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# Eye Rings: What is the Role of Finger-Worn for Seamless Interactions with Our Surroundings?

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**ABSTRACT:** Finger-worn interfaces remain a vastly unexplored space for user interfaces, even though our fingers and hands are naturally used for referencing and interacting with the environment. In this paper, we present design guidelines and implementation of a finger-worn I/O device, the EyeRing, which leverages the universal and natural gesture of pointing. We present use cases of EyeRing for both visually impaired and sighted people. We discuss initial reactions from visually impaired users which suggest that EyeRing offers a more seamless solution for dealing with their immediate surroundings than the solutions they currently use. We also report on a user study that demonstrates how EyeRing reduces effort and disruption to a sighted user. We conclude that this highly promising form factor offers both audiences enhanced, seamless interaction with information related to objects in the environment.

**KEYWORDS:** Finger-worn; Pointing-based Interaction; Wearable Input Devices; Intuitive Interfaces; Human-Computer Interaction (HCI).

## I. INTRODUCTION

Artificial Intelligence (AI) is a branch of computer science that aims to enable computers to perform human-like tasks. AI is a broad discipline; machine learning is a specific branch of AI that uses computer algorithms capable of “learning” through the simulation of human intelligence. Machine Learning algorithms have been applied to the medical field since the 1970s and since that time have proven useful in AI.

The pointing gesture is fundamental to human behavior [5] and is used consistently across cultures. It begins at an early developmental stage [1] and lets human’s reference proximal objects as well as abstract concepts in the world. Pointing gestures, which are part of our gestural language, are inherently used for interaction. Given the recent increased interest in using speech to interact with mobile devices [13], it is a logical next step to support a user in pointing at an object while stating a comment or asking a question about it.

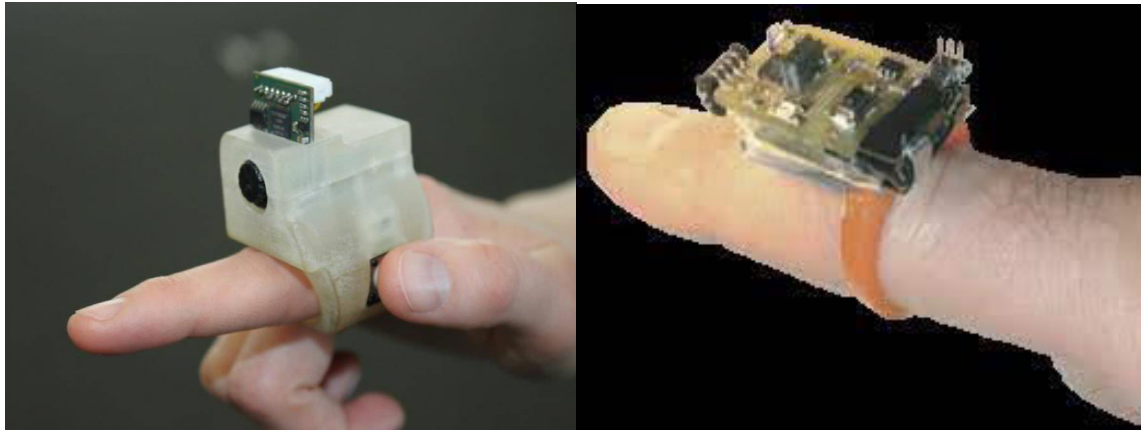
In this work, we present the Eye Ring, a novel design and concept of a finger-worn device. The ring apparatus is autonomous; however, it is counter parted by a mobile phone or computation device to which it connects wirelessly, and an earpiece for information retrieval. Despite the attention finger-worn interaction devices have received over the years, there is still much room for innovative design. Earlier explorations of finger-worn interaction devices may be divided into a few subspaces according to how they are operated: Pointing; Tapping/Touching; Gesturing; Pressing/Clicking On-Device.

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### Finger-Worn:

Finger-worn interaction devices have received noteworthy attention over the last few years from HCI researchers and experienced designers alike. Explorations of finger-worn interaction devices may be divided into several categories according to how they are operated. These finger gestures include (1) Pointing; (2) Tapping/Touching; (3) Gesturing; and (4) Pressing/Clicking On-the-Device. Remotely controlling objects in the environment by pointing with a wearable device was implemented in the Ubi-Finger [13] and FieldMouse projects. Efforts to attach and retrieve information from physical objects were implemented in and recently in using IR beacons and coded textures. However, these applications often require the environment to be instrumented with sensors and markers, which limits the interactions

with instrumented environments. Handheld, see-through AR systems that present auditory feedback and overlay information on top of a user’s field of view are probably the closest related work to EyeRing’s functionality.



