論文の内容の要旨

論文題目　Robot Painter: High-Level Planning Based on Visual Perception
（描画ロボット：　視覚に基づく高レベルプランニング）

氏　名　ルチャヌラック　ミティ

Recently, many areas of research on humanoid robots have been studied, such as motion control, man-machine interfaces, artificial intelligence (AI), and so on. Among them many research projects have tried to create artist robots, with the common objective of exploring new sensing, artificial intelligence, and manipulation techniques.

This research explores new vision and manipulation techniques through painting tasks. The ultimate goal is to create a robot painter that has capabilities similar to human artists.

Consider the vision part, the key problems of 2D/3D object segmentation, color perception, orientation mapping, geometry edge processing are what our method can directly address.

This research focuses, first, on effective 2D segmentation scheme using local and global classifiers. Our proposed method can effectively deal with a foreground cut, multiple cuts, and cut before matting. Then it is shown how to exploit normal stereo cameras to roughly extract the object automatically, based on 3D background subtraction and other vision techniques, and then use our 2D segmentation to extract the object area correctly.

The robot tries to understand color distribution of the object to select the best set of colors to use. Normally, clustering colors face the problem that it tends to produce colors with low contrast. We solve this problem by incorporating two clustering methods: maximum distance clustering and K-means.

Then, in order to draw brush strokes meaningfully, the robot senses the orientation of the object. To interpolate the orientation for the whole object, the global orientation that exploits radial basis function to generate an orientation similar in style to Van Gogh, is applied.

Furthermore, some human artists usually use edges to enhance his/her paintings. Technically, many researches use gradient information to represent edges of objects. However, this would be affected from the color information on the surface. Hence, we decide to use 3D geometry edges as an input. It will be described how to extract 2D edges from 3D model. Then, the 2D edges are processed into brush strokes.

We then show how to apply these methods to high-level manipulation using a robot platform that consists of two arms and multi-fingered hands. The robot also has a stereo vision system. Based on the derived information, the robot then performs a visual feedback drawing. First, it detects a brush and grabs it using cameras and force sensors. Second, a position of the brush tip is calculated using principal component analysis (PCA). Third, it then draws and compares the canvas with the picture produced by the stereo cameras.

Finally, as the trajectories planned by the robot may not be realized on the real robot platform since its physical limitations, this research presents a method to filter and optimize trajectories targeting offline and online applications. All physical attributes, namely angle, collision, velocity, and dynamic force, are considered as a set of constraints to be met and represented as B-spline coefficients, making the limits guaranteed.

Many of the proposed methods will be shown to outperform the current methods in the sense of correctness and minimal user interaction, and it does so in a reasonable computation time.