FORthSIGHT
an Aid for Visually Impaired People

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Abstract: simple and smart text-enlarger application for MS windows operational systems.

Keywords: visually impairment, magnifyer application, MS Windows-based text

1 Introduction

The first test version of the FORThSIGHT program was developed by Széchenyi István University from Györ, Hungary, in the framework of IECUVADVLA project. The program offers reading and writing facilities to the people with visual impairments, making thus easier the use of Internet for Information and Communication.

The idea of birth of FORthSIGTH was a simple workshop-task when my colleague, Mr. Zoltán Puklus PhD. was attended me to develop a simple software that is able to enlarge the textual content of a computer's screen because many people of the computer age suffers from several abnormality of the eye so they inevitably getting excluded from the information based society.

The original conception included a simple Microsoft (forwardly MS) Windows based application which displays for the user the pressed key on the keyboard in enlarged from. At very first time the development separated into two main directions as a result of some brain-storming of ours. Beside the original plane (keydown-monitoring) I made a suggestion what if the conception contains an output functionality, namely the application should cooperate with MS Windows

software products (like internet browser, text editor, email clients, etc.) where it can extracts the main or selected text based content semi-automatically and displays them in enlarged form. In the first round we should examine the all-over software market for similar solutions. There are several offers to this problem. The most preferred way is the speech synthetizers but these expensive devices demands complicated MI agents as the analisys of natural speech is a very hard challenge. Examined the other factor, the screen magnifyers I was quiet surprised when I realized that most of these product (freeware and shareware both) are doing the same way: uses the selected screen area as a simple bitmap dataset and sends to the display device as a raster graphic image applying for its standard transformation procedures. It has a very important consequence: in cases of large zoom sizes (and very small as well) the result could be damaged, the enlarged image endures fatal distortions and the text content might be useless. This problem is not newly-fledged. The device-independency is existing difficulty of the information science. If the picture elements are not treated as a array of picture elements (pixels) but all of them described as object with mathematical functions then we get an universal and displaying device independent result. So we caught at the chance and stepped on the right way: develop a program that use and abuse the MS Windows font policy for represent the magnified characters as vector graphical objects.

2 Theoretical Background of the Innovation

The screen of computers (for example PC monitors) made up of points of light sorted by orders and rows. It follows logically from this matrix-like ordering how to store images with the easiest and most direct method. In the case of raster-graphical technique some information (its size depends on the color-depth) describes what we should see on a screen-pixel. So on each pixel has a describer data-block. Another solution is the ‘smart-management’ of the visual content by determining the traceable object with mathematical functions on it. This one we call vector-graphic modeling.

The raster graphic formats had become portable (like BMP, TIF, PCX) but there are some substantial problem that appears under different sizes of the same raster-image. Figure 1 below helps understand the errors issue from scale-changing:

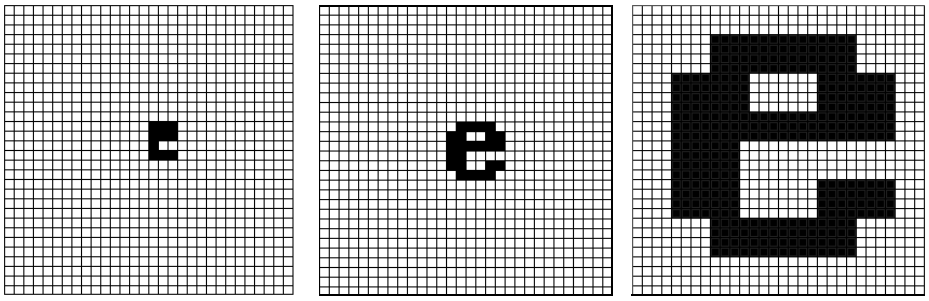

Figure 1
Sizing a raster-based letter ‘e’ on a grid

There are many algorhythms that try to solve this problem (Bresenham-algorhythm, anti-aliasing or super-sampling) with pixel-linking, edge-cutting, smoothing but a digital picture can not hold more information, can not be more detailed if we don’t know (don’t care of) its structure. Summing these up: we try to manipulate the shape but we don’t know the essence that it hides.

Other disadvantage is the raster-graphical formats that if we would like to edit a small part of the image the whole bitmap should be loaded.

The vector graphical modeling takes not the ‘artistic’ side of the image, focused on the mathematical specification instead. That’s why this mode usually named geometrical modeling. The method takes so-called geometrical primitives (like points, lines, curves, polygons) to describe the whole matter of images. In the first few decade of compute science the direct vector graphic based display devices could translate these commands straight to their screen where the electric bundle is controlled along the object’s contour and the other parts of the screen stay unstimulated by the cathode-gun. It was necessary due to the insufficient memory size of the computers but nowadays this barrier not exists anymore so the engineers turned into the hybrid raster-vector implementations which transform the (vector graphically) processed image datas to the specified display device.

