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RESEARCH ARTICLE

A Scalable Vector Graphics Warping System for Anthropomorphizing Game Characters

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ABSTRACT How can scalable vector graphics (SVG) data of human faces be transformed to resemble specific animal faces? Since the early 20th century, multimedia featuring animals has garnered significant attention, particularly as interest in anthropomorphic animals has grown. In this paper, we survey various anthropomorphic studies. Additionally, we develop a warping system for anthropomorphizing animal characters. Our system enables the automatic generation of anthropomorphized animal characters using SVG datasets. This dataset includes frontal and side views of 60 animal species commonly featured in animations, as well as male and female human characters. Users can create new anthropomorphized animal characters using our dataset and their vector data. Our warping system implements a continuous warping technique between animal and human facial shapes in ten stages, supported by a developed algorithm and an SVG warping program. The code of the warping system and SVG dataset are available at link: https://github.com/jenero05458/SVG_warping

INDEX TERMS Scalable vector graphics, anthropomorphized animal character, automatic character creation, game character, warping.

I. INTRODUCTION

With the increasing availability of smart devices, character animation is becoming more prominent in the mobile domain [1], [2]. Firms leverage characters with established brand value for marketing, enhancing their appeal [3], [4]. The demand for diverse characters and their roles is rising as digital content industries like animation and games gain prominence. The character industry, once confined to character products and animation, is now expanding into different industry sectors. This expansion is fueled by the invigoration of ultra-niche markets, leading to a surge in content production tailored to different regions, generations, and consumer preferences [3].

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Characters that are anthropomorphized exhibit both human and animal traits. This fusion is achieved by blending the features of a specific animal with a fundamental character design. For example, Animal characters, as represented originally by Mickey Mouse in Walt Disney's <Steamboat Willie>, are often highly preferable because "animals that behave like humans can escape from reality more creatively compared to human characters [5], [6].

Interest in automatic tools for anthropomorphing is also increasing in the fields of animation and games because they enable people to design animations and games more easily. In terms of character creation, the creator generally has to perform tasks manually, which is both time- and resource-consuming. An authoring tool for anthropomorphizing animal characters needs to be developed to reduce the cost of character development and increase work efficiency.

Such transformations, common in TV ads and films, are realized through warping or morphing algorithms. In movies, this involves altering raster images of individual frames. These modifications employ a variety of algorithms, which are based on features, control points, polygons, and meshes. Research on the visual portrayal of these characters is ongoing. However, existing studies are sparse and primarily focus on classification. Therefore, there is a pressing need to explore how the concept of anthropomorphized animal characters can be applied across different industries.

Image warping, which is a method of geometric manipulation, shifts the locations of pixels. This allows for geometric changes like magnifying or shrinking images according to set guidelines. Classic feature-based image metamorphosis (FBIM) algorithms for warping pixel-based images operate by assigning the values from each image point to a predefined distortion function. Nonetheless, these algorithms are not appropriate for SVG images, as SVGs are composed of drawing elements defined by precise coordinate values.

In this paper, we introduce a warping system and scalable vector graphics (SVG) dataset which includes human and animal characters. This system simplifies the process of generating various anthropomorphized animal characters. We create a dataset with front and side vector images of prototypical animal characters, drawing on a previous study that examined 60 mammal species. Additionally, we design a warping program that integrates with this dataset. The system enables users to connect their input SVG data to the dataset of anthropomorphized animals, facilitating automatic character generation through warping. We also developed a program that, in the intermediate design state, automatically creates facial shapes of characters as desired by the users.

The rest of this paper is organized as follows: we give the related works in Section II, introduce our warping system and dataset in Section III, show the outcomes of the warping system in Section IV, and conclude in Section V.

II. RELATED WORKS

A. ANTHROPOMORPHISM

Anthropomorphism involves attributing human personality, motivation, and emotions to non-human agents such as objects and animals [7], [8]. The popularity of anthropomorphized animals in digital content, such as animation and games, is ringing. This trend can be attributed to the unrealistic nature of animal characters, who, unlike humans, are generally free from discrimination based on race, nationality, or gender [9], [10].

Epley et al. [11] explain a theory focusing on three psychological determinants that influence the likelihood of people anthropomorphizing. These determinants are accessibility and applicability of human-centered knowledge, the motivation to explain and understand the behavior of other agents, and the desire for social contact and belonging.

Since the dawn of civilization, humans have shown a fascination with animals. In ancient Egypt, Greece, and Rome, this fascination led to the anthropomorphization and worship of animals. The study of animals was prevalent in ancient Greek and Roman cultures. During these times, people believed that inner human traits were linked to physical similarities with animals. For instance, Aristotle categorized his students' facial shapes by comparing them to animals, while Darwin explored the emotions of humans and animals to understand the types of emotions expressed physically. Although the concept of animal anthropomorphism is long-standing and intriguing, as illustrated, it is only recently that the design of anthropomorphized animals has been explored for digital content creation.

