Introduction to Medical Imaging Case Study

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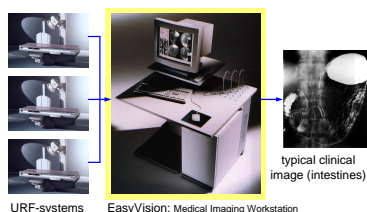typical clinical
image (intestines)

URF-systems   EasyVision: Medical Imaging Workstation

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Abstract

Easyvision is a medical imaging workstation used to enhance the printing functionality of URF systems. URF systems are used for gastrointestinal examinations. The reduced film usage is a direct economic justification for the use of Easyvision.

The technological challenge of this product is to build it entirely with standard off the shelf hardware components, while the performance and image quality are critical for a successful application. Many technical innovations were introduced to create this product family.

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1 Market and Application

The Easyvision is a medical imaging workstation that provides additional printing functionality to URF X-ray systems, see Figure 1. In a radiology department three URF examination rooms can be connected to a single Easyvision workstation. The Easyvision can process and print the images of all three URF systems on transparent film. The radiologist is viewing the film on a light box to perform the diagnosis.

typical clinical image (intestines)

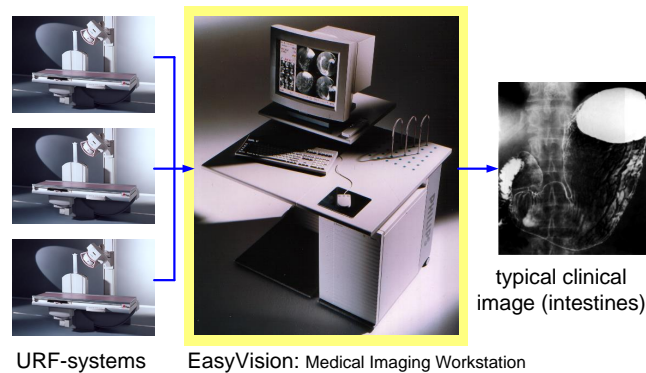URF-systems   EasyVision: Medical Imaging Workstation

Figure 1: Easyvision serving three URF examination rooms

URF systems are used in gastrointestinal examinations. The patient has to consume barium meal to enhance the contrast. Multiple exposures are made at different locations in the intestines, while the barium meal progresses. The radiologist applies wedges to expose the area of interest and to minimize the X-ray dose for the rest of the body.
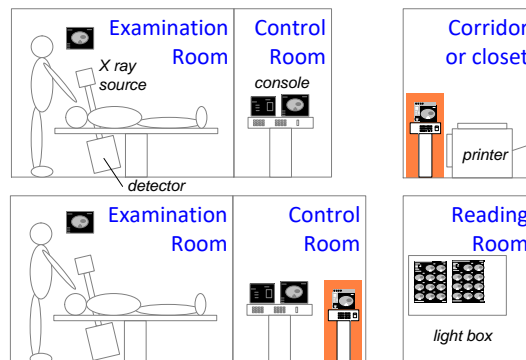

Figure 2: X-ray rooms with Easyvision applied as printserver

Around 1990 the normal production of transparent film was performed by

means of a multi-format camera that makes screen copies of the CRT-monitor. The operator selects every image and sends it to the camera. A typical radiology department layout is shown in Figure 2.

The introduction of the Easyvision made it possible to connect three examination rooms via an Easyvision to a digital laserprinter. Figure 2 shows that the Easyvision can be positioned as a server in some cabinet, in which case the system is used remotely, without any direct operator interaction. The Easyvision can also be placed in one of the control rooms, thereby enabling manual processing of the images and manual formatting of the film.

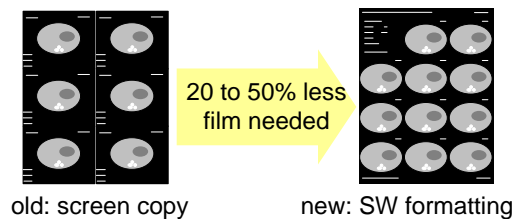old: screen copy   20 to 50% less film needed   new: SW formatting

Figure 3: Comparison screen copy versus optimized film

The introduction of an Easyvision can immediately be justified by reduced film costs. Figure 3 shows a comparison of the conventional way of working, where images are screen copies of the CRT-monitor, and the films obtained by means of software formatting, where the film layout can be optimized to maximize the number of images.