**Model Classification:**

After modelling and analysis of the input hand image, the gesture classification method is used to recognize the gesture. The recognition process is affected by the proper selection of feature parameters and a suitable classification algorithm [2].

Euclidean distance metric used to classify the gestures [10]. Statistical tools used for gesture classification, the HMM tool has shown its ability to recognize dynamic gestures [11] besides, Finite State Machine (FSM), Learning Vector Quantization, and Principal Component Analysis (PCA). Neural networks have been widely applied in the field of extracting the hand shape [6] and for hand gesture recognition. The figure below explains the architecture of the classification system.

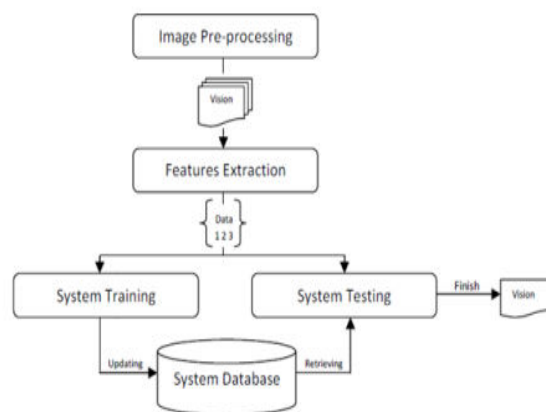


Figure: Architecture of gesture recognition system.

**Designing interaction with finger-worn devices:**

Rekimoto’s work on Augmented Interaction proposed several guidelines for designing unobstructed wearable technology: straightforward operation, using real-world situations as implicit input, and ensuring that the technology is socially acceptable. These guidelines suggest that users should be able to operate the device without holding it and the device should allow for “quick changes between normal and operation modes.” The goal is embodied in our work through the use of a camera and computer vision methods. In addition, the device “should be as natural and (conceptually) unnoticeable as possible for use in various social settings.” EyeRing is designed to look like a common wearable accessory, a wireless ring worn on the index finger, to appear less conspicuous. In addition, we consider the following to be important design considerations: leveraging the pointing gesture and minimal instrumentation of the environment.

### **Leveraging the pointing gesture:**

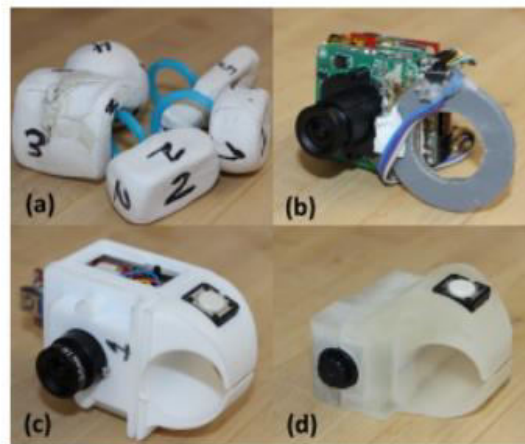
Finger-worn proposes to leverage attributes of the pointing gesture, the focus of attention, and the implied dialog, as guides for the device to support the interaction.

### **Minimal instrumentation:**

A generic system requires additional features to make the interaction specific and focused, which we try to achieve in EyeRing by leveraging the pointing gesture to infer what the user is interested in.

### **Design of assistive devices for the visually impaired**

The design of EyeRing was informed by recent insights into the design of assistive technology for the visually impaired.



**Prototypes of the EyeRing. (a) Clay models were used for initial exploration. (b) First working prototype. (c) Prototype with plastic casing. (d) Second prototype.**

The insights made by Shinohara through ethnographic research of assistive technologies struck the right chord with our intentions, most specifically their notions of independence, portability, and social acceptance. EyeRing is designed to support operation by both sighted and visually impaired users in the same fashion. It is worn on a finger and still allows one to use the hand a finger for feeling and holding. Even though it was not our primary concern, we also strive to make the device appealing for sighted people to wear, which inherently aligns with the claim that generic devices used both by sighted and non-sighted are far more successful.

Other design principles that resonated with us were independence, portability, and distinguishability of similar.

### **Hardware design:**

The first working prototype of EyeRing used a JPEG Camera, AVR processor, Bluetooth module, polymer Lithium-ion battery, and push button switch. These components were attached to a ring-shaped plastic piece (Figure B).

**Microcontroller:** A digital I/O pin is configured as an input and connected to push button switches for user interaction. Two UARTs are used in the AVR. One is used for serial communication and the other is used for setting up a Bluetooth communication channel.

