**Abstract**

**What is TAVI? Why the tracking of aortic valve plane? Why the tracking of calcification? Contributions? Results?**

Transcatheter aortic valve implantation(TAVI) is a therapeutic alternative for high-surgical-risk patients with severe symptomatic aortic stenosis. 2-D X-ray angiographic and fluoroscopic images are typically used to guide TAVI procedures, for which contrast agent needs to be injected from time to time to make the anatomy of the aortic root visible under X-ray. Exact valve placement is crucial during the intervention, also, the contrast of fluoroscopic images is generally limited to minimized the radiation exposure for the patient and the physician. Advanced visualization and augmented reality involving patient-specific 3-D models of the aorta can greatly facilitate the relatively complex TAVI procedures by providing a more realistic anatomy of the aortic root. In this paper, we propose a new method based on the *Tracking-Learning-Detection* approach, applied to the aortic valve calcifications in order to determine the position of the aortic valve plane and 2-D/3-D fusion in intra-operative TAVI images. (Contributions). The approach has been evaluated on 25 TAVI procedures (graphy/scopy). Edwards SAPIEN and CoreValve were implanted in 12 and 33.33% of patients, respectively. The TAVI approaches used were transarterial (transfemoral: 66%; subclavian: 5%) or transapical in 29%. Tracking success rate was 68.3%. Providing an absolute mean displacement error less than 10 pixels (≈2mm),the early results are satisfactory in terms of feasibility. Its suitability for the TAVI procedure has been analyzed.

**Introduction**

Affecting 1.8% of the global population, aortic stenosis is the most common valvular lesion occurring among elderly patients and has become extremely frequent because of changing demographics in industrialized countries. There are about 60,000 surgical aortic valve replacements every year in Europe and even more in the United States [1]. For people who have significant aortic stenosis, the only really effective treatment is to surgically replace the diseased aortic valve with an artificial valve. Unfortunately, the standard method of aortic valve replacement requires a major open-heart surgical procedure, and, especially in the elderly patients who most typically develop aortic stenosis, it is a procedure that carries significant risk. Transcatheter aortic valve implantation (TAVI) has emerged as a promising alternative to conventional aortic valve replacement for elderly patients with severe, symptomatic aortic stenosis who are otherwise left untreated due to the perceived high risk of operative mortality. Compared to the standard aortic valve replacement surgery, TAVI offers a replacement valve introduced through an artery via a small incision (usually the femoral artery) or, less often, surgically with an incision into the chest and then into the left ventricular apex (the transapical approach). About the transfemoral artery procedure that is the most common used, after catheterization through a femoral access, the overall procedure consists in introducing the transcatheter valve passing through successively the descending aorta, the ascending aorta and the native valve to finally perform the deployment of the aortic valve bioprosthesis. For both access types, the last stages concerning the localization and the deployment of the valve need the development of efficient tools to make more secure and reliable the TAVI procedure.

During TAVI procedures, X-ray angiographic and fluoroscopic imaging is routinely used to guide the operation, because the visibility of the target area is limited to the naked eyes due to the small incisions. However, fluoroscopic images do not display the anatomic structures without the contrast agent, which on the other hand needs to be minimized for patients’ and physician's safety. Determining exactly valve location and minimizing the use of contrast injections are urgently needed during the surgical intervention, because complications can arise from a misplaced valve [2]. The objective is thus to develop efficient tools coping with difficulties in obtaining an optimal view of the native valve to define then an optimal target location. Only few previous studies deal with intra-operative support for TAVI procedure.

(The annular plane is sometimes visible depending on the amount of annular calcification, but often only indirect clues are provided by the position of a pigtail catheter. The pigtail catheter should be placed at the bottom of a coronary sinus.)

**References**

[1] V.T. Nkomo, J.M. Gardin, T.N. Skelton, J.S. Gottdiener, C.G. Scott, M. Enriquez-Sarano. Burden of valvular heart diseases: a population-based study. Lancet, 368 (10) (2006), pp. 1005–1011

[2] Yan, T. D., Cao, C., Martens-Nielsen, J., Padang, R., Ng, M., Vallely, M. P. & Bannon, P. G. Transcatheter Aortic Valve Implantation for High-Risk Patients with Severe Aortic Stenosis: A Systematic Review. The Journal of thoracic and cardiovascular surgery, Vol.139, No.6, 2010, pp. 1519-28, ISSN 0022-5223.