Animal anthropomorphism has been studied in various countries, mainly in psychology. Studies have examined the link between anthropomorphized animal characters in storybooks and the social learning of children, as well as various elements of anthropomorphism. Véronique [12] argues that anthropomorphism is a valuable tool for studying human-animal relationships, emphasizing the role of situational perceptions of human and/or mental qualities. She highlights the importance of uncertainty, imagination, and illusion in these relationships. Conversely, Milton raises concerns about using "anthropomorphism" in social science to interpret human behaviors toward animals. She suggests that "egomorphism" might be a more appropriate model to understand human perceptions of animals [13].

In the Republic of Korea (South Korea), Hong-Im Shin analyzed the relationship between loneliness, social connection needs, and anthropomorphism, and studied the effects of loneliness on anthropomorphism and dehumanization of external groups. This study revealed that the degree of loneliness influences the tendency to anthropomorphize animals.

Additionally, anthropomorphism was related to the desire for social connection as a remedy for loneliness [14]. An et al. [15] explored the connection between anthropomorphism, anticipatory guilt, and prosocial behavior. Their research identified predictive guilt as a key driver for increased compliance with anthropomorphic causes, especially from a social and policy standpoint.

The initial studies on anthropomorphized animal characters were conducted in the 2000s, shifting focus from the traditional research on their symbolism in literature and art. Only recently have researchers begun exploring the physical attributes of these characters.

Lee and Kim [10] analyzed the structural facial shapes of 60 mammal types. Their analysis involved the morphological characteristics of animals in systematics and taxonomy, relating these to the appearance of anthropomorphized characters. The authors proposed a foundational model for animal facial components, classifying and defining them in comparison to human facial structures.

B. IMAGE MORPHING

Image morphing techniques include thin plate spline transformation, energy minimization, and multilevel free-form deformations [16]. Recently, deformation methods in image morphing have been the subject of extensive study. Recent trends in these studies indicate a significant focus on two-dimensional deformation techniques for image morphing, first proposed in 1996, as noted by Lee [17]. Blanz has modeled a three-dimensional face using two-dimensional images [18].

The transformation of facial expressions using mesh data has been extensively studied. In addition, various methods for generating facial expressions are being explored. These include dividing a face into regions and applying different deformations [19], separating a three-dimensional facial image into texture and shape using a generative network [20], employing an encoder-decoder structure for a 3D dataset [21], [22], [23], and utilizing graph convolutional networks [24].

Meanwhile, Khan et al. [25] minimized deformation by performing triangulation-based morphing between a human face and an animal face. Zhang et al. [26] proposed a novel approach for retargeting human facial expressions to a virtual character. Their method employs a graph convolutional VAE to learn facial expressions of people and avatars, effectively matching these expressions through domain transfer. Consequently, they successfully retargeted facial expressions.

Yan et al. [27] proposed an alignment-aware 3D face morphing framework utilizing an encoder-decoder structure, effectively morphing three-dimensional human face mesh data into an animal face with alignment-aware control. Wang et al. [28] proposed neural cages, a method for cage-based deformations that predicts deformations in a more natural space with greater accuracy than existing techniques. Le and Deng [29] conducted research focused on generating cages for three-dimensional cage deformation.

III. FORMATION OF THE WARPING SYSTEM FOR ANTHROPOMORPHIZING ANIMAL GAME CHARACTERS

In this paper, we introduce a character warping system designed to easily generate anthropomorphized animal characters using the SVG dataset.

A. DATASET FORMATION FOR ANTHROPOMORPHIZING CHANGEABLE ANIMAL CHARACTERS

We analyze mammals from 48 feature-length American animations (1940-2019) to create this dataset. Characteristics of these mammals extracted from these animations are examined through their systematics and taxonomy. Sixty species are visually categorized based on their head and facial shape. The system processes these data to extract the main visual images of each animal species and visualize the morphological features of each species in vector images.

We analyze the morphological differences among animal characters using our dataset. Feature points of the anthropomorphized animal characters are identified and visualized in SVG vector format. The dataset, encompassing 60 mammalian species and human characters, allows users to perform 10 stages of continuous warping to generate hybrid characters. Additionally, users can also input their own SVG data with our system to create new characters. The system is thus capable of generating unique anthropomorphized animals by applying user-inputted data to the existing dataset.

