

CapacitiveMarker: Novel interaction method using visual marker integrated with conductive pattern

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ABSTRACT

The visual markers have spatial limitations to require certain distances between a camera and markers. Meanwhile, as capacitive multi-touch displays on mobile devices have become popular, many researchers proposed interaction techniques using conductive patterns and a capacitive display. In this study, we propose a novel visual marker, “Capacitive-Marker”, which can be recognized both by a camera and a capacitive display. The CapacitiveMarker consists of two layered markers: a visual marker printed on a seal and a conductive pattern on a plastic film. We also propose a new interaction method using CapacitiveMarker through applications.

Author Keywords

Visual marker; conductive pattern; capacitive touch display

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

Many researchers have proposed the interaction techniques using visual markers and cameras attached on mobile devices[2][3]. These interaction methods are quite popular because of their simplicity and cheapness. However, they have spatial limitations come from the angle of view of cameras; that is, the camera cannot detect markers in close positions. Meanwhile, many researchers come to propose interaction techniques using conductive patterns and a capacitive touch display[1][4]. These techniques can detect the ID and locations of objects on the touch display. However, these systems also have spatial limitations; that is, they cannot detect “hover” actions over the display. In this study, we propose a novel visual marker, “CapacitiveMarker”, which can be recognized both by a camera and a touch panel. The CapacitiveMarker consists of a visual marker attached on a conductive pattern (Figure 1). Using the CapacitiveMarker, the system can detect the ID, position, and direction of the marker both in hover state and touch state (Figure 2). We also propose

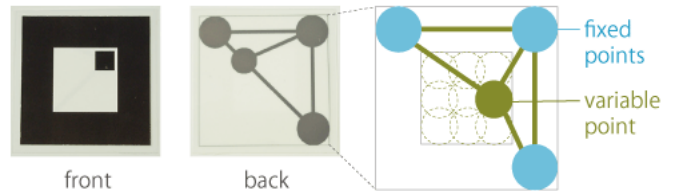


Figure 1. The structure of the CapacitiveMarker. A visual marker is attached on a conductive pattern. The marker width is 40 mm.

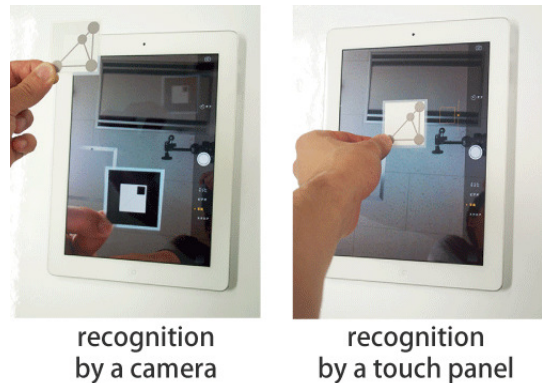


Figure 2. The feature of CapacitiveMarker. The marker can be detected both by a camera (in hover state) and capacitive display (in touch state).

a new interaction technique using CapacitiveMarker through applications.

CAPACITIVEMARKER

The CapacitiveMarker consists of two layered markers: a visual marker printed on a seal and a conductive pattern on a plastic film. The visual marker is designed as compatible with the ARToolKit¹. The conductive pattern has three fixed points on the corner and a variable point on the center. The fixed points are used to detect the position and direction of the marker, and the variable point is used for the ID recognition (Figure 1 right). We call these points as “touch points”. We made nine conductive patterns by changing the position of the variable point. Since the conductive pattern is hidden by the visual marker, it looks like common visual marker.

