Modelling the behaviour and recognizing 3D virtual objects

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Abstract

In this document, we present an overview of our research topic, mixing both software modelling and computer vision. Our work will focus on two problems, the first is the research of a generic solution to specify the interactive behaviour of 3D virtual objects, the second is the improvement of the robustness of the 3D object recognition. Eventually, resolving those two problems will allow the computer, equiped with a 3D sensor, to automatically associate a behavioural model to recognized objects, allowing advanced interaction in a virtual scene. In order to be able to use next generation 3D sensors we will develop an extensive framework to deal with the rapid evolution of sensors and will allow to use our new recognition algorithm on various 3D sensors.

1 Introduction

Objects around us differ in nature, composition, function... Also in their behaviour, every object reacts differently to stimuli depending on many factors such as those aforementioned. In this context, the first part of our research work consists in identifying and classifying different types of objects based on their behaviour. We will then model this behaviour using a visual formalism (such as statecharts or petri nets). The purpose of this approach is to provide a generic and expressive way to reduce the complexity of interaction with 3D virtual objects (we already used such a formalism to specify the behaviour of a 3D graphical application [1]). Interaction is here expressed in a broad meaning; it can be interaction between two virtual objets (e.g. physical contact), between a real object and a virtual one or it

can be a gestural interaction between a virtual object and a user (e.g. hand movement).

In computer vision, a common problem for a machine is to detect and recognize the objects around it, using a capture device (e.g. a camera). Currently, this kind of problem is often resolved by using learning-based algorithms along with a set of 2D views of the object to be recognized. Nowadays, thanks to 3D sensors (such as Microsoft Kinect) and 3D reconstruction algorithms, we can exploit the geometric shape of objects to be identified to provide a greater robustness for recognition algorithms, especially when the 3D objects are located in a complex scene containing many objects that can be partially occluded. Current techniques based only on 2D views can not directly exploit the geometric shape of the objects , making recognition difficult to achieve. Methods exploiting 3D vision have started to appear, but their use in complex scenes with partially occluded objects is still a topic under research.

2 Research challenges

A first scientific challenge of our research is to develop a domain-specific visual modelling language (DSML) based on visual languages such as statecharts or petri nets to model the interactive behaviour of real world objects. These objects will be usable in Virtual Reality (VR) applications bringing a substantial opening in the field of computer simulation. It is therefore necessary to study in depth the advantages of both formalisms mentionned to see if one of them is most appropriate to meet the needs of our research.

A second scientific challenge consists in proposing a new algorithm for 3D object recognition based on knowledge of the geometry of the object to be recognized using a 3D sensor (e.g. a Kinect sensor). Recognition algorithms typically use databases containing 2D pictures of an object in order to recognize it. Thanks to the 3D information that is available using such 3D sensors, we have a lot more informations that are interesting to exploit. Using those additional informations will help to improve the robustness of the algorithm because it will no longer be necessary to make assumptions about the shape of the objects to be recognized (which is dificult using 2D only). We will also improve the complexity of these algorithms because fewer calculations must be made for recognition. Indeed, the search of particular features is a very expensive process on 2D images. Lastly, we will use 3D vision to allow our recognition algorithm to segment a 3D scene and more precisely to detect discontinuities in the scene.

In order to be able to use next generation 3D sensors (which will prob-

ably be more accurate and work at a higher resolution), we will develop an extensive framework coupled with high level routines to access raw data of the sensors in a generic way. Developing this framework will help us to deal with the rapid evolution of capture devices and will allow to use our new recognition algorithm on various 3D sensors.

References

[1] R. Deshayes and T. Mens. Statechart modelling of interactive gesture-based applications. In *First International Workshop on Combining Design and Engineering of Interactive Systems through Models and Tools (ComDeisMoto), organized at INTERACT 2011*, 2011.