The conventional way of working results in many duplicates of the textual information around the image itself, because for each image the complete screen is copied. This is a waste of film space. On top of that all the textual information is high contrast information, which is distracting while viewing for the diagnosis. The digital availability of images opens all kinds of possibilities. The simplest is the separation of duplicate text information and images, which makes a much higher packing of images possible. Secondary possibilities are automatic shutter detection and zoom-to-shutter.

2   Technology

The vision of the original designers of the product was that the technological innovation in computer hardware is so fast that proprietary hardware development would hamper future product innovation. A product policy was chosen to create products with the value in the software, using standard off-the-shelf hardware. This policy is potentially in conflict with the performance and image quality requirements. This challenge is shown and annotated in Figure 4.
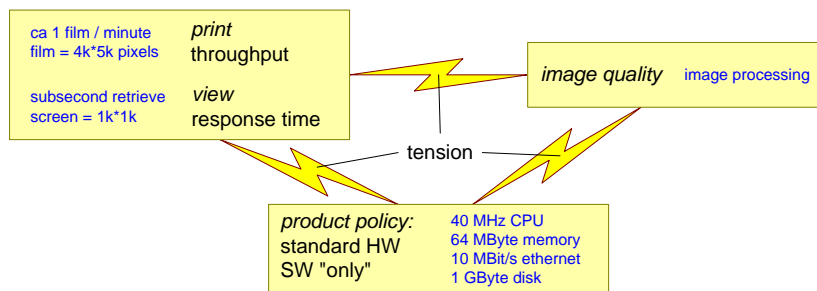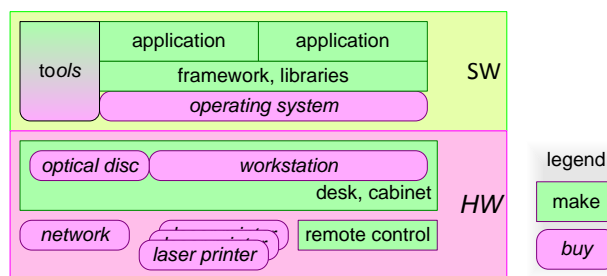
Figure 4: Challenges for product creation

Figure 5: Top-level decomposition

Two types of performance are important in this product: throughput (the amount of film sheets printed per hour) and response time (the user interface response time should be subsecond for image retrieval). This performance must be achieved with a minimal guarantee in image quality. For instance, pixel replication for still images on screen is not acceptable, while bi-cubic interpolation is required for the high resolution of the film images. These requirements must be realized with the workstation in the 5 to 10 k$ range of that time, which corresponds with a 40 MHz CPU and a maximum amount of memory of 64 MByte. The examination rooms are connected to the system via 10 Mbit ethernet, which was state of the art in 1990.

Figure 5 shows the top-level decomposition of the system. Most hardware is off-the-shelf. A custom remote control was added to obtain a very direct and intuitive user interface. In order to fit the system in the hospital environment, the packaging of the system was also customized. The packaging part of the system was decoupled from the hardware innovation rate by a box in a box concept: the off-the-shelf computer box was mounted in a larger deskside-cabinet.

The software is based on a standard operating system (Unix), but the libraries, framework and applications are tailor-made. The framework and libraries contain a lot of clinical added value, but the end user value is in the applications.

The designers of Easyvision introduced many technological innovations in a

relatively conservative product creation environment. The following list shows the technological innovations introduced in the Easyvision:

- standard UNIX-based workstation

- full SW implementation, more flexible

- object-oriented design and implementation (Objective-C)

- graphical User Interface, with windows, mouse et cetera

- call back scheduling, fine-grained notification

- data base engine: fast, reliable and robust

- extensive set of toolboxes

- property-based configuration

- multiple coordinate spaces

The introduction of these innovations enabled the later successful expansion into a family of products, with many application innovations. In Part III we will show some of these innovations in more detail and in relation to the product value.

References

[1] Gerrit Muller. The system architecture homepage. `http://www.gaudisite.nl/index.html`, 1999.

History
Version: 1.4, date: April 5, 2004 changed by: Gerrit Muller
- added explanatory text to some figures
- added reference to Part III
- changed status to finished
- small text improvement

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- changed status to concept
- small text improvement

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- layout change of figures
- innovations: list instead of figure

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- removed X-room diagram around 1990
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- Created, no changelog yet