Pathfinder Vision: Tele-operation Robot Interface for Supporting Future Prediction Using Stored Past Images

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1. Introduction

Manual operation of the robots is an important approach for critical missions taking places in complex environments, and requires educated operators for best performance.
There are many challenges to improve manual operability of tele-robots. Time Follower's Vision provides images of virtual third person view by recording camera images [Sugimoto et al. 2005]. A popular interface is a car parking assist system with rear view camera [TOYOTA]. This assistance system is able to show future models of the control targets. However, these assistance system is not enough to predict correct near future situation due to consider about 3D geometry of the environments around the targets and consider into physical interference. Therefore, it is still dependent on the operator's prior experience to predict the near-future event that may or may not result from the current course of vehicle movement, which makes it hard to set the proper route for the vehicle.
We propose an informative interface that supports the operator to become cognizant of near-future event by generating and presenting images depicting the predicted events in consideration of the physical interferences.

2. Our Approach

The block diagram of Pathfinder Vision is shown in figure 1.

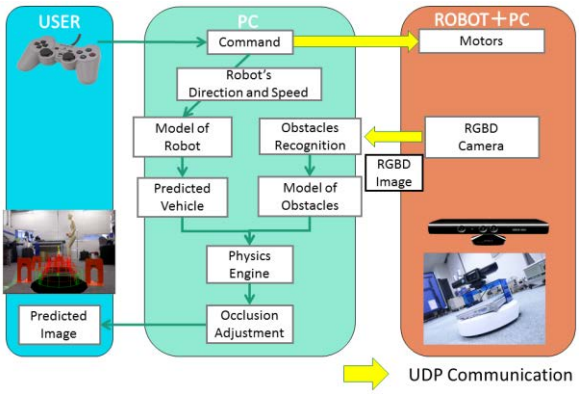
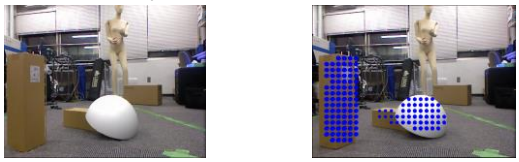


Figure 1. *Block Diagram of Pathfinder Vision.*

To support the prediction of the near-future situation, we propose "future-predicted image". Future-predicted image refers to the subjective viewpoint images in which the CG model of the robot depicts the expected physical location of the robot if the robot keeps the given course of movement.
The real-world obstacles are rebuilt virtually within the future-predicted image and are physically simulated. We obtain a three-dimensional shape based on the information from the depth camera and approximate the shape of the obstacles with a collection of spheres [Fig.2 (a) (b)]. Moreover, the prediction of the near-future robot state is governed by the physics simulation of the robot model and the shape models of the obstacles. By simulating the future trajectory of the operator's experience, the operator is able to operate the robot safely.



(a) *(b)*

Figure 2. *Model of Obstacles.*
(a: raw model, b: approximate model)

In our implementation, the CG-based vehicle model is projected on the stored sequence of images to compensate for the shape model of the obstacles. These stored sequence images are composed of RGB color image and depth image. Projecting the state of the vehicle to the stored image allows to add the information of the nearby obstacles as RGB color image, and recognize the current state of the robot easily. Moreover, by considering the depth information, the future predicted image allows to render occlusion between the robot and the obstacles. We can recognize the relative position of the robot in the real environment [Fig.3].

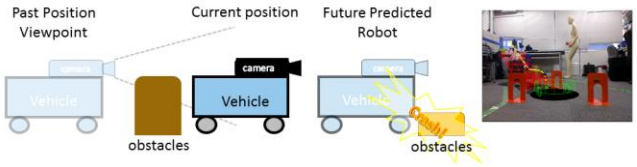


Figure 3. *Concept and Future Predicted Image.*

References

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