Science & Art Hand in Hand @ CVL

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Abstract – *In the Computer Vision Laboratory our work spans from basic scientific research to industrial projects, but our interest in wider impact of such technology on society and the interest in contemporary art, brought our attention also to the applicative field of use of computer vision methods in art. And art is definitely a perfect testbed for our research. The talk will walk us through a few projects, proving the complementary nature of science and art from our perspective: 15 Seconds of Fame, Virtual Skiing, Dynamic Anamorphosis, Virtual Dancer, Smart Wall and Virtual painter, from face detection, motion following, depth recovery, touchless human computer interaction to pop-art, constant eye gaze of a person on the portrait, regardless of where the spectator stands, immersion into different virtual worlds without the need for any special equipment.*

Keywords - *Computer Vision, Contemporary Art, Face Detection, Tracking, Depth Recovery, Transformations, Human-Computer Interaction, Virtual World, Social Impact*

1. INTRODUCTION

Human ability to function in multiple disciplines, communities is again becoming very important. Latest observations in computer vision community are also showing the need for collaboration between computer vision community, computer graphics community and contemporary art community. We are talking about some kind of convergence, even though the idea has been around for some time now.

A wider discussion is always appreciated as similar problems are enlightened from different perspectives. In such a way a specific professional terminology becomes community-independent (or at least less dependent), similar solutions are refactored, joined, improved, the ideas become clearer, new applicative areas are found.

By following this philosophy, we initiated collaboration between the Faculty of Computer and Information Science and the Academy of Fine Art and Design at the University of Ljubljana. To be more precise, the collaboration between the students of both faculties within the undergraduate subject Communication Methods at the faculty was initiated by prof. Franc Solina (Faculty of Computer and Information Science) and prof. Srečo Dragan (Academy of Fine Art and Design). The successfull collaboration resulted also in the establishment of the formal association called ArtNetLab [1], which core purpose is to support fusion of science and art.

This is way the next section talks about the way the students collaborate and points to some latest projects like Virtual Dancer, Smart Wall. Because of our interest in contemporary art and also because of seeing art as the perfect testbed for our research, a new and interesting applicative area for us, we also developed some installations out of the scope of the mentioned undergraduate subject. Thus, in section 3 we present a project 15 Seconds of Fame, an interactive art installation, which elevates the face of a randomly selected gallery visitor for 15 seconds into a work of art. In section 4 we describe another project called Dynamic Anamorphosis, an installation that enables constant eye gaze of a person on the portrait, regardless of where the spectator stands. Virtual Skiing and Virtual Painter ideas are discussed in section 5, and the conclusion are given in section 6.

2. HOW COMMUNITIES COLLABORATE?

At the Academy of Fine Art and Design they have a Department for Video and New Media. Postgraduate students studying at this department develop an idea that incorporates new technologies into it. Since the art students are less experienced with technical development, have less engineering skills, we form a project group around them. The project team normally consists of one art student and two to four undergraduate students from the Faculty of Computer and Information Science in their final year of study. The advisor is also assigned to them to help them successfully carry out the project in the given time-frame, to monitor the progress, to suggest, point out the right approach.

Each year we form around 10 teams and they have a bit less than a semester to finish the project, present it and write a final report. The projects are then also presented, exhibited at different festivals.

2.1. Virtual Dancer

One of the latest interesting projects was Virtual Dancer, a system for interactive virtual dance performance. The system allows to define a set of visual markers and to associate them with visual icons in the interactive video (Figs. 1 and 2). By tracking the markers, dance moves are transferred to the interactive video on screen in real time. The implementation integrates standard tracking methods and modifies them to support fast moving markers, small markers and discontinuous tracking of markers [2].

