# iLight: Information flashLight on Objects using Handheld Projector

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## Abstract
Handheld Projectors are novel display devices developed recently. In this paper we present iLight, Information flashLight, which is based on the ongoing research project Guiding Light [9] using a handheld projector. By using a handheld projector with a tiny camera attached on it, system can recognize objects and augment information directly on them. iLight also present a interaction methodology on handheld projector and a novel real-time interactive experiences among users.

## Keywords
Augmented Reality, Handheld Projector, Object Augmentation, Interactive Object

## ACM Classification Keywords
H5.2. [Information interfaces and presentation (e.g., HCI)]: Input devices and strategies.

## General Terms
Design

## Introduction

Handheld Projectors are novel display devices developed recently. Many manufacturers (e.g.[1,2]) introduced various model of them, and they are handheld and lightweight hence extremely portable. However, people treat tiny projectors as merely a variant of the typical mounted projectors – just displaying the presentation, movie, or similar contents on the wall.

When handheld projectors are combined with mobile phone [3], this combination inspires innovative interactions. Recent mobile phones are becoming comprehensive sensor platforms that include vision sensor such as a camera, and a gesture sensor such as an accelerometer. By merging the displaying capability of mobile projector with the rich sensor environment and networking ability of the mobile phone, novel interaction experiences can emerge.

In this paper, we present iLight that is based on the ongoing research project Guiding Light [9] at MIT Media-Lab. The core metaphor involved in this research is that of a flashlight which reveals objects in and information about the space it illuminates. iLight system is capable of recognizing an object by a vision sensor, and it augments information around the object by a projector, and interacts with users by various sensors and network.

## Related Work

Wear Ur World (WUW) [4], also known as sixth sense, introduced the vision-based wearable gestural interface using a small projector. Camera shares the vision – camera sees what the user sees – and a small projector is attached on the user's hat or hanged as a pendant. This work focused on gesture recognition and object augmenting technique. Bonfire [5] is another approach to use a handheld project as a nomadic system for hybrid laptop-tabletop interaction. This system is capable of recognizing everyday objects and provides augmenting interaction with physical objects. This work is also related with vision-based object positioning and calibration techniques on projector environment (e.g. [6, 7]). Those advanced techniques provide real time tracking of object and calibration with great precisions.

## Application Design Motivation and Ideas

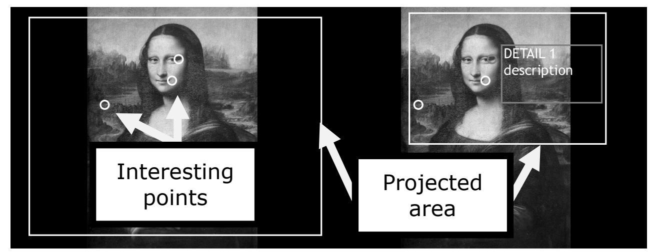


**Figure 1.** iLight is the information flashlight that augment information directly on object. The granularity of information depends on flashed area. (Left) Larger portion with general information (Right) Smaller portion with detailed information

The main idea was started from this simple question,

*"What is this picture in front of me?"*

At the museum, we often encounter a very puzzling situation. Even though we see a picture and read the description, sometimes we still cannot understand what's going on in the world of art. Moreover, sometimes we cannot even find any descriptions. We frequently just glance objects we cannot understand, and miss a great portion of what can be truly

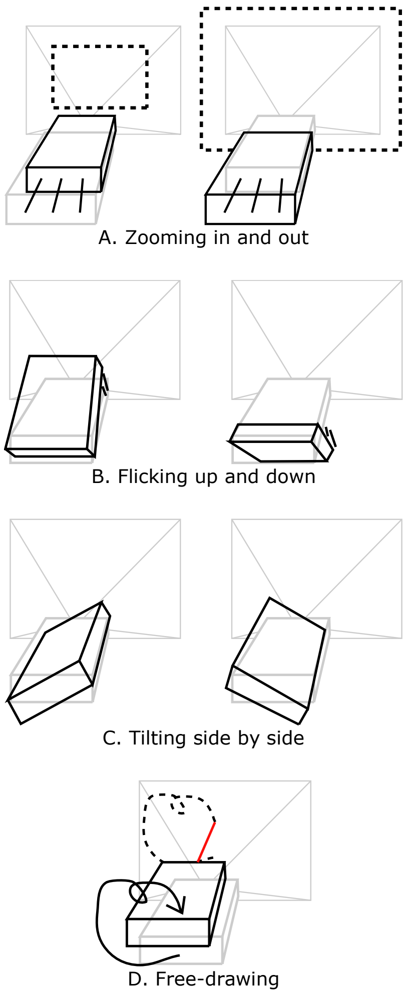


**Figure 2.** User-Device interaction

appreciated. A deeper understanding can lead to a richer experience.

iLight is the answer to that problem.

