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Viewpoint Transformation Training System Based on Discovery of Relationships between Objects

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Abstract: Although having multiple viewpoints is important for utilizing objects in various ways, some people can only focus on limited aspects of objects. An object's viewpoint is regarded as its role, as seen from its relationships with other objects. To discover new roles by finding relationships with other objects, another object must be recognized. Thus, our study proposes a method of two steps that transforms viewpoints consisting of "finding other objects in a space (object discovery step)" and "considering roles based on the relationships between a target object and other objects (role discovery step)." In addition, our study constructs a viewpoint transformation training system to acquire multiple viewpoints in the mathematical world, where objects correspond to individual figures whose viewpoints are their roles viewed from the stances of other figures.

Keywords: Viewpoint transformation, role of objects, relationship between two objects, mathematical diagram

1. Introduction

We are often suggested "to see things from a different viewpoint," for example, when we are worried about something or trying to solve a problem. By seeing things from a different viewpoint, we can sometimes find new solutions. Looking at things from a new viewpoint is also important for exploiting objects. Assume the utilization of a pair of sunglasses. If we only see them as an item that protects our eyes from the sun, we are unable to use them for any other purposes. However, if we frame them as a "fashion item," they become a lifestyle accessory.

Once we see something from one aspect, changing that viewpoint is difficult. The objective of our study is to propose a method that changes viewpoints for recognizing things/objects and develops a training system for it. One way to change viewpoints is using another person's perspective. Han et al. proposed an idea generation support system which acquires other person's perspective from social networking platforms as Twitter and Wikipedia (Han, Park, Forbes & Schaefer, 2020). If a user wants to generate new ideas for a specific thing, he or she can retrieve a huge number of posts from various social networking platforms. Itou et al. proposed an idea generation support system that presents hints for brainstorming associated with a theme (Itou, Higashi & Munemori, 2015). It previously collected web texts related to that theme and classified words into clusters based on the degree of word co-occurrence to make a hint database. Both of these studies use other people's viewpoints to derive new ideas. However, sometimes the viewpoints of others are unavailable when we need to solve problems or derive ideas. To obtain various viewpoints for cases, a method must be acquired with which we can transform our viewpoints by ourselves.

The objective of our study is to propose a method for changing the viewpoint of an object. Things/objects are often recognized by their roles, which are defined in combination with other objects. To change the viewpoint of things/objects is regarded as discovering their roles by identifying meaningful relationships with other objects. Therefore, our study proposes a method consisting of two steps; to find objects and to find the relationships between two objects. In addition, we propose a system with which to experience the proposed method.

Currently, our system limits the problem space to the mathematical world.

2. Method for Changing Viewpoints

The viewpoints of objects are regarded as their roles for other objects. To discover a new role, we must notice not only relationships with other objects but also the objects themselves. Our study proposes a method for discovering viewpoints consisting of two steps: 1. finding objects in a problem space (object discovery step) and 2. defining the role by considering the relationships between the target object and other objects (role discovery step). After recognizing different objects, it is easier to focus on various combinations of objects and ponder their relations.

Note the method using Figure 1, where the existing figures are points A, B, C, and D, line segments AB, AC, BC, AD, and CD, triangles ABC and ACD, and quadrilateral ABCD. In the object discovery step, these figures are recognized by considering the combinations of all the points. In the role discovery step, the relationships of pairs of figures are considered. For example, line segment AC is an adjacent side with line segments AB, BC, AD, and CD as well as one side of a triangle with triangles ABC and ACD.

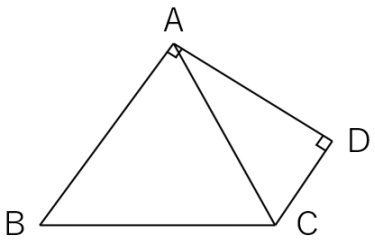


Figure 1. Mathematical Diagram.

3. System for Acquiring Method for Changing Viewpoints

To acquire the steps for changing viewpoints, these steps described in Section 2 must be consciously practiced. Our study develops a system where the steps for changing viewpoints can be experienced individually using mathematical diagrams. The more figures are discovered, the more viewpoints are derived. Therefore, the object discovery step's goal in our system is to find all the figures from a given diagram. In the role discovery step, the relationships of all the discovered figures should be considered.