B. DESIGN AND FORMATION OF THE WARPING SYSTEM FOR ANTHROPOMORPHIZING ANIMAL CHARACTERS

Image warping, a geometric processing method, moves pixel positions. It enables geometric transformations, such as enlarging or reducing images, following specific rules. This process involves deforming a picture on a two-dimensional plane by distorting the plane itself. By warping an image, it becomes deformable as per the devised rules. In this paper, we discuss a warping algorithm that anthropomorphizes SVG characters using FBIM. Traditional raster-image-warping algorithms transform images by mapping each image location's values to a warping function. However, these are unsuitable for SVG images, which contain only real-type coordinates for drawing elements. Thus, we adjusted the FBIM warping process to accept real-type coordinates. Furthermore, we input the SVG elements' coordinates into this process. The existing element coordinates are replaced with new coordinates, converted from the output values of the warping transformation.

Figure 1 illustrates the layout of the developed warping system. The program includes a panel dataset featuring anthropomorphic characters (marked by a red dotted line), a control display (marked by a blue one-point chain line), and the continuous-warping result (marked by a green two-point chain line).

In the red area of Figure 1, a user selects a target image for warping from the visual images of 60 species of animals. Users can search by clicking a direction button on the panel and the panel displays characters in order. The datasets include the front and side images of the characters, with the front view set as the default. The blue area includes a 'Warping' button for initiating the warp process and an 'Open' button for uploading human images from the user's device. Moreover, in the green area, the process of warping a human image selected from the blue area into an animal image chosen from the red area is continuously displayed through ten results.

Figure 2 shows the SVG warping system. Figure 2(a) shows a set representation of anthropomorphism warping using the front-view image of a human and a wild boar. Figure 2(b) shows the overall flow of the warping process.

The system developed used a range-based algorithm for warping. The algorithm performs transformation based on a control line, which requires both input and target images. The dataset of anthropomorphized characters contains character images and their corresponding control lines.

Fig. 3 shows a new FBIM system for anthropomorphizing game characters. We designed and implemented a closed system to handle the personification of game characters.

The heart of the system is the improvement of the FBIM (New feature-based image metamorphosis) algorithm in the

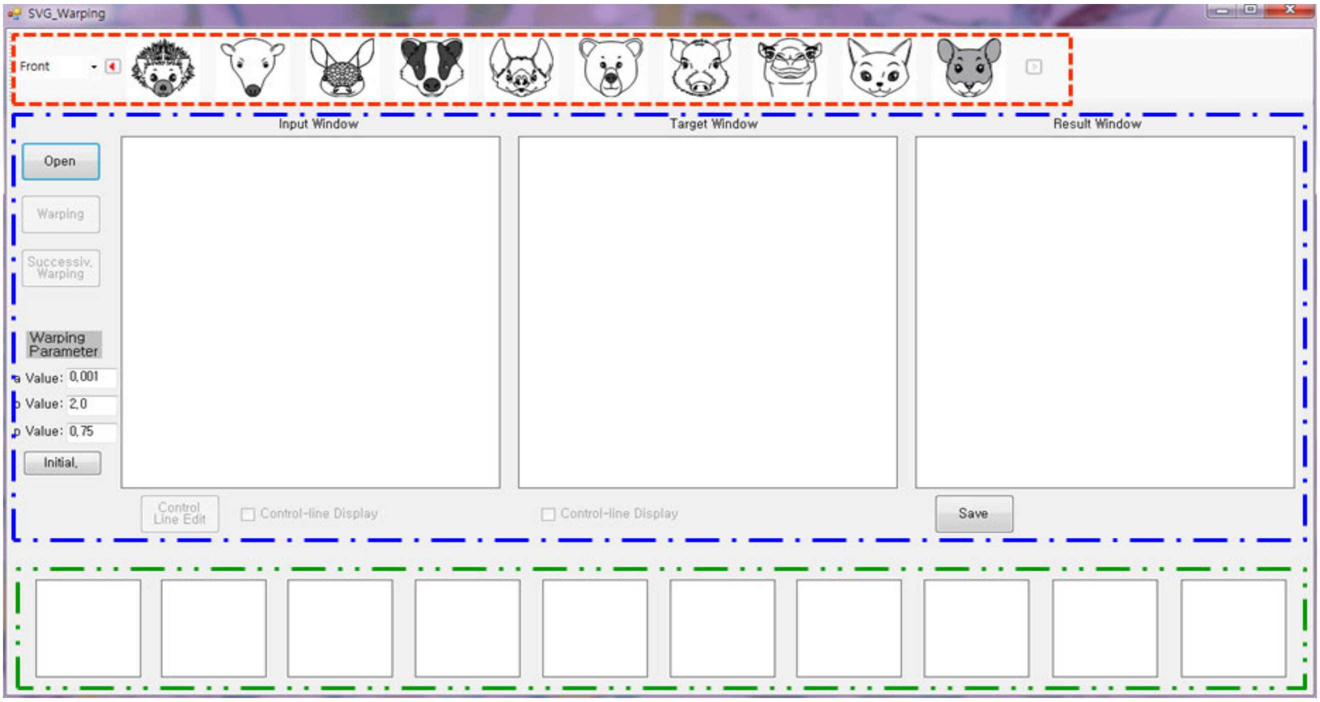

FIGURE 1. Structure of warping program using C++/C#/XML.

