COMP*PASS: A Compass-based Drawing Interface

Ken Nakagaki
Keio University
5322, Endo, Fujisawa, Kanagawa, Japan
kennakagaki@gmail.com

Yasuaki Kakehi
Keio University
5322, Endo, Fujisawa, Kanagawa, Japan
ykakehi@sfc.keio.ac.jp

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Abstract
Down the ages, people have been utilizing various stationeries to draw precise figures by own hands. On the other hand, as technology developed, CAD software has enabled us to draw such figures easily on the display. In this paper, we present a compass-based drawing interface, "COMP*PASS", which integrates advantages of digital control to manual works. By focusing on the tool "compass", we developed a novel drawing interface that can draw not only circles but also other kinds of figures under physical environment. In concrete, the radius of the interface is regulated according to the rotation of the device therefore the user only needs to twist the interface to draw a specific figure. The interface is composed of a rotary encoder which detects the rotation angle, and a servomotor which regulates the radius of the drawing. In this paper, we discuss the system of the interface and an evaluation.

Author Keywords
Compass; Stationery; Drawing Interface.

ACM Classification Keywords
H.5.2. [Information interfaces and presentation]: User Interfaces.

Introduction

Down the ages, many people have been using various kinds of stationeries for drawing pictures or drafts such as pens, rulers, compasses or brushes. Such tools enabled us to draw precise figures or extend our range of expression, while they require geometric knowledge or time to draw specific figures such as regular polygons. Also, there are template rulers or French curves which are tools to draw preset figures and lines easily, yet it has a limit of variety. On the other hand, as digital technologies have developed, softwares that support drawing have been widely used. Such systems can support users to draw figures precisely and easily on displays without advanced knowledge. But these systems lack the intuitiveness comparing to manual drawing on physical papers.

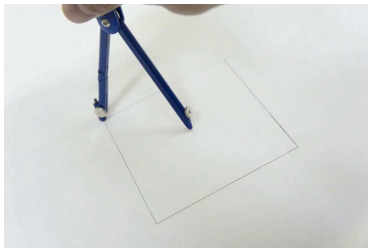

Figure 1. Our Concept Image

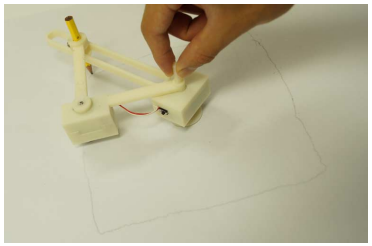

Figure 2. Drawing Square using COMP*PASS

In our research, we aim to develop a system which integrates such advantages of digital technologies to manual works under physical environment which papers and pens are used. Therefore, it includes advantages of both computers such as the duplicability or variability, and handworks such as the intuitiveness or simplicity. Especially, this time, we focused on the tool "compass". Compass is a tool for drawing accurate circle only by rotating it. By adding digital control to its mechanism, we developed a compass-based drawing interface, named COMP*PASS, which enables users to draw not only circles but also other figures such as rectangles, stars and so on (Fig 1). Using the interface, users can draw various figures only by rotating the interface since the radius of the interface is regulated according to the rotation of the device (Fig 2). Because of its mechanism, the interface doesn't require any special environment so that it can be used anywhere. This interface can be used not only for technical drawing, daily creations but also for educations and entertainments.

Related Works

Sketch supporting systems have been developed with improvement of computer human interfaces. Especially, SketchPad [3] was a pioneer of such system which can correct figures drawn on a display to geometric graphics using penlight. Such systems enabled users to draw accurately and easily under digital environments. In our research, we propose a compass-based drawing interface which integrates the advantages of the computers for supporting drawing in analog drawing environment which papers and pens are used.

There are some supporting systems which help hand drawing using pens or papers by adding advantages of digital technology similar to our approach. Digital Rubbing [2] is a system that enables users to draw figures previously chosen with a pen whose tip can be controlled according to the position of the pen. In this system, the figures can be drawn even if the pen is randomly moved. dePENd [4] has a X-Y plotter underneath a table to control a magnet's motions utilizing the ferromagnetism of ball-point pens. These systems require special conditions such as bulky implementation like tabletop interfaces. In contrast, we aim to develop a system that only needs an interface for the basic system configuration.

COMP*PASS

In this research, as an interface which integrates digital manipulation to manual works, we propose a compass-based interface "COMP*PASS". When a user rotates the device as the same way as for ordinary compasses, it can draw various figures by regulating the radius of a pencil according to the angle of rotation.

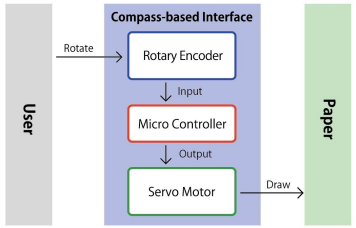

Figure 3. System Configuration.

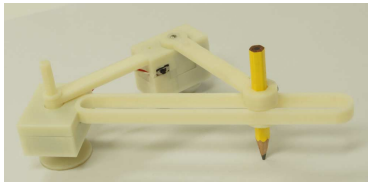

Figure 5. The Appearance of the Interface

System Design

The interface is basically composed of a rotary encoder which detects the rotation angle of paper and the compass, and a servomotor which regulates the radius of arm holding a pencil. They are connected to a microcontroller (Fig 3). Through prototyping, we adopted the shape of a beam-compass for the interface to stabilize the regulation of radius (Fig 4), since the shape of an ordinary compass is difficult to handle when the radius changes while rotating. As sliding a pencil along the beam, it controls the radius. For the mechanism, we applied clunk mechanism so that the rotating motion of the servomotor is converted to a linear motion. A knob and a rotary-encoder are placed at the pivot of the interface, and users hold this knob and rotate it to draw figures. A rotating plate is attached to the rotary-encoder to detect the rotational relationship between the interface and paper by adhering the plate to the paper.

