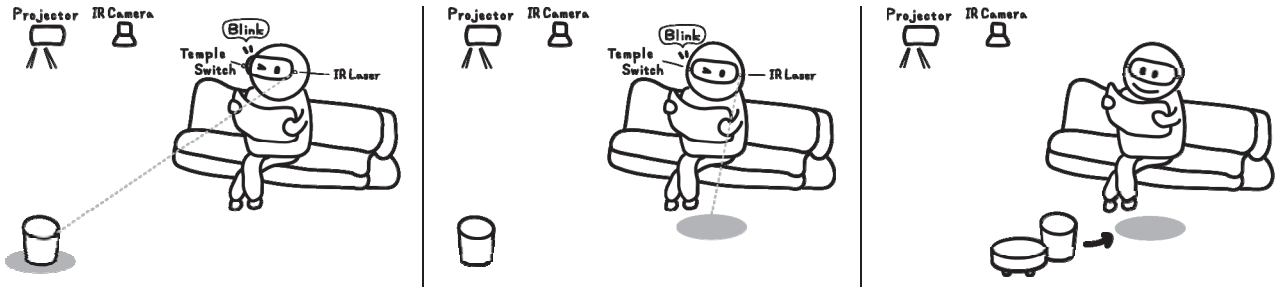
BlinkBot – Look at, Blink and Move

Pranav Mistry[2,1], *Kentaro Ishii*[1], *Masahiko Inami*[3,1], and *Takeo Igarashi*[4,1]
[1]Japan Science and Technology Agency, ERATO, IGARASHI Design Interface Project
[2]MIT Media Laboratory, [3]Keio University, [4]The University of Tokyo
pranav@mit.edu, {kenta, inami}@designinterface.jp, takeo@acm.org



(a) Selecting the object (b) Specifying the target location (c) Autonomous delivery

Figure 1: System overview: (a) The user selects the object by the first intentional blink. (b) The user then specifies the target location where the user wants a robot to deliver the object by the second intentional blink. (c) The robot performs the delivery task

ABSTRACT
In this paper we present BlinkBot – a hands free input interface to control and command a robot. BlinkBot explores the natural modality of gaze and blink to direct a robot to move an object from a location to another. The paper also explains detailed hardware and software implementation of the prototype system.

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General terms: Design, Human Factors

Keywords: Robot, blink aware interaction, human-robot interaction, hands free interaction

INTRODUCTION
Traditional interactive systems (computer interfaces, robots or electronic home appliances) require the user to use her hands to either type, move the mouse or press/manipulate controls. The multi-touch and gesture based interactions provide an intuitive alternative to the traditional interaction devices such as mouse, keyboard or data-gloves. But still the user has to use her hands and motor-senses. Speech is one alternative (e.g. [1]), but it is not good at directing a specific point in the field (c.f. "20cm south from the corner of the room"). In this research, we explore the natural modality of gaze and blink to control and command a robot.

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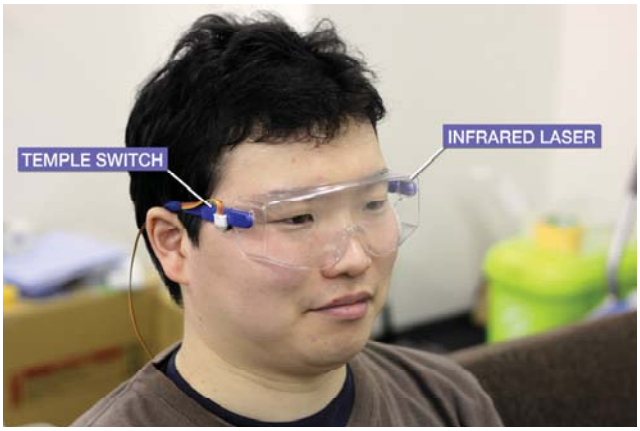

Figure 2: BlinkBot controller

BLINKBOT INTERACTION
Figure 1 illustrates the BlinkBot Interaction. With the wearable BlinkBot controller (Figure 2), the user can specify the real world location just using gaze, and trigger system actions with intentional blinks. Using this interaction, the user directs the robot to deliver an object to another location. In the sketched scenario, the user specifies the trash bin by an intentional blink. The projector on the ceiling projects a circle as a visual clue to show a selected target object. As the user redirects their gaze, the circle follows along to the new gaze location. When the user gives another intentional blink, the visual clue changes its color and stays; the robot starts working. The operation to the robot is done in a hands-free intuitive way. The robot pushes the trash bin to the destination, while the user can continue the user's own activity.