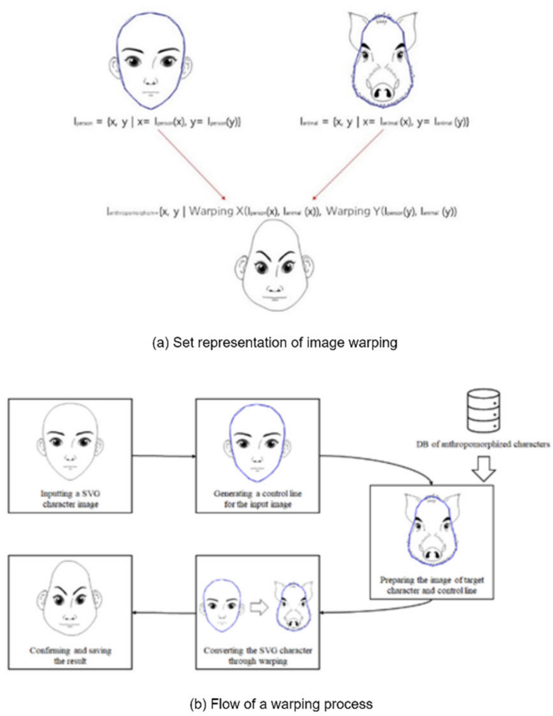

FIGURE 2. Graphic abstract of the SVG warping system.

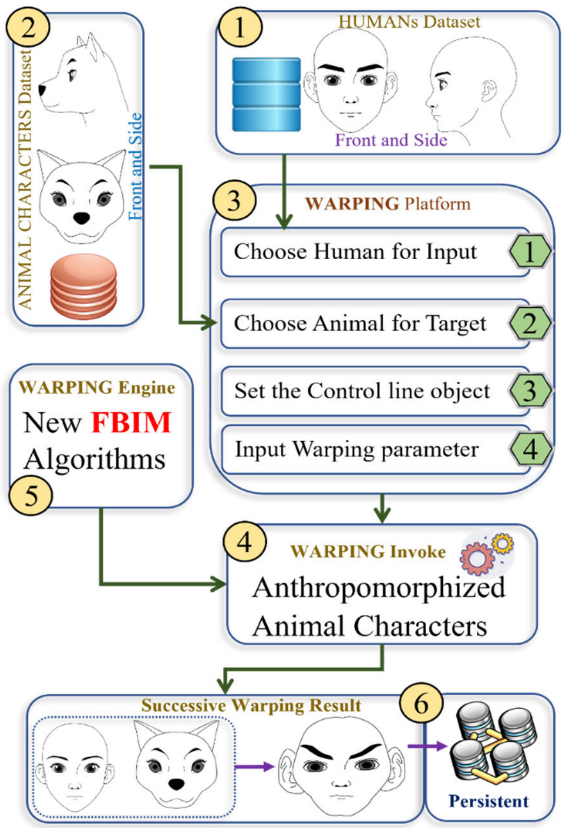

FIGURE 3. New FBIM system for anthropomorphizing game characters.

5th step ⑤, we adjusted the FBIM warping process to accept real-type coordinates. We input the SVG elements' coordinates into this process. The existing element coordinates are replaced with new coordinates, converted from the output values of the warping transformation.

In the 1st step ① we build a database of animals in SVG format and Vectorize this data to serve as personification, for each animal we have a front and side face, The user will

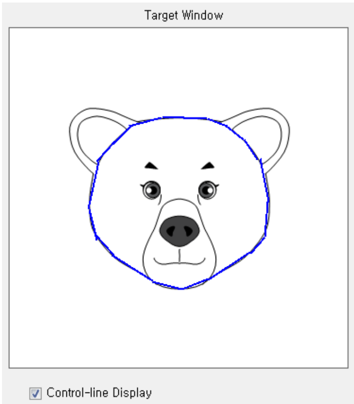

FIGURE 4. Image of an anthropomorphized character overlaid with its control line.

choose any Animal characters to put into the Target Windows. In the 2nd step ② we build human data, similar to step ① that each human will have a Front and Side, and the user will choose any Humans to put in the Input Window group. in the 3rd step, ③ will receive the character data selected in steps ① and step ② to start the process of processing the personified character in the game character. In addition, in step ③, the user can pass Warping Parameters and control line edits to invoke the new algorithm FBIM (New feature-based image metamorphosis) to perform personification in the 4th step ④, and we provide functionality so that users can consecutively select personification results and these results will be displayed in the 6th step ⑥, and these results will be persistent to the hard drive for it to be used. Used for games with anthropomorphic characters.