*"Just flash iLight on the picture to know what you see."*

If a user flashes iLight on the entire picture, general information about the picture will be displayed. If the user gets closer and flashes iLight on part of the picture, then more detailed and fine-grained information will be displayed (Figure 1). Moreover, information is not fixed. Advanced networking technology available nowadays enables delivering most-recent information in real time. Moreover, users are also able to create contents and interact with each other.

## Interaction on iLight

Interaction using iLight can be divided into two categories; User-Device and User-User. User-Device interaction mainly focuses on how the user manages the device and how to get the desired information. User-User interaction focuses on information flow between users.

### *User-Device Interaction*

iLight uses the concept of flashlight. Hence the first interaction that happens between the user and iLight is *"Turn on the iLight and flash something."* As the user flashes on an object, iLight system automatically identifies the flashed object and retrieves information from the server. The granularity of information depends on the position and the portion of object that is being flashed on (Figure 2.A). Generally, flashing on the entire object will bring coarse and general information, and flashing on a small detail will bring more detailed and fine-grained information.

iLight also supports navigational interaction. By flicking entire device up and down (Figure 2.B), the facet of information will be changed. For example, the default information displayed is the historical explanation about the picture. After flicking up once, several spots are highlighted to indicate important checkpoints. Next flick brings comments from other visitors. Tilting the device left or right (Figure 2.C) will scroll screen up and down.

Another interaction supported by iLight is free drawing (Figure 2.D). The small pointer is popped up on the object and the locus will be drawn followed by device movement. By using this pointer, user can easily navigate through elements and draw a figure.

### *User-User Interaction*

In iLight system, information displayed to the user is not only pre-provided contents, but also user created contents from other users. User drawings, annotations and comments are stored at the server and retrieved back by requests from other users. By this, objects are augmented with information that is more interactive and evolving over time.

## iLayer Prototype

iLayer prototype is implemented to verify this idea. Small USB webcam and accelerometer are attached to a handheld projector. Projector mirrors screen on a laptop, and camera and accelerometer data are transferred to the laptop via USB. The laptop is attached to the network and acts as a main processing unit to simulate projector phone action.

