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Pattern Independent Fiducial Marker Detection for an Interactive Public Display

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***Abstract*— The use of keyboard and mouse introduced with the advent of the first GUI operating system is a proven way of interaction with interfaces based on window, icon, menu and pointer (WIMP) paradigm, which has prevailed for few decades. Traditional input devices have limitations as they are originally designed to support two dimensional interfaces in single user environment, thus increasing interest on interactive software and use of novel ways of interaction. As a result, interaction using tangible real objects that can eliminate cumbersome intermediate input devices to provide natural interaction is deemed as an important approach for developing alternative interaction paradigms. This research attempts to develop an alternative interaction methodology to enable interaction using tangible real world objects with fiducial marker detection and using commonly available hardware such as webcam. The research explores two novel capabilities of using fiducial markers. First it attempts to enable pattern independent marker detection that can replicate mouse interface and finally it exploits multiple marker detection along with a multi-user driver to construct an interactive public display. Tests prove that both the attempts of the authors are applicable in practice and they promise to make human computer interaction more entertaining.**

***Keywords*— Computer Vision, Fiducial Markers, Interface: Interaction Devices and Tools, Virtual and Augmented Reality**

I. INTRODUCTION

The use of conventional intermediate input devices such as keyboard and mouse which was popularized with WIMP (window, icon, menu and pointer) paradigm is still predominant when users interact with computers. However WIMP is designed to support single user interaction. Hence it has become a major attraction for researchers as well as vendors to design and develop alternative natural interaction paradigms which can make Human Computer Interaction (HCI) more enjoyable and intuitive. Consequently, researchers have developed a broad range of new interfaces that diverge from the WIMP or direct manipulation interaction style [10]. However, they are not frequently made available for personal computing as additional hardware may be required and often a considerable amount of hardware engineering knowledge on the users' side is also demanded at the inception. In other cases special software such as 3D interfaces need to be developed to support them since support for WIMP paradigm is not provided [7].

Interaction using tangible real world objects is presumed to be a promising alternative. Manipulating physical objects is a natural mean of interaction for humans, and also a natural modality for human-computer interaction. This research makes a unique attempt to develop an alternative interaction methodology to enable interaction using tangible real world objects. It attempts to utilize fiducial markers to explore their applicability in the context of HCI.

II. AUGMENTED REALITY

The notion of augmented reality (AR) refers to overlaying computer generated virtual objects on real world environment. In [1] Augmented Reality is defined as, a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called. Prior to this [11] proposed Reality-Virtuality Continuum which includes AR as illustrated in Fig 1 since in AR typically, the surrounding environment is real and only a part of it can be virtual. VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, as opposed to complete replacement.

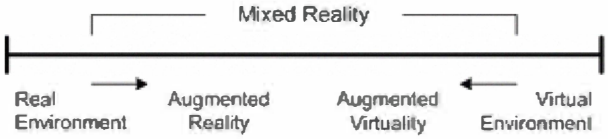

Fig. 1: Reality-Virtuality Continuum

Displays used for superimposing virtual objects on real environments they can be categorized into head-mounted, handheld and projective displays [2]. Early researchers used Head Mounted Displays (HMD) to create immersive virtual three dimensional environments for AR.

An example use of an HMD is described in [8] where a vision-based tracking method for table-top AR environments that finds pose information from multiple fiducials is discussed. Here the users wear Olympus HMDs with cameras attached. Thus the users experience a video see-through augmented reality, seeing the real world through the video camera.

There is ongoing research on HMD due to its applications on Ubiquitous Computing and the problem with HMD is that when it is worn, a user cannot typically see the keyboard or mouse [9] and the user therefore, is limited to the use of markers. Thus, [2] states that displays, trackers and AR systems in general need to become more accurate, lighter, cheaper and less power consuming.

This research attempts to address the above consideration by using a low cost webcam. A prime aim of this work is to use commonly available hardware. Consequently for end-users, the use of the webcam can be more comfortable and easy as opposed to wearing a head mounted display.

III. FIDUCIAL MARKER DETECTION

Tangible augmented reality interfaces typically use fiducials made out of cardboard. Such tangible interfaces will

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