Therefore, when an image was loaded from the dataset in the warping program, its corresponding control line was also loaded. When the 'Control-line Display' check box is selected on the controlled display, the character image is shown overlaid with its blue control line like Figure 4.

The control lines are designed in the XML file. Each one includes the coordinates of its starting and endpoints. Example 1 shows the XML file. In Example 1, the <line(s)> element refers to a control line. Within the <line> structure, <num> represents the number of the control line, <px> and <py> represent the *x* and *y* coordinates of the starting point, respectively. Similarly, <qx> and <qy> refer to the *x* and *y* coordinates of the endpoint, respectively. The <parts_name> element divides a control line according to facial parts, facilitating the application of distinct weights to each part during the warping process; it is determined by the user.

When character images of humans and animals are uploaded to the system, control lines are generated. Additionally, users can manually adjust these control lines by clicking the 'control line edit' button shown in Figure 1. Once the control lines are established, the system is ready for warping. Traditional warping algorithms are based on raster images and thus cannot utilize vector graphics included in SVG format. However, the warping system presented can adjust and convert files in SVG format.

```
<?xml version='1.0' encoding='utf-8'?>
<warping_control_data>
<name>bear.clp</name>
<direction>front</direction>
<line_num>18</line_num>
<version>4</version>
<lines>
<line>
<num>0</num>
<px>121</px> <py>10</py> <qx>145</qx><qy>11</qy><par
ts_name />
</line>
<line>
<num>1</num>
<px>146</px><py>11</py><qx>167</qx><qy>19</qy><part
s_name />
</line>
</lines>
</ warping_control_data >
```

EXAMPLE 1. XML file for control lines.

```
Example of a relative coordinate.
<path id="line" d="M10,10 L 0,90 L 90,0"
fill="transparent" stroke="black"/>

Example of a relative coordinate adjusted to an absolute
coordinate.
<path id="line" d="M10,10 L 10,100 L 100,100"
fill="transparent" stroke="black"/>
```

EXAMPLE 2. Example of relative coordinates conversion to absolute coordinates.

The warping process is largely divided into transformations based on the following five factors: (1) relative coordinate, (2) <Path>, (3) <rect>, (4) <circle>, and (5) <ellipse>. We explain each factor in detail as follows.

First, the relative coordinates of the input and target images are converted to absolute coordinates for ease of coordinate operations in the warping system. Example 2 shows the result of converting arbitrary relative coordinates to absolute coordinates using path elements. In this example, the first and second cases show relative and absolute coordinates, respectively. Both are rendered in the same image.

Second, <path> process converts the vertical *V* and horizontal *H* elements into *L* elements. The use of *V* and *H* does

Example showing V and H elements

<path d="M10,10 H 90 V 90" fill="transparent"

stroke="black"/>

Example of converting V and H elements into the L

element

<path d="M10,10 L 90,10 L 90,90" fill="transparent"

stroke="black"/>

EXAMPLE 3. Example of converting the V and H elements of the path into the element L.

Example of a square element

<rect x="10" y="10" width="100" height="100"

fill="transparent" stroke="black"/>

Example of converting it into a path

<path d="M1\0,10 L 10,110 L 110,110 L 110,10 z"

fill="transparent" stroke="black"/>

EXAMPLE 4. Converting a square element into an element connected by four points.

not reflect various transformations because the coordinates only move vertically or horizontally during the warping process. Therefore, the V and H elements are converted into L elements that are free to convert. The Example 3 shows the result of converting V and H elements to L elements.

Third, <rect> process converts three elements representing a square in SVG (coordinate representing the vertex of the square, the width, and height elements) into four elements. Rectangles in the existing SVG format can only represent rectangles even after warping, so the types of shapes that can be converted are limited. For conversion versatility, three SVG elements are converted into four elements. Example 4 shows an example of elements before and after conversion.

Fourth, <circle> process converts the two elements representing a circle in SVG (coordinate representing the central point of the circle and radius elements) into elements representing equiangular points at an equal distance from the central point of the circle. The points are calculated using Equation 1 where a and b are coordinates of the central point of the circle, respectively. r and n are radius and the number of divisions.

$$(x-a)^2+(y-b)^2=r^2$$
$$x=a+r\cos t$$
$$y=b+r\sin t \tag{1}$$

Example 5 shows an example where the central point and radius of a circle are converted to new coordinates. In this example, the center point of the circle is (150, 150) and the radius of the circle is 100. The circle is divided into 24 divisions, and the angle corresponding to each division is 15°.

