LIFT-THE-FLAP: A toolkit to realize interactive paper books

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ABSTRACT
We introduce a simple toolkit called LIFT-THE-FLAP for interactive paper books. LIFT-THE-FLAP is a combination of capacitive sensing touch sensors embedded in each paper tab of a lift-the-flap book, an I/O module and a media playback system on a PC. Since a touch sensor is embedded in the paper, the user is not aware of the sensors. The user's actions working with the lift-the-flap book will be associated naturally corresponding sounds.

ACM Classification: H5.2 [Information interfaces and presentation]: User Interfaces. - Input devices and strategies.

General terms: Input Device, Real-world interface, GAINER, LIFT-THE-FLAP

Keywords: capacitive sensor.

INTRODUCTION
Many picture books with electronic devices have been released so far. Especially, a picture book with sound (music) is a popular style for children and adults. Typical implementations of this kind of book are:

- Open a page, then press a corresponding button to play a sound.
- Open a page, then a sensor detects which page is opened and plays a sound automatically.

In the first case, the user has to do double action, and these two actions are not continuous. In the latter case, the user doesn't have to do additional actions, but the user is inactive (i.e. just wait a moment to hear a sound).

To create storybooks that a user can actively engage in, we have developed LIFT-THE-FLAP, a toolkit to create lift-the-flap books with capacitive sensing switches and actuators. By embedding thin capacitive sensing switches into tabs, the user's action to move an object will be naturally associated with corresponding feedback (e.g. sound, light, rotation).

Figure 1 is a storybook example. When a user pinches a tab to move an object, a corresponding sound is played until the user releases the tab.

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Figure 1: An example created with the LIFT-THE-FLAP toolkit: "The Rainy Day"

RELATED WORKS
Various ways to link information to ordinary papers have been proposed[1][5]. Ultra Magic Key uses printed key-shaped symbols to identity pages[6]. PaperIcons uses printed 2D bar codes at the corner of each page to identify the page[3]. In these systems, computer vision with camera is used. For flexibility to handle a wide variety of input methods (e.g. a 2D bar code, fingers and so on), computer vision systems have advantages.

Siio et al. has proposed Active Book as an application of FieldMouse[4]. FieldMouse uses a barcode reader and a mechanical mouse. At first, the user detects an ID on a paper by using the barcode reader, then drags it from the ID using the mouse. Compared to computer vision systems, FieldMouse approach is inexpensive and easy to calibrate, but a special input device is required.

Compared to these approaches, LIFT-THE-FLAP method is easy to learn, and easy to use. Since natural actions of the user to operate contents in a lift-the-flap book are associated with media playback, the user is not aware of sensors.

IMPLEMENTATION
A toolkit consists of the following components: A gainer I/O module, a breadboard with resistors, electrodes for capacitive sensing, optional photo reflection sensors to detect which page is opened, optional actuators (e.g. a small electric mo-

tor) and software libraries and templates on a PC.

The toolkit is based on the gainer environment[2]. Gainer is a rapid prototyping environment consisting of an I/O module and software libraries to create user interfaces or media installations. The gainer I/O module is capable of creating capacitive sensing switches (in relaxation oscillator method) just by adding an electrode and resistor pair. An electrode is thin and flexible, so it's easy to embed in between papers.

Since software libraries are provided for the highly customizable programming environments, Processing and Max/MSP, it's easy write programs to interact with the user's actions.

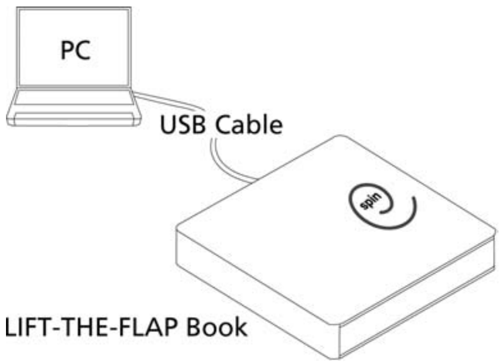

Figure 2: An example of LIFT-THE-FLAP system.

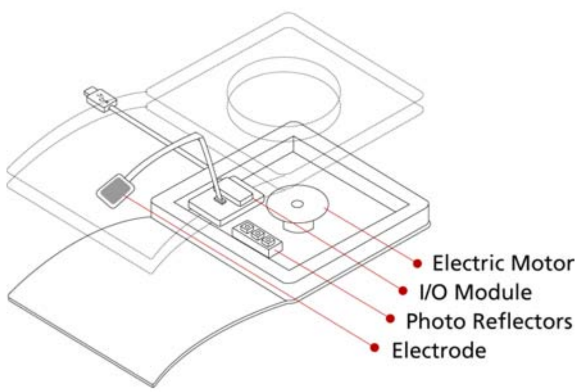

Figure 3: Toolkit overview: electrodes for capacitive sensing, photo reflection sensors, a motor and an I/O module etc.

RESULTS

For the first example, we could build up within several days. The brief steps of building were as follows: Draw pictures, print out the pictures, embed electrodes for capacitive sensing into tabs then write a very basic program by modifying from templates to play sounds.

Figure 4 is another example created with the toolkit. When a user opens a page, a corresponding sound is played and the disk rotates at various speeds corresponding to the content (an electric fan in a room, a car in somewhere outside and a coffee cup in a caffe). Additionally, in the first page, a user can control the rotating electric fan by using capacitive sensing switches embedded in the page (sound varies accordingly). We built up this example within several days, too.

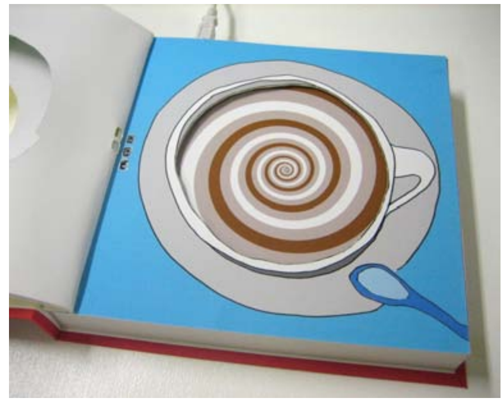

Figure 4: Another example created with the LIFT-THE-FLAP toolkit: "Spin"

CONCLUSION AND FUTURE WORK

We introduced a toolkit to create interactive books. The first two prototypes were picture books. We are investigating other types of lift-the-flap books (e.g. book art, language teaching systems) to explore possibilities of the toolkit. Our future plan is as follows:

- Provide easy-to-use development kits that allow artists to create their own books.
- Pressure sensitive touch sensors to interact in analog (e.g. capacitive sensing, pressure sensors, piezo elements and so on).
- Haptic feedbacks (e.g. vibration).
- Wireless connection capability (e.g. Bluetooth or ZigBee, partially tested).
- Stand-alone capability (i.e. run without a PC).

Acknowledgement

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