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AUGMENTED REALITY–APPLIED INFORMATICS TECHNOLOGY TO PRODUCTS MAINTENANCE, REPAIR AND SERVICING

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ABSTRACT

Augmented Reality (AR) enhances a user's perception of the real world by enhancing it with specific objects that are over-imposed to the real objects. The virtual objects display information that the user may use. The information conveyed by the virtual objects helps a user perform real-world tasks. An augmented reality application is the assembly, maintenance, and repair of complex machinery or common goods. Instructions might be easier to understand if they were available, not as manuals with text and pictures, but rather as 3-D drawings superimposed upon the actual equipment, showing step-by-step the tasks that need to be done and how to do them. These superimposed 3-D drawings can be animated, making the directions even more explicit. This paper describes a proof-of-concept AR application to be used for office printer service operation.

KEYWORDS: augumented reality, informatics, maintenance, repair

1. Introduction

Augmented Reality enhances a user's perception of the real world by enhancing it with specific objects that are over-imposed to the real objects.

The virtual objects display information that the user may use. The information conveyed by the virtual objects helps a user perform real-world tasks.

There are several AR applications. such as medical visualization, maintenance and repair, annotation, robot path planning, entertainment, and military aircraft navigation and targeting.

The next section describes only little research in the AR field. An AR system is defined as a system which combines real and virtual objects in a real environment and run interactively and in real time.

In the medical field**,** doctors could use Augmented Reality as a training aid for surgery using 3-D datasets of a patient in real time, using non-invasive sensors like Magnetic Resonance Imaging (MRI), Computed Tomography scans (CT), or ultrasound imaging, the AR might be a solution to simulate operation [2] [3] [4].

At the moment many research groups are aiming at developing augmented reality algorithms and applications [5] [6] [7] [8], but no commercial robust products are available on the market. World known company BMW A.G. is developing in their research labs an augmented reality application to help mechanics as shown in Fig. 1. By adding more information to the reality, the mechanic will be assisted to service the car. The mechanic is using special goggles to access a computer by wireless communication and to access the exactly information they need in workshop, such as order of assembly, torque, etc.

Another category of Augmented Reality applications is the assembly, maintenance, and repair of complex machinery. Instructions might be easier to understand if they were available, not as manuals with text and pictures, but rather as 3-D drawings superimposed upon the actual equipment, showing step-by-step the tasks that need to be done and how to do them. These superimposed 3-D instructions can be animated, making the directions even more explicit.

Current maintenance systems require even the most experienced user to spend time to search manuals, or search through manuals for specific procedures and component data.

Besides that, the stress induced by this search within manuals can affect work for certain maintenance and repair operations.

Fig. 1. *AR application developed by BMW for workshop repair*

During the maintaining process, the user must interpret the information in the manual and apply it spatially and conceptually to a particular repair procedure. This means filtering relevant information to matching components in the manual to real world components.

In the early 1990s, Caudell and Mizell invented the term “augmented reality,” to define the idea of using an AR system to replace the complex manual documentation used for airplanes, such as the Boeing 747 [11].

In servicing such system provides several advantages, such as to be able to synthesize additional information and complex sequences relatively hard to be explained especially to an inexperienced user (in case of common goods products such as office printers). The information in the manual must synthesise information and it is very hard to place and describe a specific context of servicing.

Feiner and colleagues introduced the idea of Knowledge-based Augmented Reality for Maintenance Assistance (KARMA), demonstrating a system to aid a user in servicing an office laser printer [15]. This system interactively generated instructions by tracking user position and orientation and printer position components in order to inform current servicing operation by over-imposing a virtual reality to real one (Fig. 2).

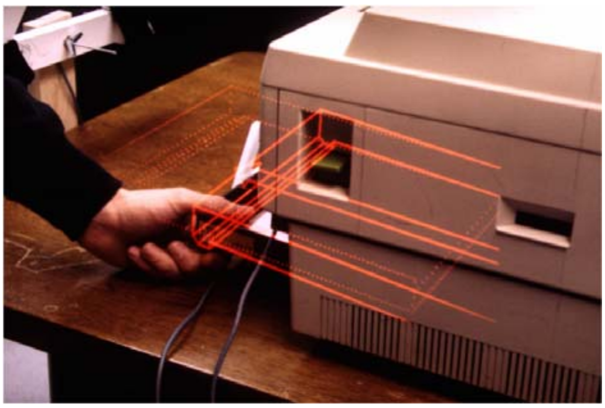

Fig. 2. *Augmented reality for servicing an office printer [9]*

2. Problem formulation

We propose the following problem statement to guide our work: providing maintenance and repair assistance to actively assisting in their performance, using augmented reality technology and incorporate instructions and assistance with specific software. We aim to develop an AR application for office printer service.