Example of a circular element

<circle cx="150" cy="150" r="100" fill="transparent"

stroke="black"/>

Example of converting a circular element into a path

<path d="M250,150 L246.5926,124.1181
L236.6025,100 L220.7107,79.28932 L200,63.39746
L175.8819,53.40742 L150,50 L124.1181,53.40742
L100,63.39746 L79.28932,79.28932 L63.39746,100
L53.40742,124.1181 L50,150 L53.40742,175.8819
L63.39746,200 L79.28932,220.7107 L100,236.6025
L124.1181,246.5926 L150,250 L175.8819,246.5926
L200,236.6025 L220.7107,220.7107 L236.6025,200
L246.5926,175.8819 Z" fill="transparent"
stroke="black"/>

EXAMPLE 5. Illustration of conversion of a circular element into an element that has connecting points.

Finally, <ellipse> process converts three elements representing an ellipse in SVG (coordinate representing the center point of the ellipse and the half-length of the ellipse along the x and y axes) into points. Existing SVG format is difficult to represent various shapes converted through warping. To solve this problem, elliptical elements were converted into elements that were connected by equiangular points around the central point. The coordinates (x, y) of a connecting point could be calculated using Equation 2. The origin of the ellipse was (0, 0), the x-axis half-length was a, and the y-axis half-length was b. When the division angle was t and the number of divisions was n, $t = 360/n$. Equation 2 is based on the origin; therefore, the converted coordinates were moved to the location coordinates of the ellipse after conversion.

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$
$$x=a\cos t$$
$$y=b\sin t \tag{2}$$

Example 6 illustrates an example where the central point and half-length of the ellipse along the x and y axes are converted to new points. In this example, the central point of the ellipse is (150, 150) and the x-axis half-length is 100, and the y-axis half-length is 50. The ellipse is divided into 24 sections based on a division angle of 15°.

The previous five-coordinate transformations are performed before the warping process. Example 7 shows simple warping where the path elements of a square were moved by 10 units in the x direction.

In the warping program, the input image changes gradually into the target image, allowing users to select their preferred

```
Example of an elliptical element
<ellipse cx="150" cy="150" rx="100" ry="50"
fill="transparent" stroke="black"/>

Example of elliptical element conversion into a path
<path d="M250,150 L246.5926,137.0591
L236.6025,125 L220.7107,114.6447 L200,106.6987
L175.8819,101.7037 L150,100 L124.1181,101.7037
L100,106.6987 L79.28932,114.6447 L63.39746,125
L53.40742,137.0591 L50,150 L53.40742,162.9409
L63.39746,175 L79.28932,185.3553 L100,193.3013
L124.1181,198.2963 L150,200 L175.8819,198.2963
L200,193.3013 L220.7107,185.3553 L236.6025,175
L246.5926,162.9409 Z " fill="transparent"
stroke="black"/>
```

EXAMPLE 6. Illustration of elliptical element conversion into an element with connecting points.

```
Path elements before warping
<path d="M10,10 L 10,110 L 110,110 L 110,10 z"
fill="transparent" stroke="black"/>
Results after warping
<path d="M20.000,10.000 L 20.000,110.000 L
120.000,110.000 L 120.000,10.000 z" fill="transparent"
stroke="black"/>
```

EXAMPLE 7. Example of element conversion through warping.

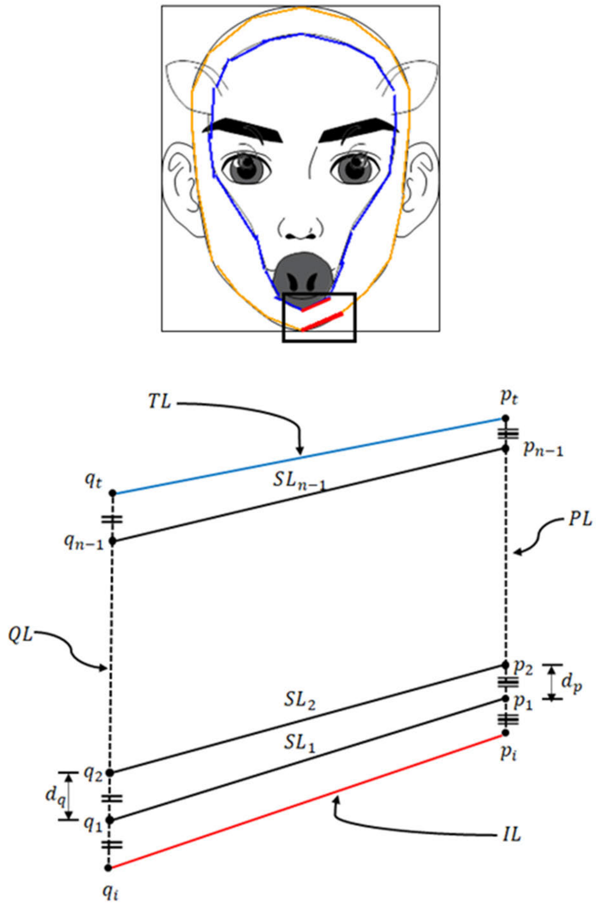

FIGURE 5. Method of generating a control line in continuous warping.

outcome from the sequence of transformed images. This paper details the implementation of this gradual transformation through a process of continuous warping. To perform multiple warping, pairs of corresponding control lines are required for both the input and target images, relative to the number of warping. The continuous warping process utilizes the control lines from both the input and target images to generate dynamically evolving control lines. Figure 5 illustrates the example of generating a control line at each stage.

