A PERCEPTION MECHANISM FOR TWO-DIMENSIONAL SHAPES IN THE VIRTUAL WORLD

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Abstract: Lifelike agent in the virtual world is an agent who is designed to be able to simulate the realistic human behavior. Agents continuously repeat the process that includes perception, recognition, decision and behavior in the virtual world. Through those processes, the agents store new information in their memory or modify their knowledge if it is needed. This study mainly deals with the perception that is intermediate step between image processing and recognition. In this study, you will see how the agents perceive shapes. And you also will realize how it is possible to infer the part of shape that was partially hidden from the agent's vision.

1 INTRODUCTION

We need to implement some kind of functions such as perception, recognition and behavior in order to make a system that can operate like real human in the virtual world, and we have to reorganize these functions smoothly. The fact that sees through the eye is natural process. However, if you analyze the process of perception, you could see many things that have been occurred progressively for a short time. Image processing is the starting point of the agent's recognition. It is called image processing which convert an image to digital data. The perception which generated by Image processing using points, lines and colors of pixels is to identify two-dimensional shape. The rule-base system is used to divide the shapes that touch each other. It is also used to infer the shapes which are partially hidden by other shapes or are partially outside the visions of agents. Main purpose of perception is to increase the success rate of recognition. In chapter 3.1, we explain how to model the agent's vision. In chapter 3.2, we explain the perception's primitive units such as points, lines and colors of pixels. The chapter 3.3 explains the inference of shape. In chapter 4, we introduce spatial relation of shapes which are contacted each other. Final chapter presents requirements for successful recognition.

2 RELATED WORK

2.1 Virtual World

The ultimate aim of the Virtual World project is to develop an authentic simulated cosmos which consists of an authentic cyber space (Park, 2000) and Virtual Inhabitants (SeJin and Kim and Park, 2004). The authentic cyber space is a virtual environment governed by the various rules and principles in a systematic and organic manner (Park, 2000). The Virtual Inhabitant is a computer-controlled agent who dwells in the authentic cyber space and interacts with the user in a manner similar to the interaction among typical humans (SeJin, 2007).

2.2 Agent Model

An agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives (Wooldridge, 2002). Believable agent is personality-rich autonomous agent with powerful properties of characters from the arts (Bryan Loyall, 1997). Lifelike agent(or lifelike character)is an agent which is designed in order to simulate the realistic human(or animal) behavior. These two agent architectures have very similar requirements such as personality, emotion and sociality because their ultimate goal is to induce

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user's interest and retain it. In addition, both believable agent and lifelike agent are designed for multimedia entertainment applications such as computer games, computer animations, and virtual communities and multimedia pedagogical applications such as intelligent tutoring systems, and simulated training systems (SeJin, 2007).

3 AGENT'S PERCEPTION METHOD FOR TWO-DIMENSIONAL SHAPES

3.1 Modelling of Vision

The agent has limited range of vision and the perceivable information depends on the distance from the agent to the target object. For a target object O^i, Scale(O^i) = f(Distance, Vision) where Distance denotes the distance between the agent and O^i and Vision denotes the visual capability of the agent. Vision determines the distance within which the agent can discern an object. The vision $V_A(t)$ of agent A is modeled by a cone with its vertex at her eyes as illustrated in Figure 1. Its dimension is specified with three parameters, i.e., the angle θ, length l and direction d. While the first two parameters depend on her bodily conditions, the direction changes to her decision. Specifically, $V_A(t) = (\theta(t_b), l(t_b), d(t_b+t))$ where t_b denotes the time with a time unit in which bodily conditions may change. An object within the cone denoted by the shaded area is considered as perceived by the agent. The cone will disappear, i.e., θ or l = 0, if her eyes are closed or impaired. The l may be extended with help of a device like a telescope or microscope. While +l denotes the range of a natural vision or vision extended with a telescope, -l denotes the range of a microscopic vision. A dotted line indicates an extended vision in either way. The object size would be perceived by the agent as multiplied by a factor proportional to |l|/d in case of +l and d/|l| in case of -l. (J. H. Park., 2004)

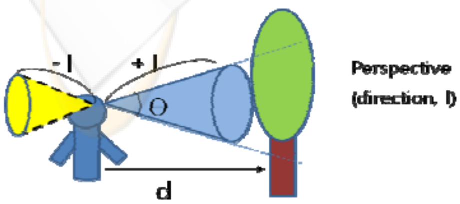

Figure 1: Scope of vision.

3.2 Primitive Units for Perception

When we put a great effort to get something into our friend's head, it is good to explain typical features of the object. This study defines the features as characteristic property. For example, if we describe a snowman to our friend, the snowman's characteristic properties are both one circle above another circle and its color is white. In this study, the characteristic properties of the objects to define them are type of shapes, their spatial relations and their colors. Figure 2 shows an object came within vision of agent. The inside of circular area represents vision of an agent. Our image processing step converts an image in the scope into lines and points. The rapidly changing RGB values from the left image of Figure 2 are used to identify the boundary lines. The right image of Figure 2 shows the identified boundary lines.

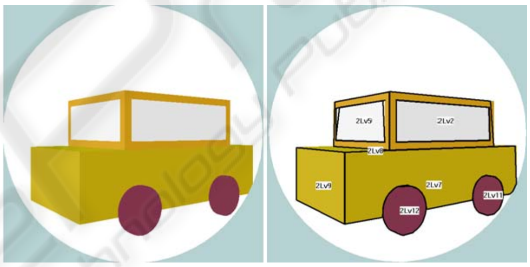

Figure 2: Image processing for object.