Let’s see an example: To draw a circle in a vector graphic based system we need the center coordinates, the length of radius, the thickness of the contour line and extra feature could be the color of the line and perhaps the filling color in case of the shape is closed. The result will always be the same: a perfect circle with small irregularity depends on the fineness of the actual display device (see Fig. 2).

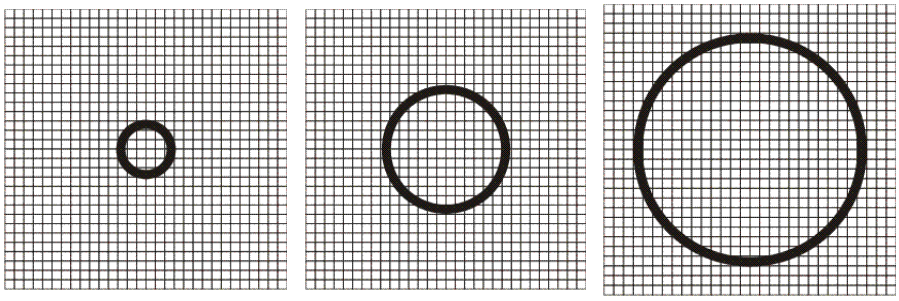

Figure 2
Sizing a vector-based circle on the same grid

In the last presentation of the vector graphical image-creation the method has several preferences against the simple raster graphic:

Minimal memory demand according to big raster-images (the memory demand doesn't depend on the size of the image)

On arbitrary large zooming will not distort the shape of the circle while in the case of bitmap rendering the curve-style will be damaged

The thickness of the contour line should not be enlarged by increasing the zooming scale

The size-parameters of the shape can be stored and later we can change these values. Furthermore it means moving, resizing, rotating, filling, etc the object will not effect the loss of information

Notwithstanding that we have the opportunity of data storage in device-independent units that allows the optimal rasterizing, there are some case when the easier way is the usage of raster-graphical image processing: the vector graphic is ideal for creating simple or composite drawings without device-dependency but the problem factor grows to its multiple when photo-realistic images should be processed.

As the main observation of our project is just the fact, the graphical characters are nothing less than sets of few basic geometrical objects. This revelation had inspired the software engineers to make a standard of vector graphical font that they named TrueType. Instead of the rasterfonts which uses a bit-matrix to store the appearance-specification for each character, the TrueType fonts describe them with crowd of curves. Each of them consists of one or more outlines (glyph outline):

Figure 3
Different descriptor curves
(out- and in-lines) of few typical letter

Other advantage of this font type that it holds additional information about how to distort the outlines in the course of increasing/decreasing of the size and about the rules of mapping into raster-based display devices with the optimal quality.

3 The Physics of Eyesight

When we develop an application surface especially for users with visual impairment we must consider the nature of optical abnormality which can be optically determined in two main groups: one of them is definition of the eye and the other is the ability of seeing colors.

At proper functionality the human eye is able to separate two different distant points if the *ß* angle of the figure below is not less then about 1' (angle-minute):

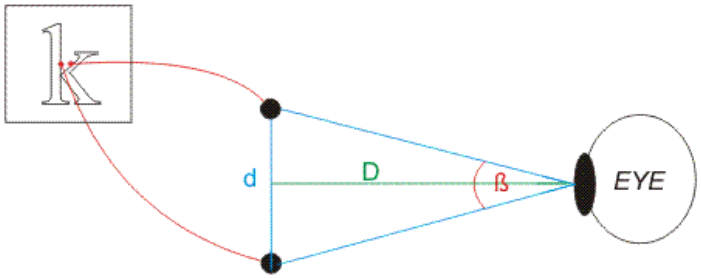

Figure 4
Optical structure of differing two distant points

It means if one concentrates on a character on the screen from the *D=0,4m* distance he can make a distinction between two nearby points of it if the *d* distance (ideal) between them is about 0,058178 mm. If the pupil in not able to dilate (for example due to the fatigue of eye-deformer muscles) then it reduces the angle of light-bundle (*ß)* thus value *d* as well.

The color sight rests on one kind of special cells in the eyes: the so-called cones. These cells dense located around the center of the retina where the image of the fixed object is generated on. There are three kind of cones: L, M and S type. The names are hide their selective sensitivity. The L receives the long wave (red light), the M focused on the medium wave (green light) and the S type is stimulated by the short wave (blue light) electromagnetic waves. All of the colors can be produced from this three basic color component. Thus the tri-chromatic color sight system is the root of defining the colors of visible light. The human eye is able to isolate approximately two hundred sort of color not irrespectively of its wavelength (the most sensitive is around 555 nm which means the green light). On each color we can separate about twenty saturation grade that is up to the attenuation by white light of the given color. In case of the deviation of cone-sensitivity from the normal then failures in color sight come forward. It has three types: protanomaly (hard to make difference between green and red, lower sensitivity of red), deuteranomaly (hard to make difference between red and green, lower sensitivity of middle-green) and tritanomaly (hard to make difference between yellow and blue, lower sensitivity of blue).