Fig. 1. The real dance: The dancer is marked with four hypothetical markers. The positions of the markers were chosen by the dancer

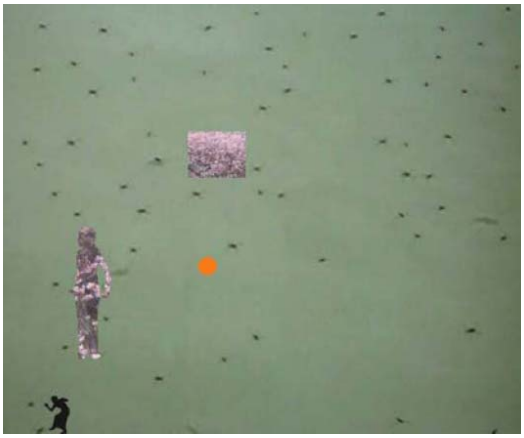

Fig. 2. The virtual dance: Four markers were chosen in the real world so the virtual world has also four markers

2.2. Smart Wall

Another project was Smart Wall, which provides a platform for a rapid prototyping of computer supported interactive presentations that sense human motion. The system is composed by a front-end application, where the user defines a number of hot-spots in a camera view (Fig. 3), a hot-spot processor, which senses the activity (detects the change) in each of the hot-spots, and a player, which displays interactive content triggered by the activity in the hot-spots.

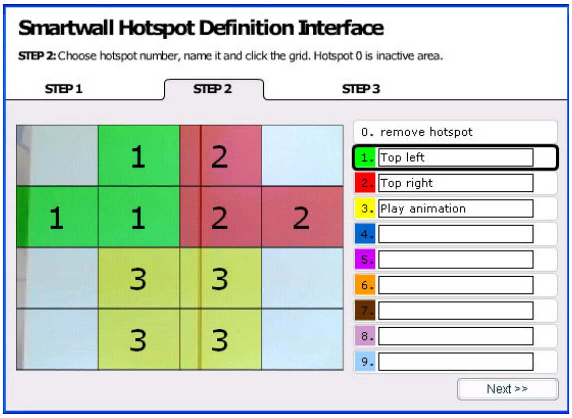

Fig. 3. Hot-spot definition interface

More projects? Sinking; Morphing; Demon; An Invitation for a 20th Century Dinner; Interactive Meeting – just to name a few dealing with computer vision methods in art. Some interesting projects are wider in the sense that they are integrating new technologies and not specifically computer vision, for instance Touch Animation; Protocols, Communications and Expanded Media (A Place of Home); Data Dune.

Everybody involved in the process gain a lot: an artist gets the possibility to put his/hers idea into life, science/engineering students get hands on practice, go through the project phases, learn to listen to and understand the customer, they all learn a lot and at the end they are all enthusiastic because of the working installation, product.

All descriptions of the mentioned projects are available on the Internet [1].

3. 15 SECONDS OF FAME

15 Seconds of Fame is an interactive installation, which every 15 seconds generates a new pop-art portrait of a randomly selected person from the audience [1,3]. The installation was inspired by Andy Warhol's ironical statement that "In the future everybody will be famous for 15 minutes". The installation detects human faces in digital images of people who are standing in front of the installation. Pop-art portraits are then generated from randomly chosen faces in the audience by applying randomly selected filters. These portraits are shown in 15 second intervals on the flat-panel computer monitor, which is framed as a painting. Electronic copies of each displayed portrait can be ordered by e-mail.

3.1. Motivation

Warhol took faces from mass media, banal in their newspaper everydayness, and transformed them into portraits. Warhol portrayed in this fashion celebrities from arts and politics. The installation tries to make instant celebrities by reversing

Warhol's process – making Warhol-like celebrity portraits of common people and putting them on the gallery walls to make the portraitees implicitly famous. Since 15 minutes would hardly make the installation interactive the fame interval was shortened to 15 seconds. The faces for the portraits made by the installation are selected by chance out of all people in front of the installation to allude that fame tends to be not only short-lived but also random. In his film and video projects Andy Warhol was in fact fascinated with celebrification of "nobodies", which marks the beginning of an era in which media attention became the new mirror of the individual's self-perception.

3.2. How the installation works

The visible part of the installation consists of a computer monitor framed like a painting. A digital camera is hidden behind the frame so that only a round opening for the lens is visible. Pictures of gallery visitors, which are standing in front of the installation are taken every 15 seconds by the digital camera using a wide-angle lens setting (Fig. 4). The camera is connected to a computer, which detects all faces in each picture, randomly selects a single face, makes a pop-art portrait out of it and displays it for 15 seconds on the monitor.