The points at the junctions of edges and the lines occurring by RGB difference between the pixels are used as the primitive units for two-dimensional perception. The connected status, angle and colors are also used to determine the shape type. These parameters allow us to judge whether an object is regular shape or not. Figure 3 shows detailed primitive shape's information. In Figure 3, *point a*, *b* and *c* show the points indicating a junction. The *rectangle 2Lv2* has a section between Junctions *point a* to *point c* (a-b-c). The number next to a line shows its Draw value indicating how many times used it.

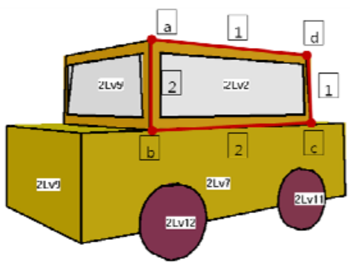

Figure 3: Detailed information of primitive shape.

For example, *Line-ad* is used in the *rectangle-2Lv2* only once, and the *Line-bc* is used twice in the *rectangle-2Lv2* and the *rectangle-2Lv7*, their Draw value being one & two respectively. Two connecting lines at the Connection point have an angle between them, gauged by the trigonometric functions.

3.3 Inference of Shape

When an agent perceives a target object that is partially blocked by other objects or partially out of the vision, she would use inference to complete her perception. Figure 4 shows the information on the Boundary lines for the shape being inferred (red boundary of ID: 2LV7 shape). In the information, we can find two sections (the red rectangle) on the rapidly changing line's length (L) and line's angle (A). The agent reforms her inferring only when the target shape is not a regular shape, and its available amount of information is to exceed minimum. An agent excludes those rapidly changing parts and starts her inferring with the rest of the information on the image to find its closed regular shapes. And the agent draws virtual lines starting from Junction points. If it is judged to be a regular shape based on the virtual lines, she adds the information on the virtual lines to her original information.

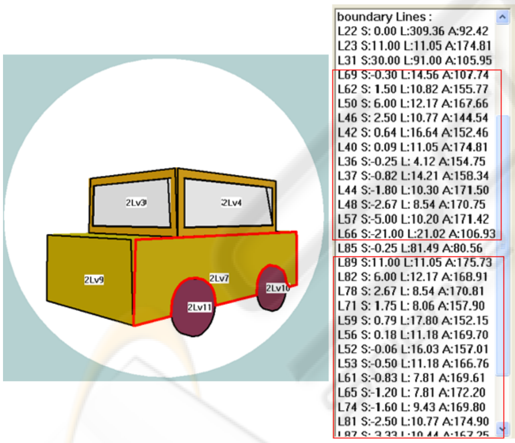

Figure 4: Inferable shape and its Boundary Lines.

4 SPATIAL RELATIONS AMONG SHAPES

With the shape type identified before, we now identify the spatial relations existent among those shapes to achieve a complete recognition. Defined spatial relation in perception is different with the recognition's relation. The spatial relations as perceived could be specialized into to diverse spatial relations in recognition. We'll follow the relations set of HSR for our recognition (Choe and Park 2005). For example, relations of HSR include among others associated with 'Touch' in perception, 'straddling', 'hanging', 'leaning'. In short, the relations of perception are redefined again.

4.1 Connection among Shapes

If there is a connection among shapes, *shape-A* based relation of *shape-B* is expressed in the database on the ontology.

Table 1: Types of Connection.

Connection	Defined rule
In	The case when central point of B insides boundaries of A. Only, The inference of A does not occur by B
Out	The case when central point of B outside boundaries of A. Only, The inference of A does not occur by B
Touch	The case when B and A have shared lines of the above one. Only, The inference does not occur by shared lines.
Behind	The case when B and A have shared lines of the above one. And the inference occurs by shared lines. In this case, The connection of shape A is Touch and shape B' connection is Behind

The Out relation occurs only when the Out Touch has been found. We mention only because there are numerous Out relations including the Out touch. From Table 1, the central point of shapes, shape's boundaries and their inference are determinant of connection between them. These connections are designed in the ontology and are stored in database. When there are some additional connections (i.e. repetition, symmetry and reverse etc.), this data structure can be used to solve the problem by adding proper rules in the ontology.

4.2 Direction among Shapes

The Direction is another parameter to special the spatial relations. The Direction uses a shape's central point as the reference. For example, 'direct3 out touch', means a shape has an Out relation on the 3:00 direction with another shape. Figure 5 shows the coordinate for area. Central circle is called Center relation. Other Coordinates proceed in order clockwise. Various spatial relations could be defined indicates by combining Connection and Direction.

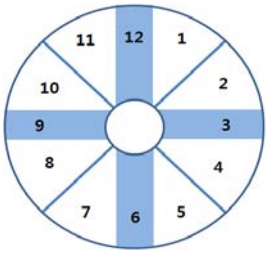

Figure 5: The Direction among shapes.

5 CONCLUSIONS

In this study, we introduce a perception mechanism for the shapes that touch each other. We also introduce the inference of shape and the spatial relations among the component shapes of a composite shape for recognizing objects in the knowledge schema. The virtual world in general is composed with regular shape. So, applying the introduced methods to the virtual world is not so difficult. However, in order to apply this technology to a realistic virtual world, we need to implement the superior image computing ability and to define abstraction for a lot of objects. From now on, the study on the perception mechanism will be focused the irregular shape expressions and additional relations among shapes.

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