

PaperPrinting: A Machine for Prototyping Paper and Its Applications for Graphic Design

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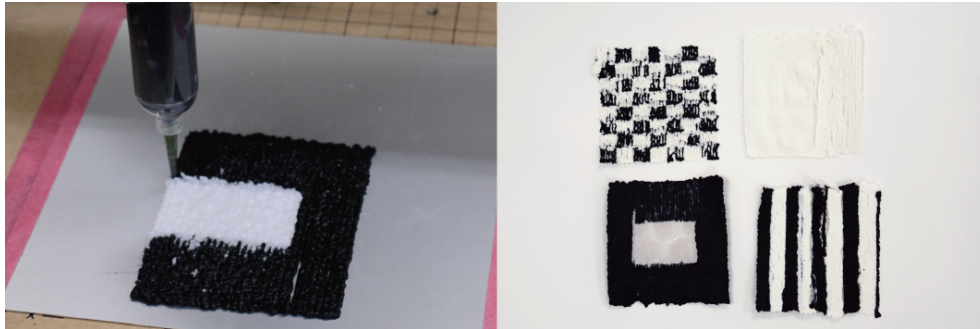


Figure 1: PaperPrinting

ABSTRACT

In this research, we propose a system which makes paper through additive manufacturing process by using a dispenser mounted on XY plotter. By using our system, graphic designers can design and output paper itself which is hard in an existing paper production process. This time, we designed and implemented a machine for fabricating paper and created several output examples. In SIGGRAPH, we will provide a workshop for participants to design their original paper using our machines.

CCS CONCEPTS

• **Applied computing** → **Fine arts**; • **Human-centered computing** → *Interface design prototyping*;

KEYWORDS

Papermaking, Graphic Design, XY plotter

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1 INTRODUCTION

Paper can be said to be one of the most important inventions for mankind. Paper, which is inexpensive and easy to process, is a

material and tool indispensable to our lives even in modern times. Along with these papermaking and printing technologies, graphic design on paper has also been advanced. Designers choose the appropriate size and type of paper and print visual information on the paper. Furthermore, it has recently become possible to add further functions such as electronics or robotics onto paper by special printing technologies [Kawahara et al. 2013] [Guberan 2012].

While most of existing graphic design processes use existing paper, in this research, we propose a new process that graphic designers can make the paper itself from scratch. By developing a digital fabrication machine which can print papers, the process of making papers and the process for designing its appearance and functions can be overlapped. More concretely, a position-controlled dispenser outputs gel made by papers, and forms a paper according to digitally designed data. By using this machine, not only the appearance but also the texture and shape can be designed (see Figure 1).

In this paper, we will introduce the hardware and design process of the paper and show some output examples and a workshop plan in SIGGRAPH.

2 PAPERPRINTING

In this section, we describe the process of PaperPrinting for designing and making paper. In our system, we developed an additive manufacturing machine for papermaking.

2.1 Materials

As a material for the additive manufacturing, we utilize a gel, which is made from existing papers. First, a paper is pulverized for about 30 seconds with a pulverizer to make the paper cottony. Then, we create gels with the pulverized paper, CMC (carboxymethyl cellulose) powder and water (see Figure 2). Here, we can use various

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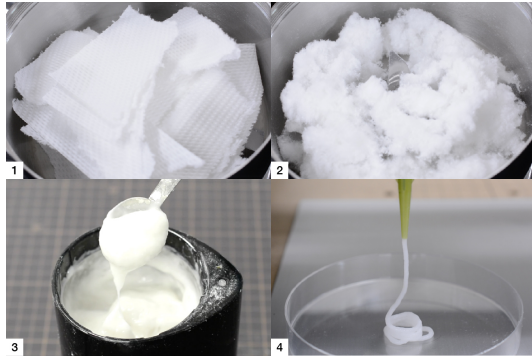


Figure 2: Making of Materials

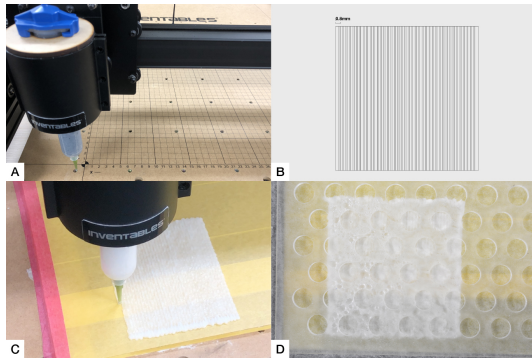


Figure 3: Printing and Drying Process

types (colors and transparency) of papers as the material to design the property of the material.

2.2 Printing Process

For fabricating a paper, we connected a dispenser (Nordson ULTIMUS V, 55 cc, 1.60 mm Nozzle) to XY plotter (Inventables, X-carve) and outputted the material according to input digital data. Regarding the data, it is based on a svg format composed of lines of 0.8 mm. The lines are overlapped by 0.2 mm each other so that there is no gap between the lines at the time of output so as to become a flat surface. the print is conducted on an acrylic plate with masking tape attached to stabilize material fixation. (see Figure3 A,B,C)

2.3 Drying Process

After the printing process, the paper needs to be dried. We dried the paper for about three hours on a 50 ÅC heat bed. Here it is useful to press the paper from the top for preventing the distortion of the paper caused by shrinkage. (see Figure 3 D) In our current implementation, we use a punched acrylic plate as the weight so that vapor can also come out from the holes of the plate for accelerating the drying. On the other hand, when it is desired to generate a shape change by using deformation due to shrinkage as in section 3, we don't need to place the weight.

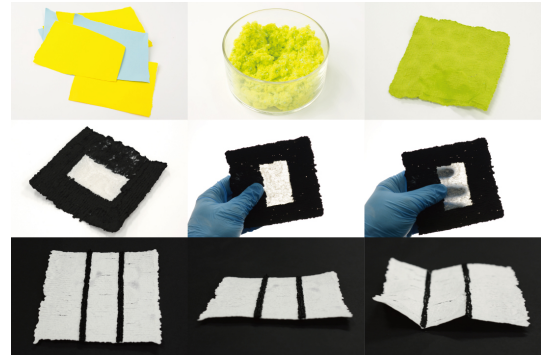


Figure 4: Output Examples

3 RESULTS AND WORKSHOP IN SIGGRAPH

We have implemented the system and designed several output examples.

First, by changing materials partially, we created pieces of paper, which has multiple colors and degree of transparencies on the surface. For example, if we try to create a paper which has opaque part and transparent part partially, in general, we need glue and connect multiple papers. However, on our system, we can create continuous surface by printing opaque material made by a black paper and transparent part made by a tracing paper seamlessly (see Figure 4).

Second, we also tried to controlling the shape of the printed paper. By using our system, it is possible to design the horizontal shape of the paper by operating the XY plotter. Furthermore, by utilizing the shrinkage of the paper during the drying process, it can be folded as shown in the bottom row of Figure 4. In this case, black vertical lines are added on the white surface. The paper is folded according to the black lines.

In SIGGRAPH 2018, we plan to have a workshop for participants to provide experiences to create papers using our system. In this workshop, the participants can design the paper by drawing. Then, the design be scanned as a image and converted to svg data. Afterward, the machine outputs it so that it can experience the output of the paper which is different from the generation of square paper such as existing paper and paper making. In addition, we will show further output examples of PaperPrinting.

4 CONCLUSIONS

In summary, we proposed a fabrication tool which gels paper called PaperPrinting and outputs it from a dispenser. In the future, we plan to add advanced functions on the printed paper such as electric circuit with conductive paper, complicated folding structure, or designing surface textures.

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