**Image acquisition module:** The EyeRing design uses an image acquisition module based on the OV7725 VGA CMOS sensor and the OV529 JPEG engine

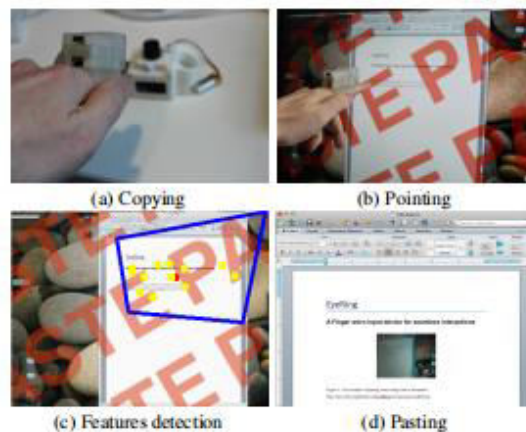
**Wireless module:** Bluetooth provides a good balance in terms of speed and availability compared to WIFI or Near Field Communication (NFC). Thus, the wireless communication between EyeRing and a mobile device is established using a Roving Networks RN-42 Bluetooth module with a baud rate of 115 kbps.

### Software design:

It has developed a Bluetooth communication module that connects EyeRing with a smartphone running Android 2.2 or with a Notebook computer running Windows 7. These modules receive binary image data from the ring, as well as button click events. Some of the computer vision algorithms (e.g. currency recognition, tag recognition) were developed in-house, and we used third-party software [8] for general object recognition. At this point, some of our computer vision software runs on the smartphone, while other applications run on the PC depending on the task at hand.

The software architecture (communication module and vision engine) allows for easy development of different applications.

### Initial reactions from visually impaired users:



During initial development, it was brought an EyeRing prototype to a group of people with vision impairments, those who are particularly interested in assistive technology. They were given the EyeRing prototype and told how they could use it. Some mentioned a few challenges they have when outside of a well-known environment. The idea of the shopping assistant was appealing to them because it helps distinguish objects. However, they raised a few concerns such as hesitation in using a camera as they have little to no experience taking photos and using the ring with basic phones or different operating systems. When it was asked to comment on the EyeRing interactions, many users commented that "It (EyeRing) can't get any easier." It was observed that the pointing gesture was intuitive to use; however, continuous feedback to assist in pointing at the right object might make it even better. They are in the process of incorporating continuous auditory feedback into EyeRing. They also conducted a shopping scenario case study of EyeRing with a blind user who had never used the device before.

## II. LITERATURE REVIEW

The motivation for the visually impaired to use pointing interfaces exists, although it stems from a different perspective. Turning to recent literature on interface design for the visually impaired, we note three desired qualities: assistive technology should be socially acceptable, work coherently for disabled and non-disabled alike, and also support independent and portable interaction [4].

Previous research work in the field of augmenting pointing gestures revolved around control [8] and information retrieval. These works and others utilize a specialized sensor between the pointing finger and the target, such as an infrared connection in the work of Merrill et al. [7]. This implies a pre-rigged environment, which inhibits natural interaction and limits the domain of use.

A generic multipurpose finger-worn input system was suggested by Chatterjee and Fumtoshi [3] who developed a device based on capacitive sensing, and more recently by Ogata et al. [9] who achieved the same with infrared sensors. Kim et al. [10] presented a similar interaction in the form of a wrist-worn device. These devices overcome several

drawbacks of the common data-glove systems [11], such as reduced physical contact between the hand and the environment, inconvenience of wearing and removal, etc.

### III. CONCLUSION & FUTURE WORK

EyeRing, which leverages the pointing gesture, shows the potential of building seamless interactions for people with vision impairments and sighted alike. The nature and design of the ring apparatus are driven by lessons from established design frameworks for both natural interaction and assistive technologies. Preliminary user reactions suggested that the use of EyeRing applications is intuitive and seamless. A controlled user study indicated that EyeRing is an immediately accessible device that performs faster than a smartphone application for a single object detection task. Future applications using EyeRing (or even multiple EyeRings) rely on more advanced capabilities of the device, such as real-time video feed from the camera, increased computation to perform low-level computer-vision tasks such as edge detection or optical flow, and additional sensors like gyroscopes. These hardware capabilities and applications are currently in development for the next prototype of EyeRing.

#### CONCLUSIONS:

In this paper various methods are discussed for gesture recognition, these methods include Neural Networks, HMM, and fuzzy c-means clustering, besides using orientation histogram for feature representation. For dynamic gestures, HMM tools are perfect and have shown their efficiency, especially for robot control [11][8]. NNs are used as classifiers and for capturing hand shape in [6]. For feature extraction, some methods and algorithms are required even to capture the shape of the hand as in, applied Gaussian bivariate function for fitting the segmented hand which used to minimize the rotation affection [9]. The selection of a specific algorithm for recognition depends on the application needed. In this work application areas for the gestures system are presented. An explanation of gesture recognition issues and a detailed discussion of recent recognition systems are given as well. A summary of some selected systems is listed as well.

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