*Device Design*

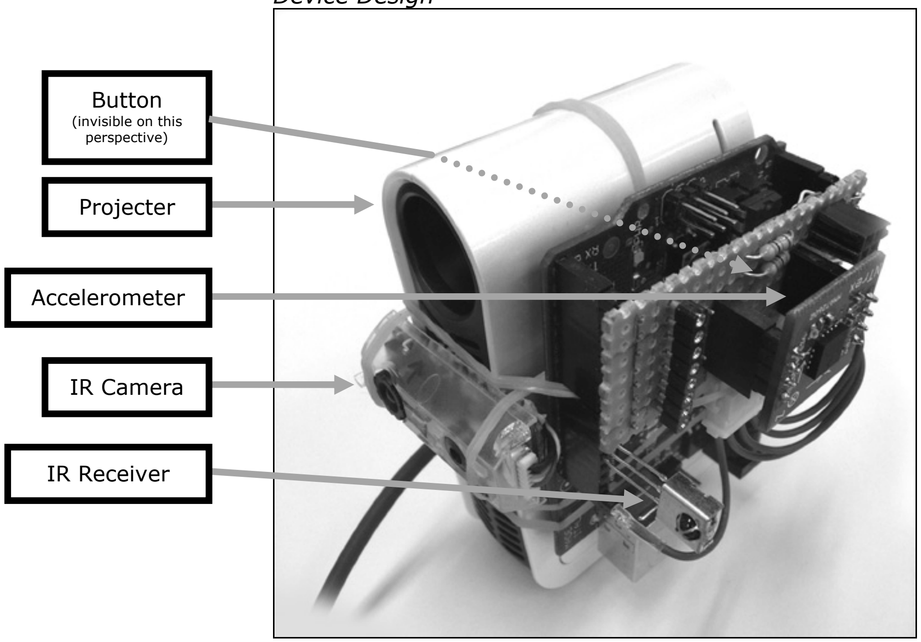


**Figure 3.** Prototype – Projector part

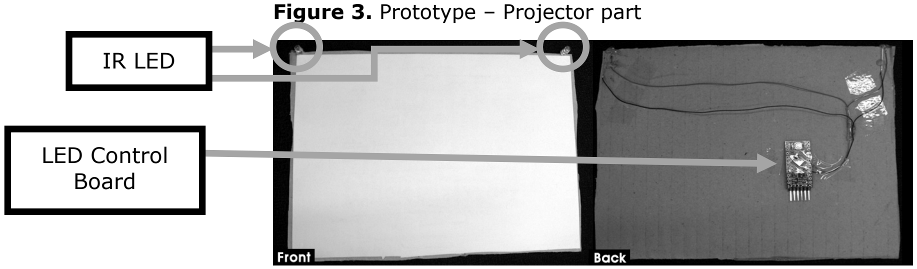


**Figure 4.** Prototype – Object part

Prototype design is constructed with two parts – Projector part (Figure 3) and Object part (Figure 4). The projector part simulates a projector phone device, and the Object part works independently and continuously transmits the object ID by IR LED.

Unid-electro UMP-15A Mobile LED Projector is used to construct the prototype. This projector supports VGA 640x480 resolution, 27(W)x58(D)x90(H) mm, 40 min working time on battery. This projector is connected to the laptop via D-SUB interface and reflects laptop screen.

For vision sensing, Microsoft Lifecam NX-3000 is modified – converted into an Infrared-Camera and plastic casing is detached – and attached to projector by rubber band. This camera is chosen due to its core unit size, which is small enough, also ease of modifying into Infrared(IR) Camera by just putting a piece of negative film on lens module.

For sensor part, Freescale MMA7331L accelerometer module with Arduino control board is used. For object recognition, IR LED is attached to object, and IR Receiver is attached to Arduino control board.

In current prototyping, iLayer system recognizes objects with IR coding and IR camera simultaneously. IR coding is the technique that transfer bytes on IR ray, which is same technique used at typical remote controller. By IR coding, iLayer system can recognize what they are "watching". Two IR LEDs are attached on upper side of objects and driven by tiny microcontroller to send a signal continuously. IR Receiver next to camera reads that signal and decodes the object ID. At the same time, the IR camera catches the position and distance of object by position and distance between two IR LEDs.

Current prototype supports only simple flicking and tilting action, and gestures can be recognized using an accelerometer with simple threshold filtering.

*Scenario*

The current prototype implements the museum scenario. A User stands in front of a picture, and flashes iLight on the picture. General information like history, artist and its description is flowing out with sound and annotation. This description is more interactive than the static description panel beside the picture – Annotations can be directly augmenting on the picture so instead of "at upper left side above the waterfall…" just "here" is enough with highlighting.

Now the user is interested and wants more detailed information. He/she flicks up once to get into next mode. Several points are getting highlighted. He/she steps closer and flashes on a part he/she is interested in, and more detailed description flows out. Those detailed descriptions are stored in the server, so those can be easily updated.

The User flicks up once more to access the user-created content mode. Annotations, drawings and comments from other users are displayed. If two or more objects having the same object ID are exhibited in many places, those users in front of objects can communicate and exchange their opinions in real-time through the object hence able to get novel interactive experiences.

## Discussion and Future Work

In this paper, iLight system is introduced which is a portable system for augmenting various information facets of object directly onto object itself. Also, possible ways of interaction technique available on the system and iLight implementation are presented.

iLight introduces a way of augmenting information on object and provides unique interaction style by using projection gestures. Enlighten unknown information is easily achieved by flashing on the exact location where unknown information places. Also this system can be used as a real time communication and interaction tool. Although the idea of this system was discussed here with the museum scenario, this system can be easily expanded to various other application scenarios. Other useful ideas using this system include navigating public transportation, assembly instruction, remote institution and more various applications.

There are several improvements that we can work out. First, we can investigate passive tagging. In the current implementation, object itself actively sends a signal – called active marker – toward the system. This approach requires LED driving unit and battery for every object, so it is difficult to distribute objects in a wide area. The marker needs to be working with passive manner like printed diagram – called passive marker. This can be achieved by more comprehensive vision sensing technique and using invisible marker like retro-reflective marker [8]. Second, information provided to the user needs to be context-aware. Object have many facets and have different meaning and priority within various contexts. By adopting AI techniques to figure out the user context, the system can provide more appropriate information tailored to the situation.

Although detailed user evaluation is not yet performed, and implementation only supports very little portion of its potential, user feedbacks gathered from informal experiments were very promising.

## Acknowledgements

The project iLight was initially developed as a workshop project, in the Mobility and Experiences group, during Sharing Experiences 2009 [10]. Projects in this group are conceptually based on ongoing research, Guiding Light at MIT Media Lab. We thank the group members of the workshop, Deayoul Na, Najung Kim, and Yeri Lee.

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