Tracking Technology for Multiple Device Interaction

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ABSTRACT

We present an infrared tracking system, which consists of several identical beacons. These beacons are able to detect each other's relative position and orientation by transmitting and receiving in defined sectors.

This system enables a new way of interaction with available devices in a collaborative workspace, e.g. dragging and dropping data from a laptop to a projection device by moving a personal pointing device into the direction of the desired target.

ACM Classification: H5.2 [information interfaces and presentation]: User interfaces, input devices, and strategies (e.g. mouse, touch screen).

General terms: Human factors, design

Keywords: interaction device, infrared tracking, low cost network, video conferencing, remote collaboration.

INTRODUCTION

Today's meeting rooms integrate a lot of different devices. Laptops, projectors, PDAs, cameras, LC-displays, audio devices, printers etc. are used to set up a collaborative environment. Thus, the problem arises that the user does not know how to move the data to be displayed onto another device. Plugging and unplugging display devices to the active computer are time consuming and decrease the efficiency of team sessions. With a unifying system it becomes possible to use a personal pointing device intuitively on multiple displays.

This holds especially true for creativity sessions (such as brainstorming, technical design reviews, discussions, etc.), in which multiple information has to be transferred to different screens. The content of personal displays is frequently shifted to other displays and vice versa.

A major task of using and interacting with such an environment is to intuitively exchange data and views between devices. A new way to interact with the different devices is to have a drag and drop user interaction relative to the real environment. Moving a document from one laptop to another display can be done by just dragging it out of the screen towards the device's geometric location (figure 1).The interaction doesn't need a physical transport as in [2], is neither bound to the user's arm reaching area nor does it require a stylus compatible device [3].

The possibility of dynamically determining a geometric map of all devices in a room could significantly increase the intuitiveness of applications like PointRight [4].

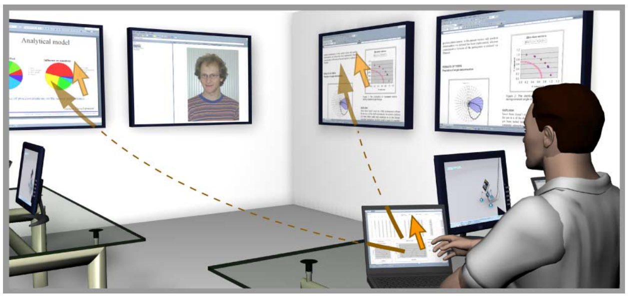

Figure 1: Dragging and dropping of windows from a laptop to another display device. Since the system knows where all devices are located, new directional interactions can be realized.

SYSTEM DESCRIPTION

To determine position and orientation of a device, a low cost infrared tracking system based on the principle of the angle of arrival has been developed. Unlike Hallaway [1], each beacon is identical and consists of an array of infrared receivers and emitters. Each transceiver has a defined field of reception/transmission. Thus, the beacon is separated into several sectors of transmission and reception (figure 2).

By sequentially switching the receivers and transmitters on and off, it becomes possible to determine the position and orientation of each beacon relative to each other (figure 3).

Each beacon is connected to a device (e.g. laptop), which has connection to the LAN. The determined direction vectors of each beacon are then exchanged via a network.

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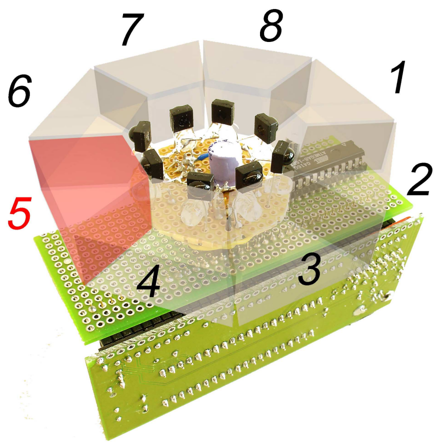

Figure 2: The realized prototype with visualized sectors. Each sector contains an infrared receiver and emitter. Sector 5 is receiving.

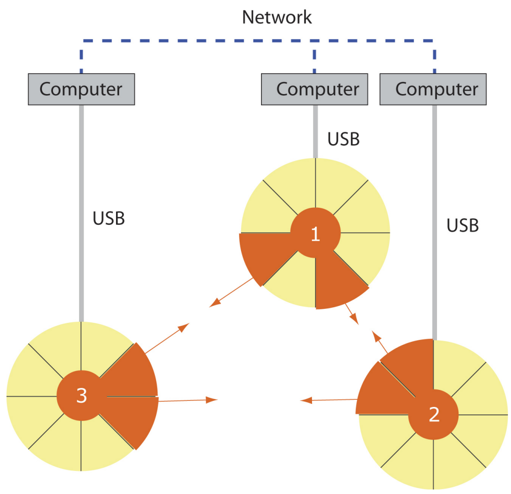

Figure 3: Sectorial determination of the relative position of each beacon. Each pair of sectors (receiver and transmitter) represents a direction vector. The vectors are exchanged via Ethernet network.

RESULTS

Precision of angle

The maximum deviation of the real angle compared to the determined angle was measured to 21°, while the mean angle deviation is 9.1° with a standard deviation of 6.1°. These values could be improved when using multiple devices with error correction algorithms.

Operational Range

The operational range of one beacon lies within a radius of 5.4 m, which is sufficient for normal meeting rooms.

Visualization

To test a setup with three beacons, a visualization application was implemented (figure 4), that shows the relative positions and orientations of present beacons connected to the network in a room.

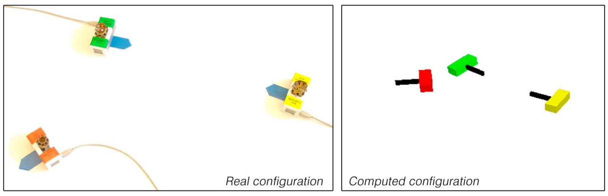

Figure 4: Left: Real arbitrary configuration of three beacons. Right: Test application showing the computed positions and alignments.

OUTLOOK

We are connecting existing collaborative software developed at ETH Zurich with our proposed system.

Communication between all beacons is planned to be realized only via infrared. This means that no additional network (Ethernet) has to be available to use position determination.

By using small SMD components a further miniaturization is possible.

CONCLUSION

We presented a system, which could significantly improve intuitive handling of multiple devices in a collaborative environment. This system can be used to determine the position and alignment of devices within a room. With the use of this system it becomes more intuitive for users to exchange data by just dragging and dropping them into the direction of the desired device.

Several tests have shown that the presented system is capable of determining the position and orientation of multiple devices precise enough to allow a proper interaction.

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