

Development of a Digital Content for Computational Thinking Education Using Origami

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Abstract—In this study, we have developed a digital content for computational thinking education for early children using origami. The distinctive feature of the content developed in this study is the combination of origami with educational effects related to mathematics and spatial perception, along with robot control through visual programming commonly used in computational thinking education. By implementing the system and conducting workshops, we validated the usefulness of the proposed content.

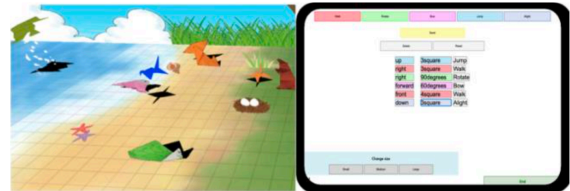


Fig. 1. The developed digital content.

I. INTRODUCTION

Recently, there has been a growing emphasis on STEM education, which includes computational thinking, with the goal of cultivating individuals who can contribute to the progress of science and technology. Therefore, various methods for children's STEM education are being proposed. It has been shown that educational tools dealing with robot programming are beneficial for children's STEM education [1]. In addition, in Japan, origami has been integrated into early childhood education for a long time, and it has been shown to be useful in teaching mathematics and spatial perception, recently [2].

In this study, we have developed a digital content for computational thinking education for early children using origami (Fig 1). The distinctive feature of the content is the combination of origami with educational effects related to mathematics and spatial perception, along with robot control through visual programming commonly used in computational thinking education. Since origami can be easily started with just paper, it is also suitable for education involving a large number of people. Moreover, by controlling the origami creatures created within a 3D CG scene, a variety of movements can be applied, including not only simple translations and rotations but also dynamic actions like jumping and flying. As a result, it is expected to stimulate children's imagination, leading to a higher potential for educational effectiveness.

II. METHODS AND A WORKSHOP

At first, users craft origami of animals or birds freely. The choice of origami paper color is unrestricted. Users can also freely add eyes, mouths, patterns, and other details to the crafted origami using a pen.

Next, users capture the origami they have created with a camera. The system removes the background from the image captured of the origami, extracts only the origami area, and generates a CG origami object. Here, the origami comes in various colors, with different colors on the front and back. Additionally, there are no outlines drawn around it, similar to

hand-drawn or colored-in images. Therefore, during origami capture, a display image with changing brightness is used as the background. By capturing multiple images with different brightness of backgrounds and utilizing their differences, it becomes possible to extract the origami area where colors do not change. The origami area is used as is to generate a 2D CG origami creature it is placed within the 3D CG scene.

Controlling the movements of CG origami creatures is achieved through visual programming on a tablet. Visual programming is accomplished by combining basic actions (movement, rotation, flying, descending, and bowing) while modifying parameters. Each basic action and its parameters are represented by a single block. By arranging multiple blocks that represent simple action, complex action can be generated. By applying the action to the corresponding CG origami creature, it starts moving in the 3D CG scene. The visual programming interface is built on the Web and is accessible by multiple users simultaneously. Within the 3D CG scene, there are several CG origami creatures placed, each assigned with an ID. Each user can control the action of their own CG origami creature by inputting the corresponding ID when accessing the visual programming interface.

We implemented the system and conducted a workshop in May 2023. The workshop involved approximately 300 children aged 4 to 12 years old. According to the survey results after the workshop, among the participants, 57% found origami difficult, and 27% found visual programming challenging to control the CG origami creatures as intended. However, 98% of the participants responded that they enjoyed the experience.

REFERENCES

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