

# Inkantatory Paper: Interactive Paper Interface with Multiple Functional Inks

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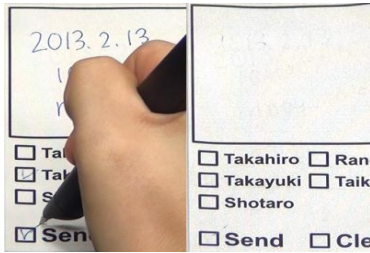


Figure 1. Erasing handwritten content



Figure 2. Highlighting printed content

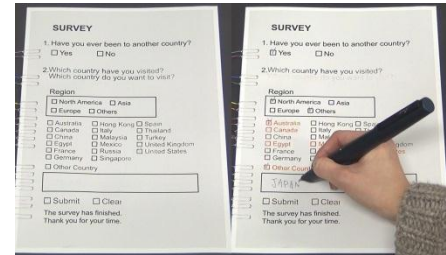


Figure 3. Dynamic questionnaires paper

## 1. Introduction

There has been an increase in the number of solutions dealing with integrating paper and digital information. For the input method, the Anoto pen enables us to capture handwritten content as digital information. For the display method on paper, there are two approaches: (1) projecting visible light and (2) controlling colors of chromic inks. The authors focus on the latter approach since it can dynamically display information on paper in print-like color. Hand-rewriting [Hashida et al. 2012] realized automatic rewrite processing on paper corresponding to handwriting using regular pen and paper. It utilizes a laser-based heating system to erase handwritten characters with bistable thermochromic ink. However, this means that it works just on a special desk equipped with the laser system.

The aim of this paper is to realize an interactive paper interface that can automatically erase printed and handwritten contents and highlight printed contents on paper anywhere depending on a user's handwriting. For this purpose, the authors have developed a printing method for multiple functional inks including conductive silver ink, reversible thermochromic ink, and bistable thermochromic ink. We call this incantatory system "Inkantatory Paper." The merit of the proposed system is that we can keep the flexibility and mobility of paper since it does not require any special desk.

## 2. Inkantatory Paper

The "Inkantatory Paper" system has three technical innovations: (1) it retains the flexibility of paper, so we can use it freely without special desks; (2) this is realized by printing multiple functional inks, which enables localized heating for changing color of printed and handwritten thermochromic contents and (3) the printing system consists of commercially available products: an ink-jet printer and a screen printing kit for home use.

We utilize three types of functional inks: (a) printable conductive silver ink (MU01, MITSUBISHI PAPER MILLS Ltd.), (b) bistable thermochromic ink (FRIXION, PILOT Corp.), and (c) reversible thermochromic ink (THERMOCHROMIC Pigments 29°C, QCR Solutions Corp). We confirmed that the conductive ink can be printed on the back of a paper by PIXUS iP100 (CANON Inc.) and is useful for heating paper surface by electrifying the printed pattern. We filled an Anoto pen with the bistable thermochromic ink that becomes colorless at 65°C for

handwriting input and automatic erasing [Simon et al. 2010]. The reversible thermochromic ink changes its color around 29°C, for instance, red/transparent at 30°C and black at 28°C. We can print it on the front side of paper by a screen printing kit (T-shirts Kun, Taiyoseiki Co. Ltd.) for automatic highlighting and hiding of printed content.

Inkantatory Paper has the following four functions.

1. Erasing handwritten content: By electrifying the conductive ink pattern, the temperature of paper surface reaches 65°C, at which point handwritten FRIXION ink disappears.
2. Highlighting printed content: By electrifying the conductive ink pattern, the temperature of paper surface reaches 29°C, at which point printed reversible thermochromic ink changes its color.
3. Hiding printed content: the same as in highlighting, but the printed reversible thermochromic ink becomes transparent.
4. Capturing: We use Anoto pen in this system, so Inkantatory Paper can capture and save handwritten information as input.

Applying the above-described functions, the authors implemented three types of interactive applications. Figure 1 shows the combination of Erasing and Capturing functions. For example, when the user writes something and checks the "send" box on the paper, the handwritten content is captured and sent to the indicated receiver. Then all the handwritten letters are automatically erased, so the paper is reusable. Figure 2 shows the combination of Highlighting and Capturing functions. When the user checks the city's name, the color of the city on a map is turned to red. Figure 3 shows an application of dynamic questionnaire paper that uses all the functions. Depending on the user's handwriting, the system hides useless content and highlights important content on paper. When the user checks the "submit" box, all the handwritten answers are captured on computer and erased on paper.

## References

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- SIMON, O AND JUERGEN, S. 2010. Towards Understanding Erasing-based Interactions: Adding Erasing Capabilities to Anoto Pens, *PaperComp* . p. 4.