1 Abstract

Calligraphy robot and potrait drawing robot have become an increasingly popular research area nowadays. Some papers and applications allow robot arm to perform potrait of people on paper or make quite complex and elegant calligraphy. For potrait drawing, a developed system usually contains four parts: image acuisition through a webcam, image processing to retrieve contours and features of objects, vectorization of coordinates in image plane and conversion of coordinates. For calligraphy, the process is similar but more involved in finding the connecting point between each stroke and improving the whole trajectory. Ability to write and draw could be one of the prosepective features of educational or humanoid robots, which can teach children how to write or help artists improve their work, in the future.

2 Related Work

2.1 Calligraphy robot

Ka Wai Kwok et al.[10] combined Genetic Algorithm(GA)-based brush stroke generation scheme and an experiment-based brush footprint acquisition method to replicate Chinese character. The brush footprint is captured by a video camera system below the transparent glass plate where brush moves on. Video frames are indexed with corresponding time for subsequent analysis. Chordal Axis Transform(CAT), a morphological transform, is adopted to obtain the skeleton of polygon shape(brush footprint). Constrained Delaunay Triangulation (CDT) is used as a preprocessing step of CAT. Rather than using artificial brush templates in their previous work [11], they applied GA and used the obtained experimental brush footprint to determine the (x, y) trajectory and z-depth altogether. Nico Huebel et al. [12, 4] applied a P-type iterative learning controller(ILC) to adapt the z-coordinates of the brush to form the desired trajectory(change thickness of strokes), the new trajectory is stored in database for next iteration. This method used visual feedback from installed camera and an iterative learning process to improve the quality of calligraphy by using information from previous iterations. Asymmetric point matching(APM) algorithm presented by Wei et al. had a good performance for matching limited nonlinear deform and quantity-uncertain point sets [5]. Bocheng Zhao et al [6] based their research on this and introduced a constrained global energy function (CGE) in the matching process and utilized a global spatial distribution energy function (EF) to evaluate relationship among point sets in order to solve specific problem in robot writing. Salman Yussof and his colleagues proposed a character-segmentation-based algorithm[7] which stores the character information as segments and this information is then used by robots to write. They tested this algorithm on Latin characters and the resullts turned out to be successful. Sabine Dziemian et al. implemented an eye-tracking system to continuously control a complex robot arm for writing and drawing, which could be widely used by people with movement disorders [8]. Their results outperform other invasive or non-invasive brain-machine-interfaces in training time and calibration time.

2.2 Drawing robot

Gazeau Jean-Pierre et al. [9] installed their artist robot by combining a 6 DOF Kuka model(KR6), KRC2 controller and a KCP (Kuka Control Panel). After taking the pictures from camera, they used Canny edge detection to obtain a maximum of 1000 points for the image vectorisation. The robot path and motion planning for drawing will be based on these vectors. S. Calinon et al. [10] used a Fujitsu humanoid robot HOAP2 with a 4-DOF right arm, 1 DOF right hand and 2-DOF head. They used an external Phillips webcam to track the head of the object at a rate of 15Hz with a resolution of 640*480 pixels. This robot model first take a snapshot of the user, start the potrait by first drawing a rough contours and then adding details iteratively. Their project involves image processing, speech recognition and simple human robot interaction. Shunsuke Kudoh et al. [11] used various feedback techniques to improve the performance of their multi-finger robot model. They proposed that robot painting action could be divided into 3 parts: obtaining 3D model, composing a picture model, and painting, which is also the whole procedure involved in human painting. By using a stereo camera and creating a picture model by extracting features of original objects, the robot could reproduce the outlines and some details of the 3D objects. Ahmed El-Barkouky et al. [12]proposed an interactive educational system with a humanoid robot NAO. They used light polarization to make fast segmentation for the image appearing on the Liquid Crystal Display (LCD) of any laptop.

3 Hardware/Robot platform

- Sony EVI-D30/D31 Pan/Tilt/Zoom Colour Video camera with a resolution of 640*480 pixels, capture 20-30 frames/sec[10, 11]
- KUKA light weight robot, a Prosilica GC 655C camera, and a brush [12, 4]
- AxiDraw V3
- scribit, write&erase robot, https://www.scribit.design
- Mitsubishi RV-2AJ robotic arm[7]

4 Software/Github repo

- Inkscape, https://inkscape.org/en/ (for AxiDraw)

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