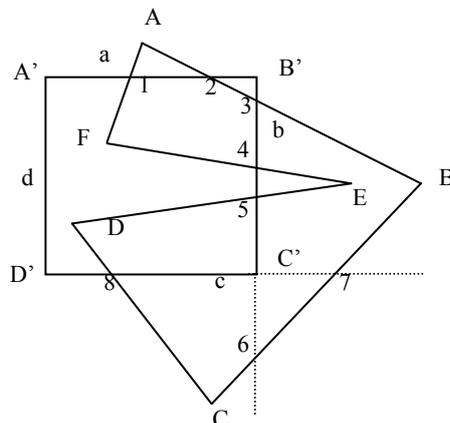


Fig.2. The result after adding points

Step 2: Using the moving points regulation, let point 7 and point 6 which are added into the linked lists in previous step move to point C'. Then the linked lists becomes:

$A \rightarrow 2 \rightarrow 3 \rightarrow B \rightarrow C' \rightarrow C' \rightarrow C \rightarrow 8 \rightarrow D \rightarrow 5 \rightarrow E \rightarrow 4 \rightarrow F \rightarrow 1 \rightarrow A;$

Step 3: Use the combining points regulation to simplify the linked lists. Now the linked lists turns into:

$A \rightarrow 2 \rightarrow 3 \rightarrow B \rightarrow C' (6,7) \rightarrow C \rightarrow 8 \rightarrow D \rightarrow 5 \rightarrow E \rightarrow 4 \rightarrow F \rightarrow 1 \rightarrow A;$

The Figure 3 shows the result after combination.

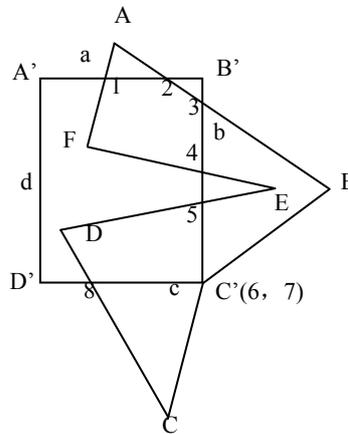


Fig.3. The result after moving points and combining point

Step 4: Use the useless points decision regulation and the deleting points regulation to delete the useless points from the linked lists. The process is detailed below:

a) According to definition 1, we know that, point A and point 2 are out points. And according to the useless points decision regulation (b), the beginning point A could be deleted. Using the deleting points regulation, the linked lists turns into:

$2 \rightarrow 3 \rightarrow B \rightarrow C' \rightarrow C \rightarrow 8 \rightarrow D \rightarrow 5 \rightarrow E \rightarrow 4 \rightarrow F \rightarrow 1 \rightarrow A;$

b) Since point 3, point B, point C' are out points, point B could be deleted according to the useless points decision regulation (a). Point C, point E could be deleted the same as point C. Using the deleting points regulation, now the linked lists turns into:

$2 \rightarrow 3 \rightarrow C' \rightarrow 8 \rightarrow D \rightarrow 5 \rightarrow 4 \rightarrow F \rightarrow 1 \rightarrow A;$

c) According to definition 1, point 1 and point A are out points, and according to the useless points decision regulation (c), the ending point A could be deleted. Using the deleting points regulation, the linked lists finally turns into:

$2 \rightarrow 3 \rightarrow C' \rightarrow 8 \rightarrow D \rightarrow 5 \rightarrow 4 \rightarrow F \rightarrow 1;$

The Figure 4 shows the final result.

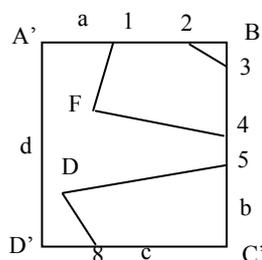


Fig.4. The final result

The vectorgraph decided by points 2, 3, C', 8, D, 5, 4, F, 1 in serialization order is the querying result image, and its effect in the screen is equal to the effect showed by polygon ABCDEF, but the needed displaying memory is lower.

5. Experiment on BREW

In order to examine the efficiency of the displaying control algorithm, we do an experiment on BREW platform. BREW is binary runtime environment for wireless. It is a platform for embedded development and application. It provides a high-efficiency, low-cost and extendable environment in which application can be implanted into any portable radio communication equipment. So it is fit for examining our algorithm.

In our experiment, we send out a requirement with a portable radio communication equipment that is implanted the BREW platform and running our multidimensional image signal processing with displaying control technique. During the system running, we check the usage of memory, processor, displaying memory, and find out they all have more efficient than the multidimensional image signal processing without our displaying control algorithm. Figure 5 compares the mean time of showing the querying result image between with our displaying control technique and without our displaying control technique on BREW platform.

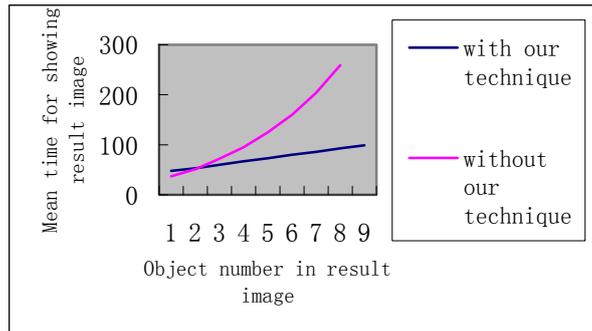


Fig.5. Compare the mean time for showing image

6. Conclusions

It has received considerable attention to combine portable radio communication equipment and traditional applications in recent years. But little effective work has been done in this field. In this paper, we propose improved multidimensional image signal processing technique to deal with this problem. By the simulation test done on BREW, the result shows, the displaying control algorithm based on measurement of user's location is effective for portable radio communication equipment in mobile computing environment.

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8. References

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