Project: Augmented Reality	**Document:** Augmented Reality for equipment maintenance

1. Augmented Reality

1.1. Brief introduction to vision-based Augmented Reality

We define Augmented Reality (AR) as a real-time direct or indirect view of the physical real world environment that has been enhanced/*augmented* by adding computer-generated information to it. In other words, Augmented Reality is a live copy of the real world view which surrounds us: the surplus value is given by augmenting the reality by computer-generated sensory input such as sounds, videos, graphics or GPS data. It is important not to confuse Augmented Reality with other types of mixed reality like Virtual Reality (Fig. 1); in a virtual experience, the real world is replaced with a complete simulated one. Instead, AR experience is conventionally in real-time and in semantic context with environmental elements.

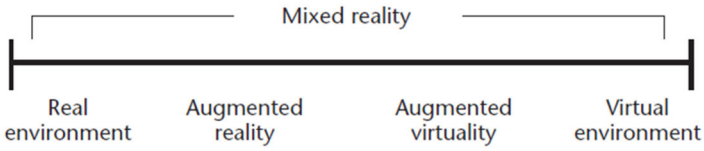

Fig. 1 – "Virtuality Continuum" defined by Paul Milgram and Fumio Kishino

The evidence of this introductory description is that Augmented Reality experience could potentially be applied, with suitable enabling technologies, to each of 5 human senses: sight, hearing, taste, smell and touch. Nevertheless, most diffused applications regard Visual AR (Fig. 2). In a more specific way, our research interests are focused on vision-based Augmented Reality, in which Computer Vision, Image Processing and Computer Graphics are topics of paramount importance. In a vision – based Augmented Reality system, two main activities have to be performed:

- Object detection and recognition: independently from the specific application, recognizing the surrounding environment and sensible objects inside it is a fundamental activity to discover where to show the augmented content;
- Camera tracking and consistent graphics rendering: virtual content has to be integrated in a coherent way based on the pose of the object which needs to be *augmented* and with reference to the camera position and orientation. Pose estimation algorithms and Computer Graphics techniques are necessary to give to users the best possible visual perception, as the virtual object would be truly present in the scene and not rendered artificially.

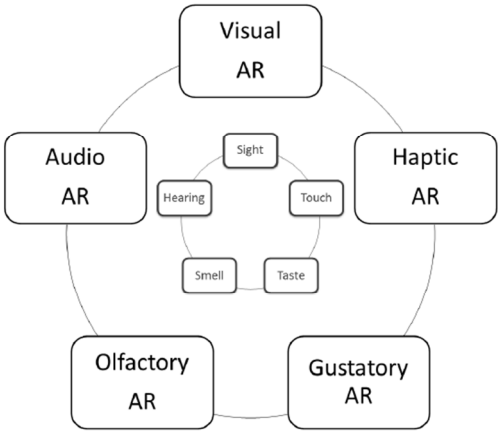

Fig. 2 – Different kinds of Augmented Reality based-on different human senses

1.2. Augmented Reality for equipment maintenance

Because of the necessary requirements for its use, both in terms of functionality and computing power, Augmented Reality had initially a limited diffusion and has been used in specific contexts, such as the military, medical and educational fields.

In recent years, Augmented Reality has had a considerable boost thanks to exponential spread of mobile devices such as tablets and smartphones as well as their increasing processing power. Modern devices are equipped with high resolution cameras that allow the acquisition of images and videos of excellent quality. These and other factors have contributed to the diffusion of Augmented Reality technologies, transferring AR from scientific laboratories to industrial applications as an aid to conduct daily operations.

Today, Augmented Reality represents a surplus value for many different applications. An important field for which we aim to apply Augmented Reality is equipment maintenance. For example, we can think to a technician who has the task to install/modify/fix specific components: in such scenario, a technician may be required to consult a considerable amount of printed documentation (e.g. datasheet) in order to understand the exact steps for the execution of his work. As we can see in Fig. 3, Augmented Reality can give important benefits: the operator, equipped with an appropriate device, can see real-time information he needs and he can obtain support for his work directly in the workplace, without spending time consulting technical documentation.

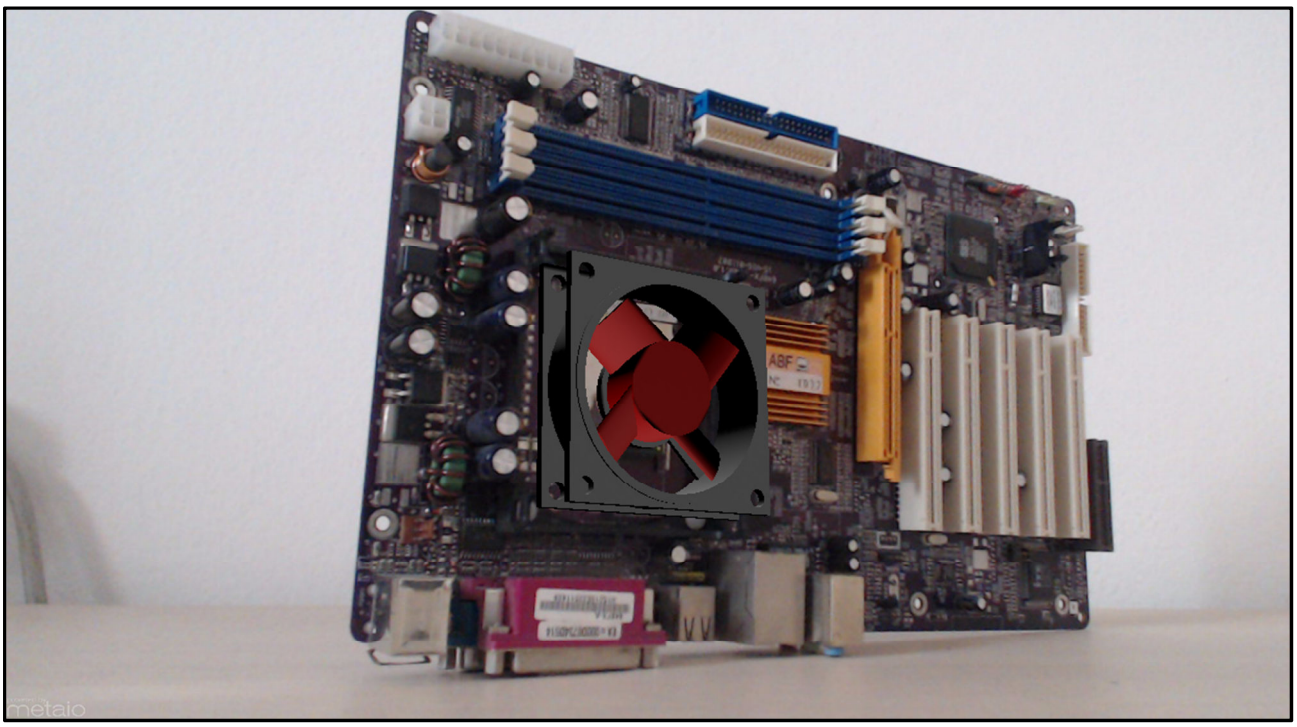

Fig. 3 – An *augmented* computer fan projected in real-time on a motherboard