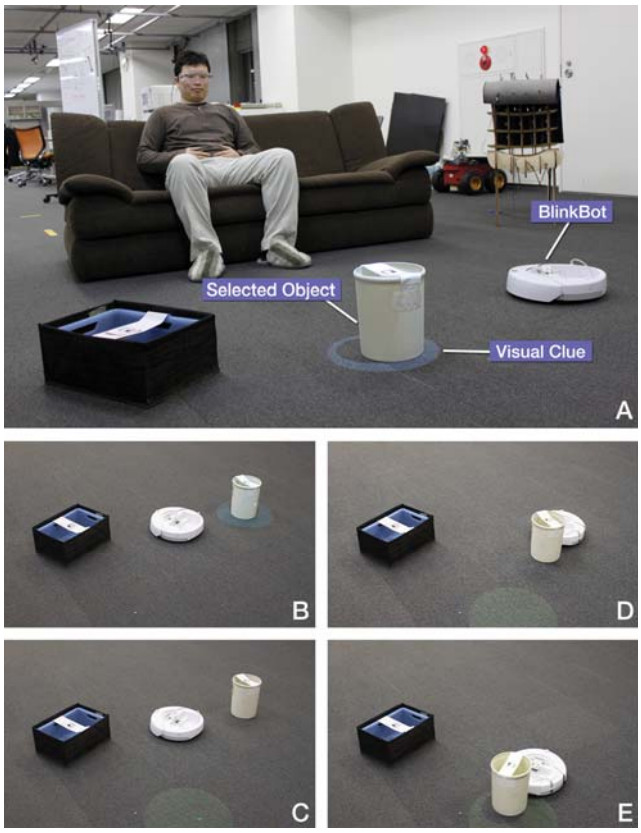

Figure 3: BlinkBot Interaction

IMPLEMENTATION

Figure 3 shows the working prototype system of BlinkBot. BlinkBot system is consisted of two major hardware components – BlinkBot controller and the BlinkBot (figure 4). The BlinkBot controller contains an IR laser module and a photoreflector (reflective photo sensor). The laser module is used for tracking gaze location and the photoreflector is used for detecting intentional blinking like KOMEKAMI switch proposed by Taniguchi et al. [3]. The signal from the BlinkBot controller is wirelessly sent using a ZigBee connection to the host computer of the system. This part of the system consists of the wearable controller, a microcontroller, and a battery.

At the other end, a computer processes the signals and controls the robot. There are four software modules working on the computer: control module, laser tracking module, robot and object tracking module, and robot driving module. The control module receives the signal from the user and all tracking modules, and directs the robot driving module so that the robot will move the object. The control module also displays visual feedback using an overhead projector. The laser tracking module tracks laser trails with the image acquired from a camera with an infrared band- pass filter. Since the band-pass filter shuts

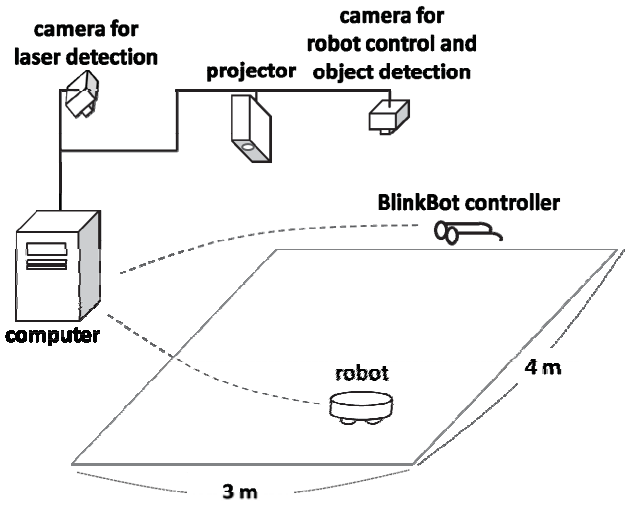

Figure 4: Hardware configuration

out the light except infrared light, the laser is easily recognized by tracing the most significant pixel on the image. The robot and object tracking module uses a camera and recognizes vision-based fiducial markers attached on objects. We use 3x3 matrix patterns to obtain location and orientation information of the objects. The projector and two cameras required for the tracking modules cover a 3m x 4m area as a robot working area. The robot driving module drives the robot using a pushing algorithm, which is simply to go behind the target object and push it toward the destination. Robot and object tracking and robot driving modules are explained in detail by Ishii et al. [2].

CONCLUSION

In this paper we presented BlinkBot - a novel interactive system that explores the natural modality of gaze and blink to control a robot to move an object from a place to another. The paper explained the user interaction and implantation details of the BlinkBot prototype system.

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