In Figure 5 (upper), the blue and orange lines are the control lines of the target and input images, respectively. The red line of the black bounding box can be enlarged and drawn, as shown in the figure (below). The control line of the input image is IL with a starting point of p_i and an endpoint of q_i. The control line of the target image is TL with a starting point of p_t and an endpoint of q_t. To generate a control line at each stage, lines PL (connecting p_i and p_t) and QL (connecting q_i and q_t) are generated. If the image is warped continuously n times, the line PL is divided into n sections of equal length d_p. The equidistant points $p_1, p_2, \cdots, p_{(n-1)}$are generated along PL. The points $q_1, q_2, \cdots, q_{(n-1)}$ are generated in the same way on QL. After division, points p_1 and q_1 are connected to generate the line SL_1. In the same way, points p_2 and q_2 are connected to generate the line SL_2. In general, the control line $SL_{(n-1)}$ is generated by connecting $p_{(n-1)}$ and $q_{(n-1)}$. Warping is performed based on IL_1 and SL_1 for the first step, and IL_2 and SL_2 for the second step. We use a continuous warping program with n=10 steps. In addition, by applying the method described above, control lines are generated as often as warping is performed. Figure 6 shows the flowchart of the proposed warping framework.

Initially, when users select input and target images, these images are transferred from the dataset to the user interface for visualization and then relayed to the software. If the user initiates warping, the software employs the received images to execute the warping algorithm. The results of the warping algorithm are then conveyed to the user interface and presented to the user, upon which the software concludes all processes.

IV. RESULTS OF WARPING SVG CHARACTERS

In this section, we present the outcomes of applying our warping framework to a human-input image, transforming it to resemble a target animal character. The results show the front view, side view, and continuously warped images.

Figure 7 and Figure 8 show the results of warping a human character into a gorilla character for the front and side views, respectively.

Figure 9 and Figure 10 shows the results of warping a human character into an anteater for the front view and a human character into a bear for the side view, respectively.

Figure 7 to Figure 10 show the warping results on the warping system interface, which are indicated by the blue one-point chain line in Figure 1. The input and target images

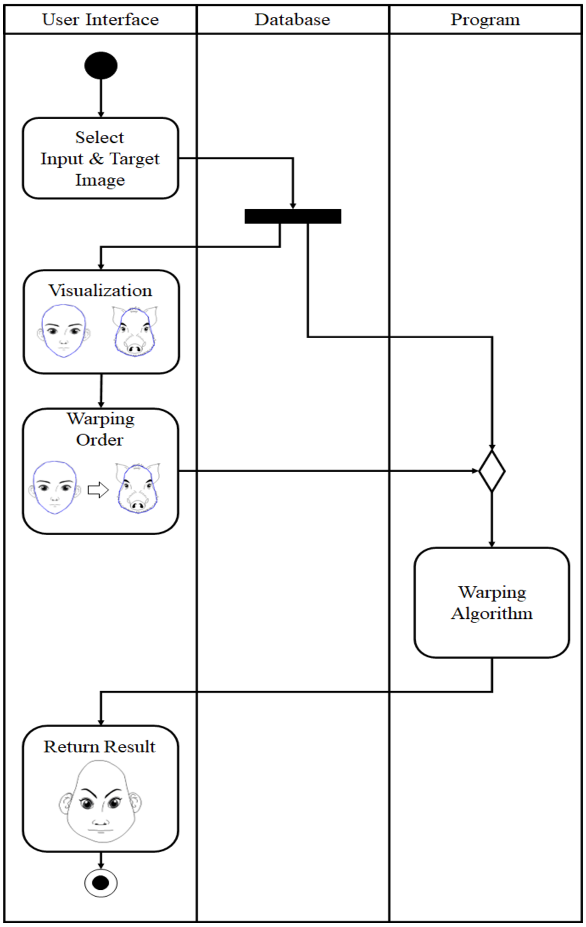

FIGURE 6. The flow-chart of the proposed warping framework.