We explain the recognition method of capacitive patterns. First, the system recognizes the position of the marker using the three fixed points. When a user puts a marker on a touch panel, the system detects “touch events” on all touch

¹<http://www.hitl.washington.edu/artoolkit/>

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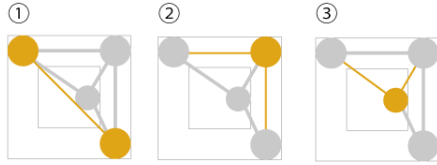


Figure 3. The procedures of the recognitions of conductive pattern.

points. The procedures are as follows: (1) The system calculates the distance between every pair of touch points and selects the pair that has maximum distance as diagonal fixed points (Figure 3: 1); (2) The system finds another fixed point located in the same distance from the above points (Figure 3: 2). In this process, the variable point is possibly located in the same distance from the diagonal points. In this case, the system recognizes the further point as the fixed point. Next, the system detects the ID of the marker. The system treats the remained point as the variable point and (3) calculates the ID based on the distances between the variable point and the two of fixed points (Figure 3: 3).

The CapacitiveMarker is designed for a common mobile device that equips a camera and a capacitive touch display. The system can detect the ID, position, and direction of the marker both in hover/touch states. For example, when the user hovers the marker over the device, the camera can recognize the visual marker. Then, when he/she puts the marker on the device, the touch display can detect the conductive pattern.

APPLICATION

We developed a map application using the CapacitiveMarker. In this application, a user can smoothly change the viewpoints by the marker states. For example, when a user hover the marker over the display, he/she can control the map from the overhead view. Then, when the user puts the marker on the map, he/she can control the map from the ground view (Figure 4). We applied Google Map as the overhead view and Google Street View as the ground view. In the overhead view, the user can control location and zoom of the map by X-Y movement and Z movement. Next, when the marker comes closer to the camera, the system restricts the control of the map to prevent unwilling operations. Then, when the user puts the marker on the display, the system recognizes the conductive pattern and shows the map in the ground view. In this view, the user can control the direction of the map by rotating the marker. We also try to develop the function to move to neighbor maps by moving the marker. Thus, the user can smoothly control maps from different viewpoints.

The physical handle for the CapacitiveMarker

Since the CapacitiveMarker has a thin-film shape, users may have handling difficulty. For example, a user needs to hold the edge of the marker without (1) touching the display and (2) hiding the visual marker. To solve this problem, we developed a physical handle, which aims for stable operations using the CapacitiveMarker (Figure 5). We attached the marker on the bottom and electrically connected the edge of the marker with the handle using copper tapes. We plan to design further

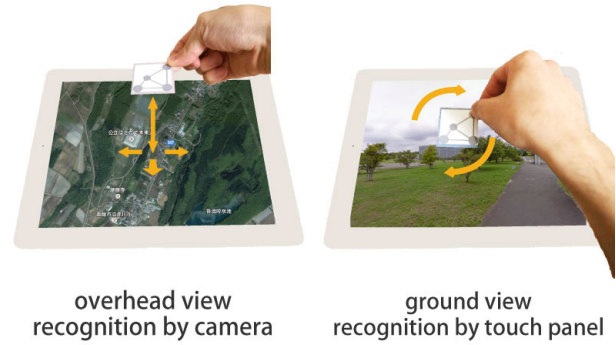


Figure 4. The map application. A user can change the angle of view by state of a marker: hovering or touching.

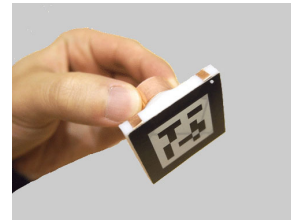


Figure 5. The physical handle integrated with the CapacitiveMarker. The copper tapes connect the handle to the edge of the marker.

physical shapes (e.g., cards or daily commodities) suited for the CapacitiveMarker.

SUMMARY AND FUTURE PROSPECTS

In this paper, we proposed the CapacitiveMarker, which can be recognized both by a camera and a touch panel for smooth operations in “hover” and “touch” states. We developed marker prototypes, a map application, and a physical handle for stable operation. In near future, we will solve the limitations of the current system (e.g., recognition rate of the conductive marker), develop further applications, and perform usability study.

ACKNOWLEDGEMENT

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