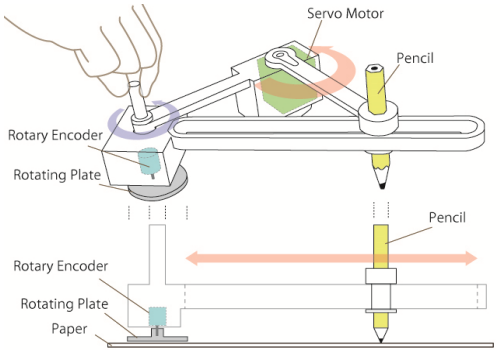

Figure 4. The Design of the Interface

Implementation

Figure 5 shows the prototype of the interface. This time we designed the interface with an 8.0cm length legs, and a beam which has a range of 1.5cm to 15.0cm length for pencils to slide. The rotation plate has a radius of 1.4cm. We used RB90 by Mini-Studio for the servomotor which has a torque of 1.6kgcm, and a speed of 0.002sec/degree. For the rotary-encoder, we used 7S-400-2MC-50-00E by NEMICON which has a 400 counts per revolution. We also used Xbee for wireless communication with other devices.

This time, we also developed a software for the interface on which user can choose or edit figures to draw. We designed the software to be handled on a smart phone so that the system can be used in any environments. In this software, users first choose the figures from 5 kinds of them: ellipses, regular polygons, stars, flowers and spirals. Then, they can edit parameters arranged for each figures such as numbers of vertexes or scales as Figure 6 shows. The red line on the image indicates the rotational angle of the interface.

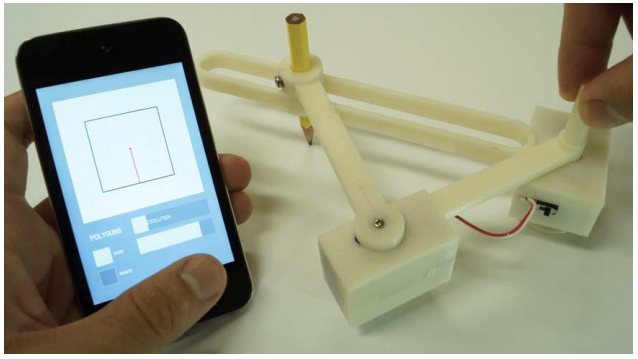

Figure 6. The Software Connecting with the Interface

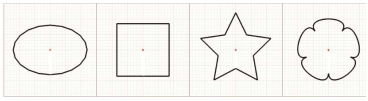

Figure 7. Figure Data Used in the Basic Experiment

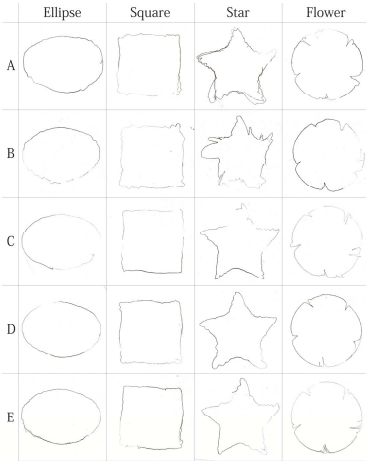

Figure 8. The Figures Drawn by Examinees.

As for the technical configuration, the software processes on a PC and communicates with the microcontroller embedded in the interface through Wi-Fi using Xbee. For now, we used an iOS application "Air Display" [1] which can receive images from a PC and also can send the touch input for the device. As for the processing, first the software calculates the radius of the pencil according to the received value of rotation angle and the chosen input figure data. Then the value for regulating servomotor is sent back to the interface.

Discussion

We implemented a basic experiment to evaluate figures drawn with this interface. In this experiment, we first showed examinees how to use the interface by drawing a triangle. Then, we let users draw 4 kinds of figures in random orders. When drawing, we did not mention what figures they were going to draw. The figure data we used in the experiment are shown in Figure 7.

Figure 8 shows the examples of figures drawn by each examinee. Comprehensibly the figures were roughly drawn correctly, although there were some noises. Straight lines in squares or stars were fluctuated. Also, for the figures which require the radii of the servomotor to change abruptly such as the star and the flower, the lines were inaccurate. On the other hand, the arcs for petals in the flowers were drawn correctly in some extent, because the servomotor does not need to change the radius, for such lines.

Conclusion

In this paper, we proposed a compass-based drawing interface which enables users to draw various kinds of figures only by rotating the interface. We also developed a software which users can choose and edit figures to draw.

In the future, we will improve the system to draw more precise figures by developing both software and hardware. Also, although we designed the interface to connect with the software on smart phones via PC, we plan to develop a smart phone application which can directly be connected to the interface using Bluetooth.

Furthermore, using the metaphor of compass, we will develop other way to input figure data, which uses the interface itself to copy figures to draw. We will also develop the interface not only to draw but also to cut digital data by attaching cutters.

We also plan to propose further applications using this interface especially for educations or daily creations.

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