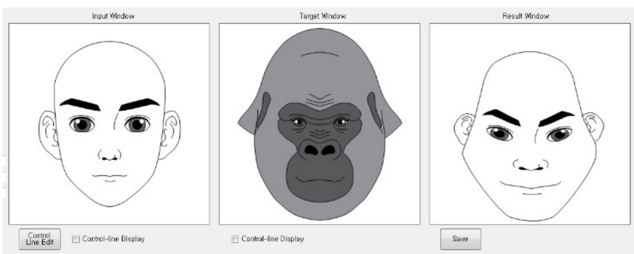

FIGURE 7. Result of warping the faces of a human and a gorilla (front).

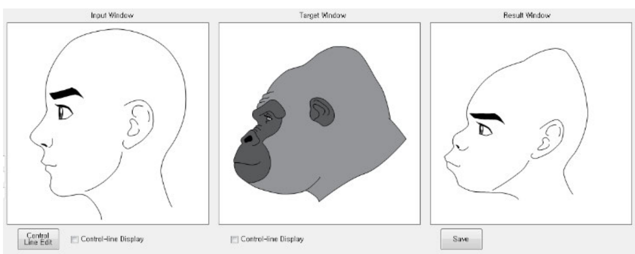

FIGURE 8. Result of warping the faces of a human and a gorilla (side).

are the front and side images of humans and animals, respectively. The final warping results, achieved through a process of ten continuous warping, are presented on the right side. Figure 11 shows the results of continuously warping a human face to look like that of a gorilla.

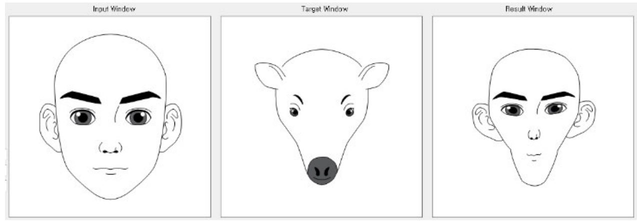

FIGURE 9. Result of warping the faces of a human and an anteater (front).

FIGURE 10. Result of warping the faces of a human and a bear (side).

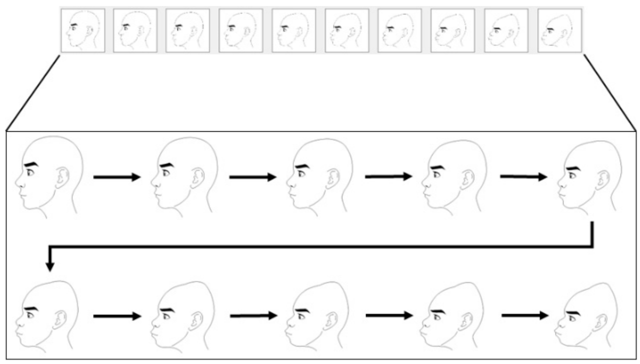

FIGURE 11. Result of continuously warping a human and a gorilla.

Figure 11 illustrates the outcomes of continuously warping the side-view images of a human and a gorilla. These outcomes are presented within the region demarcated by the green two-point chain line in Figure 1. In the actual interface, the outcomes appeared horizontally long, as shown in the top part of Figure 11. For enhanced clarity, the results have been magnified in the bottom part of Figure 11. The initial warping produces a result not markedly different from the input image. However, with subsequent warping, the result progressively resembled the side view of the gorilla. Consequently, an outcome closely resembling the target image is achievable through repeated warping.

V. CONCLUSION

This paper is significant as it enables character developers to leverage their findings for the automated generation of diverse characters across various industries. While existing studies on visual representation of anthropomorphized characters predominantly focus on classification, this paper introduces an SVG warping system, tailored to the characteristics of anthropomorphized animals. The program automatically generates anthropomorphized animal characters' front and side facial shapes datasets. This dataset is curated by analyzing animal shapes from existing literature. To enrich data sources, we analyze 60 mammal species commonly featured in animations and establish prototypes corresponding to these animals in the SVG format. Beyond utilizing the provided dataset, the system allows users to input custom data for creating new anthropomorphized animal characters. Also, this system provides the capability to automatically transform human facial features into animal-like shapes through ten progressive warping stages. Additionally, it allows users to extract the desired level of anthropomorphism from these ten progressive warping stages. This study focuses exclusively on 2D warping, with the dataset being restricted to mammals. In future works, we plan to expand the current 2D SVG warping system to accommodate 2D images and include datasets covering a broader range of mammals and various other animal species. Additionally, anthropomorphism research should not be limited to images but be expanded to video to be applied to real industries such as video games and movies.

AVAILABILITY OF DATA AND MATERIALS

Young-Suk Lee, Jaehyeon Choi, Seung-Mo Je, Jun-Ho Huh. The C++/C#/XML language is used to develop the application for experimental. ''SVG Morph source code on GitHub,'' available at Line [30]:

https://github.com/jenero05458/SVG_warping

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