Figure 2 show the interfaces and the interaction between user and our system. Our system consists of two interfaces that enable the activities of the object discovery step and the role discovery step.

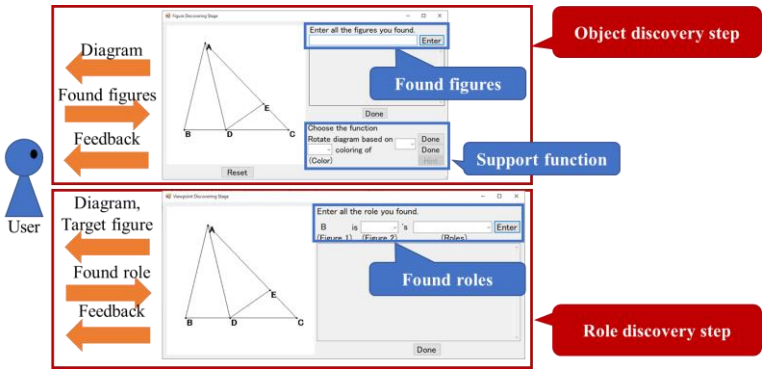
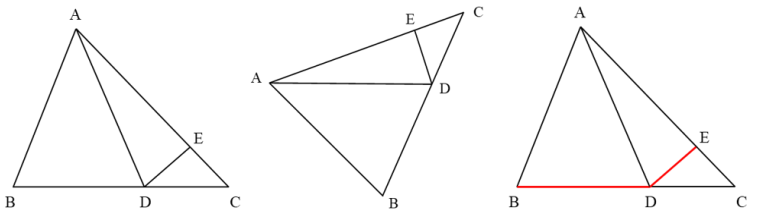


Figure 2. System Interface.

The object discovery interface presents a diagram and lets the user inputs all the figures found in the diagram. It also provides two support functions for finding figures. One function is a rotation function. One of the reasons why we cannot find particular figures is that their orientation is unfamiliar. Especially in the case of polygons, their familiarity is affected by the angle at which the diagrams are drawn. To solve this difficulty, the rotation function enables users to orient the diagram in preferred angle. Figure 3b is the diagram which shows the result of applying the rotation function to Figure 3a.

The other function is a coloring function. Another reason for the inability to detect figures is the presence of other figures. In Gestalt psychology, if a person recognizes some polygons in a diagram, he probably cannot recognize any other polygons (Richard Wiseman, Caroline Watt, Kenneth Gilhooly and George Georgiou, 2011). To recognize other polygons, since they consist of several line segments, different combinations of line segments must be focused on. By emphasizing some line segments, we may find different combinations of line segments with emphasized lines. To encourage users to change the focusing line segments, the coloring function enables users to set preferred colors to line segments. Figure 3c is the diagram which shows the result of applying the coloring function to Figure 3a.



(a) Original diagram (b) Rotated diagram (c) Diagram with colored lines

Figure 3. Example of Applying Support Functions.

The object discovery interface has all the figures and their relationships as correct answers. When all the figures have been discovered, the system activates the role discovery interface. If undiscovered figures remain, the system says, "undiscovered figures remain", and user can use hint function. Hint function generates a hint message for indicating the way of using the support function. For example, if the undiscovered figures are polygons, it gives a message, "Why don't you try coloring the line AD?"

The role discovery interface gives the target figure to focus on for finding the roles and lets the user inputs the discovered roles by finding as many relationships with other figures as possible. It compares the input roles with the correct answer. If the user could not find all relations, the interface shows correct relations one by one as feedback. When all the roles have been displayed as feedback, the interface is returned to the role input mode and a different target figure is given, which allows the user to detect a new role for the given figure.

4. Conclusion

This paper proposed a method for changing viewpoints to discover objects and think about the roles they play in relation to other objects. It also developed a system for training this method in the domain of mathematical diagrams.

If we acquire various viewpoints, we can solve more problems can be solved. Such experience may promote the recognition of the importance of acquiring various viewpoints. Our future work will extend this system for applying developed roles to answer mathematical problems and increase awareness of the importance of changing viewpoints.

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