Fig. 4. People in front of the 15 Seconds of Fame installation

The color-based nature of our face detection makes it sensitive to illumination. Since it is not always possible to exhibit the installation under daylight or white-balanced studio illumination, we improved our face detection results by applying color compensation methods to make the whole system more flexible.

To make his celebrity portraits Warhol segmented the face from the background, delineated the contours, highlighted some facial features, started the process with the negative, overlaid the image with geometric color screens etc. We tried to achieve similar effects with a set of filters that achieve effects similar to segmentation. The filters drastically reduce the number of different colors by joining similar looking pixels into uniform regions. They combine three well known filters: posterize, color balance and hue-saturation with an additional process of random coloring. In this way, we achieve millions of different effects.

Our primary goal was not to mimic Andy Warhol's pop-art portraits per se, but to play upon the celebrification process and the discourse taking place in front of the installation. In comparison to other video camera based art installations, ours does not require exact positioning of observers due to automatic face detection with the additional benefit that a group of people can interact with the installation simultaneously. The interaction is technically very simple – no visible interface is actually involved – but unpredictable and socially revealing.

4. DYNAMIC ANAMORPHOSIS

4.1. Motivation

Fig. 5. On the bottom of the painting appears a diagonal blur, which appears as a human skull when viewed from the upper right (The Ambassadors by Hans Holbein)

The concept of dynamic anamorphosis is defined in [4]. A classical or static anamorphic image requires a specific, usually a highly oblique view direction, from which the observer can see the anamorphosis in its correct form (Fig. 5). Dynamic anamorphosis adapts itself to the changing position of the observer so that wherever the observer moves, she/he sees the same undeformed image. This dynamic changing of the anamorphic deformation, in concert with the movement of the observer, requires from the system to track the 3D position of the observer's head and the recomputation of the anamorphic deformation in real time. This is achieved using computer vision methods, which consist of face detection/tracking of the selected observer and stereo reconstruction of its 3D position, while the anamorphic deformation is modeled as a planar homography. Dynamic anamorphosis can be used in the context of art installation, in video conferencing to fix the problem of the missing eye contact and can enable an undistorted view in restricted situations.

Anamorphosis serves as a model for the concept of the gaze, which suggests that visual appreciation rather then passive "looking" requires active "observing".

4.2. How the installation works

We use a face detection method to determine the position of the user's face in the pictorial plane. Face detection is now a mature technology and can run in real-time. For head tracking we must detect the faces in every frame. To improve the tracking we use addition clues such as motion, skin color or near-infrared image. By using two or even more cameras and the principle of stereo reconstruction of distances, we can further determine the position of the user's head in 3D space. The most difficult problem in stereo reconstruction is the correspondence problem – to find for a given point in the left image the corresponding point in the right image. Since the number of possible matches goes into thousands of points this is a computationally intensive task. The correspondence problem in this particular case is solved by finding faces in both images first. Next, only correspondences between faces need to be established.

We approach the stereo matching problem as a matching between homologous faces, instead of point matching. The main idea is to determinate a unique disparity value for the whole face region and no longer for the individual pixels. After we detect the position of faces in both stereo images, we construct a graph for each image where face blobs are represented as nodes in the graph. To find homologous faces in both stereo images, we perform graph matching. The computational process is simple and fast since we consider only complete face regions.

Fig. 6. Transformed frame of a video clip, when the user views it under 30° angle from the right (Big Brother from the film after George Orwell's novel 1984)

At the end we deform the projected image of the face in such a way that it looks undeformed from the viewpoint of the observer (Fig. 6).

Dynamic anamorphosis disassociates the geometric space in which the user moves from the visual cues she/he sees, since wherever the observer moves she/he sees the same image. The installation promotes a human face (Fig. 6) with the eye gaze directed straight ahead to meet the eyes of the installation user. It requires a dark room with the video projection over an entire wall so that the only visible cues seen by the user are given by the projection. The light reflected back into the room from the projected image must sufficiently illuminate the scene that face detection can be performed. Since the installation can truly be experienced only by a single user, the entrance to the room with the installation should be controlled.

