Multiple Body Tracking for Interactive Mobile Projectors

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Abstract

Detecting false bodies is a common problem in gesture recognition. It is becoming a harder problem for the projection displays. This paper introduces a novel secure control technique for mobile projectors , which combines retroreflectors, a light source and a processing unit. Retroreflectors reflect incident light back toward the direction of the light source, therefore the technique is based on a relatively simplistic algorithm which can detect multiple bodies real time and at high refresh rates.

1. Introduction

Mobile projectors use passive screens where remote tracker technologies become very important. A control interface of such a system has to be remote to maintain simplicity of the screens, which can be achieved using photo detectors [1] or cameras.

Available pattern recognition algorithms suffer from detecting false bodies and unintended gestures and require high computational power. This paper introduces a control technique based on retroreflectors, a single pico projector as light source and a processing unit. Unlike [1], the introduced technique does not require additional electronics, suitable to variety of displays beside scanning based displays and it is able to detect multiple bodies at the same time which makes the system to be suitable for additional application fields such as gaming [2], motion capture and augmented reality. The system provides also security or privacy as the retroreflected light can only be detected from a narrow viewing angle.

2. Concept of the interface

Retroreflectors [3] are able to send the incoming light rays back to the light source with high acceptance angle. They are highly visible for an observer standing in the place of the light source. They can be easily distinguished from the environment. Since it is physically impossible for two bodies to stand in the same place in the space, a conjugate of the light source must be created by using a beam splitter, see Figure 1. As observer, a camera or a photo detector can be used.

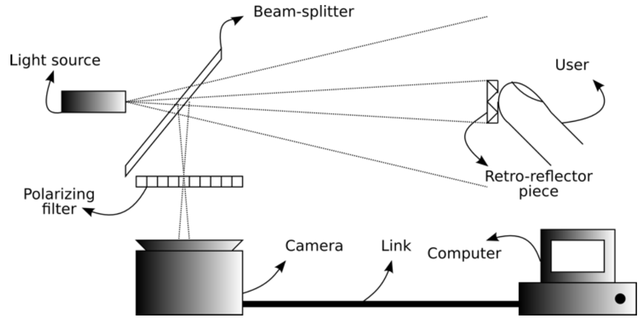

Fig. 1. Schematics of the secure control interface for next generation display systems.

There are environments, which can have strong Brewster's reflections from surfaces; such an environment can be filtered by using a polarizing filter in front of the observer. Thus, the observer will not detect these reflections as false bodies. The polarizing filter should have the same state of polarization as the light source.

3. Software

The bodies can be distinguished by using a simplistic detection algorithm [4].

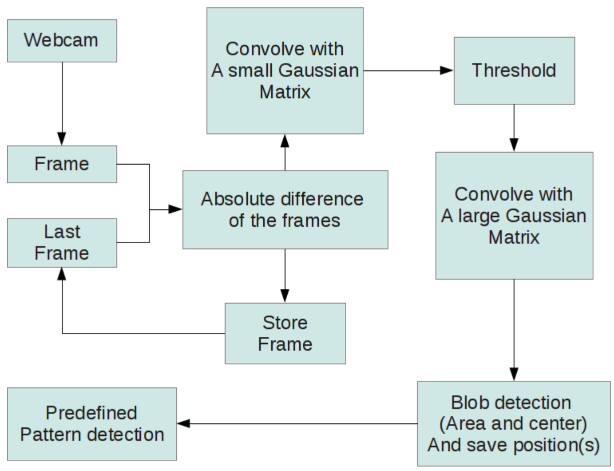

Fig. 2. The used algorithm scheme; showing how to detect the position of the retroreflector elements.

A detection algorithm is vulnerable to false body detection and threshold adaptation properties with the changing environment. But the case is solved with the introduction of the retroreflector which causes the creation of nearly saturated pixels on a CCD. Therefore a simple algorithm as in Figure 2 can be used to find the locations and areas in the perceived image.

4. Prototype

A prototype is realized so that the application possibilities of such a control interface can be observed, see Figure 3. Note that the projection surface shown in Figure 3b is below the projector shown in Figure 3a.

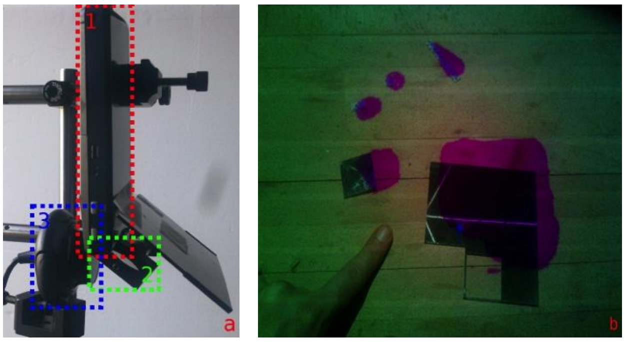

Fig. 3. (a) Photograph of the realized prototype (1: Pico projector, 2: Beam-splitter, 3: Camera with a polarizing filter). (b) Photograph from the projection surface, Pink color shows the detected blobs (Blobs are shifted to be visible).

In Figure 3a, as the light source, a pico projector from Microvision based on laser scanning technology [5] is used; so that the system becomes more compact and does not require an additional light source to display images and to detect retro-reflector positions.

3. Results and discussions

Two different retroreflector samples, from 3M and Reflexite, were used in prototyping. Corner cube structure of retroreflectors used in prototyping can be seen under Figure 4. Unlike the retroreflector from Reflexite, the retroreflector from 3M does not have a high fill factor and it has limited light diffusing property. It is observed that both retroreflectors create nearly saturated pixels in the perceived image which makes both of them suitable for use.

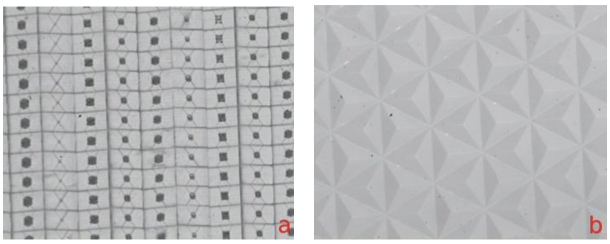

Fig. 4. (a) Microscope photograph of the retroreflector from 3M (5x). (b) Microscope photograph of the retroreflector from Reflexite (5x).

Under conditions where the projected image is a blank black screen, an additional infrared source can be used as the light source; existing cameras are able to detect light from near infrared region. The existing portable devices such as cell phones contain a camera and with a simple beam splitter any device can adopt the introduced technique. As the technique is free from the form and the technique of the display, it is highly adoptable for next generation displays. As an additional application field; the detected blob size can be used for distance measurement which makes the technique suitable for stereoscopic applications.

4. Conclusion

A secure detection interface employing retroreflectors which is suitable for existing and next generation projection displays is introduced and presented. The technique is able to avoid false body detection. Used algorithm in the proposed system is simplistic and suitable for mobile devices. The algorithm can run in high refresh rates. It is believed that the introduced technique can be used in different application fields such as distance measurement.

References

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