We should mention the constancy and contrast in few words. It's important to mind at the design phase the brilliance of neighboring components on the screen for the easier distinction. When the background changed but the cognition of the foreground has not changed we call it constancy against the background (or lighting). An antagonistic symptom is the contrast-effect: the background color induces color-effects on the color of object in the foreground.

4 Software for People with Disabilities

The worldwide software market offers several sorts of applications for visually impaired persons. In order to help visually impaired people to be well integrated in nowadays information society, the development of easily applicable computer peripheral devices was taken into consideration. Improvement of visibility and other sensual aided information transfer (hearing and touch) can be realized by special systems, speech synthesizers or enlarging applications.

Improvement of visibility and other sensual aided information transfer can be grouped as the followings:

- Special systems
- Speech synthetizers
- Enlarging applications

The typical realization of the special systems is the Braille display, being a solution mainly for blind people. The disadvantage of the special systems is the

considerable high cost and the exclusive foreign serviceability. Because of these reasons, only a few special systems are used in Eastern European countries and only a fraction of them are owned by individuals. Speech synthesizers, the so-called screen readers, are the most widespread applications. The most significant disadvantages of the speech synthesizers are the high cost and the technical problems that may occur. Most of these applications have only character mode as it is quite difficult to develop AI-s capable to recover textual information from graphical content. In fact they can convert only texts into audio formats. With regard to enlarging applications, basically software-based solutions are concerned (such as MAGic, ZoomText) to enlarge a part of the screen to the desired rate (standard output). There are, though rare, other, partially hardware-based solutions for example: reading TV, a screen attached to a video camera which place the text in front of a video camera on a rolling tray that can be driven to two perpendicular directions. Zooming can be switched to either negative or positive. Like in the previous cases, the main disadvantage is the high price of these softwares, because of an unknown reason (not necessarily the quality of the service rather the market's gap). Also, most enlarging programs use a so-called rastergraphics technique, based on pixels of the screen and the geometrical arrangement of them, which is the etalon for the enlargement and not the mathematical vector formula. So in case of low quality monitors and small characters the outcome is dim and therefore useless.

Some versions of Microsoft Windows operating system have a built in screen magnifier application and several other such software are also available on Internet. All of them work with texts as a content of the screen, so the written information is only a part of the actual screen-image. Also, all of them use bitmap (raster-graphical) file formats to store the screen prints, which means that when one wants to enlarge the image the quality of the readability might dramatically decrease, especially when the source text part of the screen was created with small fonts.

A new MS Windows based trend is spreading where MS programs are used as motors and separate applications based on them are developped for visually impaired. Unfortunately this practice is implemented by only few companies.

Some aspects to be considered in developing virtual applications for visually impaired people are:

- people living with this disorder perceive information sometimes totally different than those with full eyesight
- the good contrast is very important, dark background and light foreground, no background pattern (non ruled)
- motion picture is difficult to be watched because of quick visual frequency

- when using figures simplified style is important, any decorations may disturb recognition
- the size of the used font should be proportionate to its width
- the user should be allowed to refit the size of objects on screen
- a non-crowded text on screen is important. The mingling of fonts and the small size of them and the different directons of writing can be disturbing
- while watching from a short distance, the central visual field is greatly narrowed
- information gathered from the Internet is usually processed off-line.

Also, in developing easy applicable computer devices for people with visual impairments, should be taken into consideration that visually impaired children's precision movement develops very slowly and may cause troubles in using different devices, because starting, performing and stopping a movement can be difficult for them. Because of the above mentioned the eye-hand coordination is not perfect and the use of a mouse is more difficult, that's why is advisable to slow down the mouse and is compulsory to provide keyboard navigation, which is a weakness of presently available enlarging softwares, unfortunately.

5 Innovations that FORthSIGHT Hides

Our software package has been designed basically for the products of Microsoft Corporation as a 'read' (output function). This area includes the MS Office tools (Word, Outlook, etc.) and the MS Internet Explorer, MS Windows Notepad, Viewer as well. The FORthSIGHT's main goal is to separate the text based information retrieved from the aforementioned applications according to the user demands. This text can be easily resized and thumbed by simple mouse/keyboard controls. The other field of application is the 'write' (output) function. By the help of this service all the keyboard events display on the FORthSIGHT's program window as a control function with optional surface color themes. It's important to mention that the FORthSIGHT uses vector graphical system due to the font handling of MS Windows operating systems. Other advantage is the low price compared to other similar software products.

Summing up the preceding information, the result of our work is a screen resolution independent software which is able to display sections of the given text format documents (web site, .doc, .txt, etc.) considered to the topical font size set by the user with simple keyboard/mouse controls where both the write and read function (I/O) are obtainable. Thus, when a text is written with PC's keyboard the pressed keys are displayed in FORThSIGHT's application windows and when one

would like to read a document file or e-mail or just browse the Internet the main text body appears with the FORThSIGHT too.

For further improvement we planned the integrity of a MIDI based speech synthetizer in case of successful product launch.

Finally I've planned to finish my conference matter with a short live presentation of FORthSIGHT where all these options and functions could be presented at run time.