Proposition de thèse de doctorat

Début : 2017-2018

Titre de la thèse : Simultaneous tracking and estimation of physical properties of deformable objects in Augmented Reality

Laboratoire : AAU

Equipe : CRENAU / INRIA Hybrid

Localisation de la thèse : Nantes

Directeur de thèse	**Co-Encadrants**
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Description du sujet

Augmented Reality (AR) has drawn major attention in recent years from both the industry and research groups. One of the main challenges of AR lies in the geometrical integration between the real and the virtual worlds. Register both worlds is usually achieved by computing a geometrical transform between a known model (composed of geometric features) and their homologous features seen by a sensor, most of the time a camera.

Several approaches have been proposed regarding this registration task:

- the first one is called tracking and consists in estimating a camera pose at time $t+dt$ from time t assuming only a small motion was performed and an initial position is known (with a drift risk);
- the second type of approach assumes there exists in the real scene known rigid objects that image processing will be able to detect. Those objects may be markers (historical AR), 2D images or 3D objects. The challenge consists of retrieving features in the scene before matching them to the model features and finally robustly computing a rigid transformation between the two sets (since under and over detection of features as well as noise may occur);
- the third type of approach relies on so-called natural feature points, i.e. points that are assumed to be detected in several images of the same scene. Corners can belong to this category. A series of techniques based on simultaneous reconstruction and mapping (SLAM) have been proposed. No previous knowledge of the scene is required but those techniques either require a large number of points and views but are also prone to drift. Recent works may be adapted to fewer points~\cite{engel14eccv}. They require a static scene model such as an urban scene although some noise can be taken into account.

In medical applications (but not only), simulation of organs is performed in order to help surgeons rehearse/prepare/facilitate their work or to build robots that would be able to perform some of their tasks~\cite{Cotin99}. Simulations require accurate physical models of organs which maybe hard to acquire: a living liver is composed of 70\% of water which would disappear as soon as the liver is extracted to measure its properties. Therefore, identifying and validating the mechanical properties of living organs is a key problem. On a physical point of view, they are considered as non-rigid bodies.

The general purpose of the PhD to overcome the limitations of present AR to take into account deformable models. As they are difficult to model, the idea to track deformable models is to be able to replicate the underlying principle of SLAM, i.e. building the model and registering it as the same time by accumulating information through multiple images, possibly of different type (RGB or RGB-D).

The PhD candidate will stay in the Hybrid team, co-located in both Rennes (IRISA) and Nantes (Ecole Centrale Nantes). He/she will have to stay in both cities under a ratio that will be further discussed.

Compétences requises
Computer vision, augmented reality

Commentaires Supplémentaires