Gestural Interfaces for Micro Projector-based Mobile Phone Applications

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figure 1. Our prototype: A mobile phone and a micro projector assembled to a wearable gadget

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Motivation and Idea

Unobtrusive visual feedback is one step towards the vision of ubiquitous computing where computers become unnoticed assistants in the background. Recently, tiny projectors connectable to mobile devices hit the market. These gadgets allow the augmentation of nearby real-world objects (e.g. walls) with overlaid digital information [2][4]. To fully shift the user's attention from the device to the actual content, also interaction methods should be detached from physical components. A recently demonstrated wearable system [3] shows the visual capturing of hand gestures to manipulate projected content. However, such approaches still rely on powerful laptop computers that have to be carried by the user in a backpack.

Figure 1 shows the setup for our highly mobile solution for gesture-enabled applications. It arranges a mass market mobile phone connected to a micro projector along a lanyard into one autonomous gadget worn around the neck. The phone's camera and the projector's light beam are oriented in the user's viewing direction to observe the current field of view and to screen content onto opposite surfaces, respectively. Our software framework exploits the phone's built-in camera to spot hand gestures. Information about detected gestures is offered via a special protocol to local applications in order to make them gesture-aware.

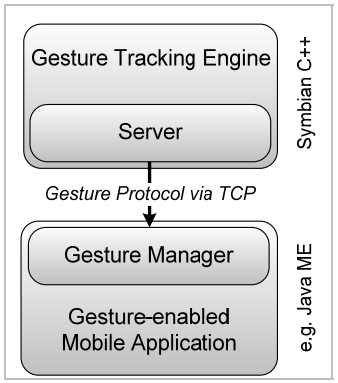

figure 2. Simplified architecture of the gesture detection framework

figure 3. Controlling a mobile 3D urban model through a panning gesture

Gesture Detection Framework

Our gesture detection framework is depicted in figure 2. Its tracking engine runs in the background analyzing the video stream delivered by the phone's viewfinder. To ease the visual detection of hand gestures performed in front of the camera, we attach colored markers to the user's fingertips. For each frame, our color-sensitive computer vision algorithm detects the positions of the defined markers and determines occurring events such as a marker's appearance, its move, and its disappearance. Based on these low-level events our system currently derives three gestures: panning (moving of one marker), scaling (changing the distance between spotted markers), and rotating (moving one marker on a circle line around another one).

After processing a video frame, both the detected events and gestures are encapsulated in a simple text-based protocol together with their appropriate parameters. To share this wrapped information in a language-independent way, our framework includes a small server component where local applications may connect to. Once bound, they are provided with the appropriate data and thus, may react accordingly.

Implementation

In our current setup, we use a N95 mobile phone from Nokia connected to a pocket projector PK101 from Optoma. The gesture tracking engine is implemented in Symbian C++. To show our approach's language independence the gesture-enabled applications are written in Java. For the rapid development of gesture-enabled Java applications, our framework comes with a ready-to-use gesture manager that transparently handles the gesture protocol and triggers actions defined by the application developer.

Demonstrations of our framework include drawing applications where users paint and write on an imaginary board in front of them to see the result on nearby wall. More advanced use cases demonstrate the gestural interaction with projected 2D maps and 3D urban models (figure 3) developed in our project ' WikiVienna' [1].

Summary and Outlook

The presented framework is executed on a common mobile phone and enables innovative gestural interfaces. The gesture protocol hides the complexity of visually capturing hand gestures from application developers: Existing applications can easily connect to the framework and thus, become gesture-aware.

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