5. IMMERSION INTO VIRTUAL WORLD

5.1. Virtual Skiing

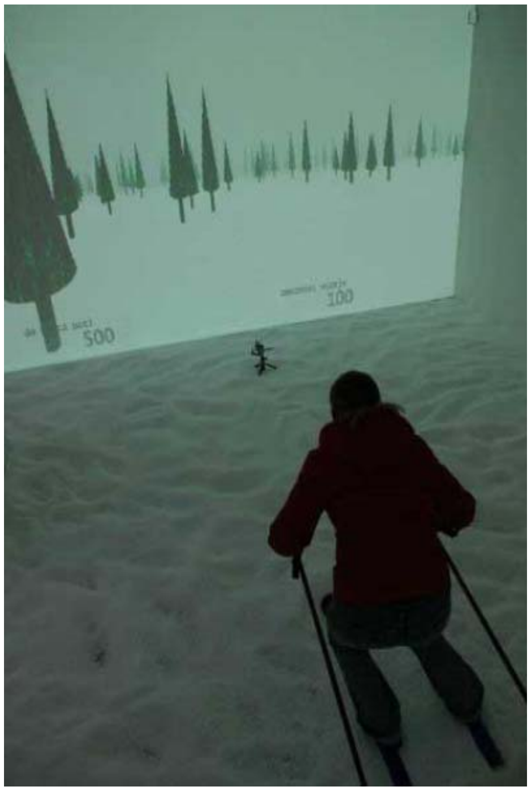

Fig. 7. Immersion in the Virtual Skiing installation

An interactive installation Virtual Skiing [1,5] enables a visual immersion into the feelings of gliding on snow through a winter landscape. The computer rendered winter landscape is displayed over the entire wall in front of the skier. As on real skis you can regulate the speed of descent by changing the posture of your body so that the air resistance is decreased or increased. By shifting the weight of your body to the right or left ski you can make turns down the slope between the snow capped trees. The interface to the virtual world is again implemented by computer vision techniques, which capture the posture of the skier's body. Fig. 7 gives an example of the installation setup and its usage. The skier's movements are recorded using a video camera placed in front of him and processed on a PC in real time to drive the projected animation of the virtual slope.

5.2. Virtual Painter

Another example of immersion into a virtual world is given by the installation Virtual Painter. As suggested by the name itself, a user of it can paint without the actual paints, while the painting forms itself on the computer or projection screen, it can be stored, printed. As in the previous cases the camera is observing the user in front of the installation and tracks hers/his palm. The movement of palm is then transformed into streaks in the painting. With the second hand you can simply switch between the colors on the pallet by raising the hand. An example of the interaction with the installation is given in Fig. 8.

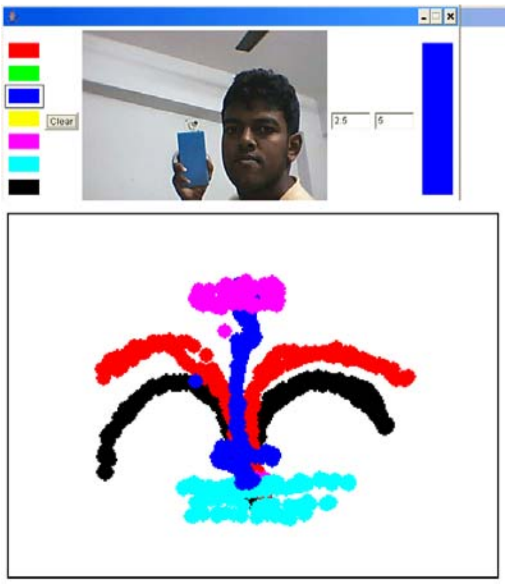

Fig. 8. Painting in the Virtual Painter installation (beta version)

6. CONCLUSION

The main idea behind this paper is to prove or at least give a very good indicator that art is a perfect testbed for computer vision based research in many cases, giving you a very multidisciplinary feeling. This indicator is provided through the summarization of the projects in the Computer Vision Laboratory dealing with the convergence of topics mostly in computer vision, graphics and contemporary art communities.

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