We found several challenges in order to develop robust augmented reality algorithm:

-real-time data acquisition and processing; in order to be effective and usable, the augmented reality algorithm needs fast execution and low processing resources.

-consistent data models; in order to identify parts we need data models. Some components are quite easy to be identified whereas others, with complex and similar shapes with other are difficult to be identified in 3D space.

3. Problem solution

The hardware used is a Genius Hd Camera and a PC with Pentium D 3 GHz processor processing. The frame's resolution to be processed is 1200X800 pixels. The proposed algorithm is shown in Fig. 3. The object recognition, which is the most challenging part of the algorithm, is represented by SURF (Speeded Up Robust Feature). SURF (Speeded Up Robust Feature) is a robust local feature detector presented by Herbert Bay in 2006, and is based on identifying remarkable features in the image. These features are compared between the model image to the one to be processed and identified.

Using known distance between identified features of the model image, we can approximate position in space relative to the camera of the object.

Once the component is identified the relative positions of features are calculated and the actual position of the component in space is approximated. Using OPenGL library the cartridge model is displayed, taking into account necessary transformation concerning rotation, scale, and point of view. The 3d cartridge model is over-imposed in real image at the correct coordinates.

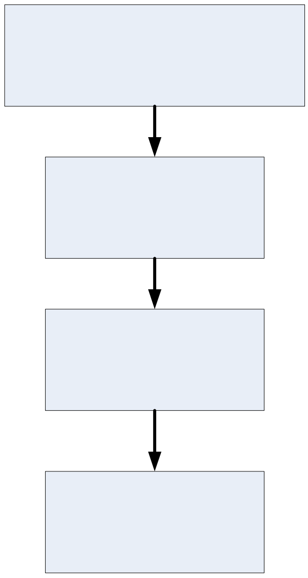

Fig. 3. *Proposed algorithm*

In Fig. 4 some of the features detected by SURF algorithm are displayed.

The features are previously selected in the model image. In Fig. 5 the real image as taken by camera is displayed and in Fig. 6 it is shown augmented reality with the 3D model of the cartridge in place and instructions to remove it.

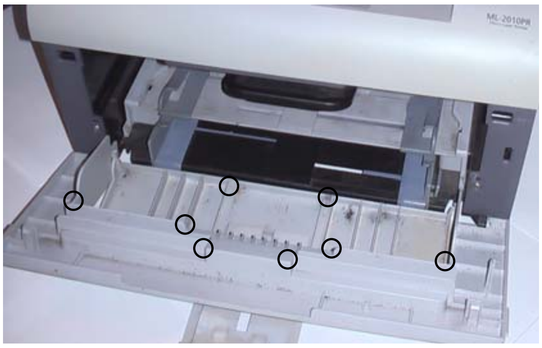

Fig. 4. *Several SURF features identified in the image*

Fig. 5. *Reality as taken by web camera*

Fig. 6. *Augmented reality with instructions for servicing*

We used Visual C 8 IDE environment along with Open CV as computer vision library and OpenGL libraries for 3D graphics display.

The algorithm can be successfully used for those components with enough image variations to be identified as features for SURF algorithm.

However, in case of complex surface with no image variations such as casing of the printer, the algorithm presented fails to identify the surface. Further algorithm and techniques need to be done to solve advanced identification image issues.

4. Conclusion

Augmented Reality is a beyond maturity at the moment.

Today AR systems are primarily found in academic and industrial research laboratories. Several manufacturers are researching currently to release commercial products.

The paper describes a proof-of-concept algorithm. The algorithm successfully can be used for those components with enough image variations to be identified as features for SURF algorithm.

However, in case of complex surface with no image variations such as casing of the printer, the algorithm presented fails to identify the surface.

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