TEDUB (IST-2001-32366)
Technical Drawings Understanding for the Blind

Summary
Digitised technical drawings are available for use not only at work or at home but also for education purposes. Sighted persons can work on them even on standard PCs, if the appropriate software is installed. The TeDUB project develops a software system, which aims at making technical diagrams accessible to blind and visually impaired people. It consists of two separate modules: One that analyses drawings semi-automatically or automatically, and one that presents previously analysed material to blind people. This system thereby helps to overcome the barrier and to access this type of information.

Setting the Scene
A number of mature techniques, like screen readers with text-to-speech synthesis and/or Braille displays, allow blind people to access text documents. Optical character recognition (OCR) software offers this access even if the documents originate from printed material. However, a considerable amount of information available today is contained in informational graphics like technical diagrams, which are inherently hard to render for people who cannot see them.

Access to diagrams is usually provided for blind and visually impaired people either by the use of tactile printouts or in the form of textual descriptions. However, these techniques suffer from a number of limitations. The linearity of textual descriptions denies some of the general properties of diagrams, e.g., the ability to get an overview fast or to extract information on multiple levels simultaneously (e.g., relationships, structure, detail). Tactile graphics, on the other hand, offer only a limited resolution. This means that diagrams that are produced for a sighted reader cannot be directly translated into a tactile diagram, a certain simplification is necessary. Information needs to be removed and several diagrams may be needed to convey all the information originally in one visual diagram. Because of these requirements, existing diagrams usually have to be completely redesigned by a sighted person in order to provide helpful support for blind and visually impaired people.

Approach
The TeDUB System will focus on technical drawings of electronic, architectural and software engineering nature. The project involves research work both in the image understanding domain and in the presentation of graphic
content to blind or partially sighted users. The technical approach used in image understanding combines intelligent feature extraction mechanisms and domain knowledge about the type of technical drawings that are processed with interactive manual interpretation and annotation. By producing a text annotation of the technical drawing the project also contributes to research areas like semantic web and multimedia information retrieval. Presentation mechanisms include a combination of tactile and/or auditory output with keyboard input. Advanced interfaces including for example force-feedback joysticks, are developed and tested in various evaluation rounds with blind user groups. It is aimed to provide a simple and intuitive way of navigation into graphical content.

The system is able to handle diagrams at different levels of abstraction: Bitmap graphics, such as acquired through standard scanner hardware or found on web pages, vector graphics as typically produced with graphics programs like Corel Draw and certain XML-based formats. The development of the interpretation tool focuses on the retrieval of semantic information from bitmap and vector graphics.

The presentation part of the system is designed to communicate semantic information to the user, rather than precise component orientation and spatial position. The diagram content is formed into a connected network of nodes and there is also a compositional hierarchy of basic and compositional components. The user usually encounters the semantic structures before the simple components. This is intended to allow blind users to access the important high-level information as immediately and quickly as possible. The interface is modelled upon common and familiar concepts like the use of cursor keys for the navigation in hierarchies. It utilises simple context and feedback sounds to supplement the text-based user interface. A miscellany of functions support common navigation and communication tasks, for example allowing annotation to be applied to any node, the ability to retrace one’s steps with a back function like that in a web browser, a search function for finding nodes by content or type, the ability to hide or show different types of nodes, and simple editing abilities. The user interface is designed to be screen-reader independent allowing users to use their familiar and reliable screen reader to access the diagram information. To support navigation through UML diagrams a generic tactile overlay and touch tablet will be used to provide connection information between nodes.

**Results and achievements**

The second prototype of the TeDUB system analyses and presents image information for digital circuits, floor-plans and UML diagrams. Because of the general system architecture implemented, it is easily to extent the number and type of diagrams that can be processed. It supports three import levels of the graphical information namely: raw images, scalable vector graphics and XML based formats.

The project’s user groups have successfully evaluated the user interfaces of the current and past prototypes with both, students and professionals using mainly material from educational scenarios. Most participants expressed a very positive response to the system and felt it would be of significant value in educational and vocational environments.

**Conclusions**

Taking the suggestions from the user studies into account, the current version of the TeDUB system has significant potential, to become a truly effective tool for understanding UML and other types of graphics for visually impaired programmers. Ongoing research and development in the project will result in both, an interpretation tool that significantly lowers the expense of creating accessible versions of existing graphics and a presentation tool that meets the requirements of blind students and professionals who need use graphical contents in their daily life.