

2018-00446 - Vibration analysis by video image processing for civil engineering structure monitoring

Contract type : Public service fixed-term contract
Level of qualifications required : Master degree or equivalent
Fonction : PhD Position

About the research centre or Inria department

The Inria Rennes - Bretagne Atlantique Centre is one of Inria's eight centres and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Team presentation :

The overall objective of this project-team is the development of Structural Health Monitoring (SHM) techniques by close coupling of statistics and physical modeling. Robust, efficient and autonomous SHM methods for applications to civil, electrical, mechanical and aeronautical structures are the goal.

The design, monitoring and maintenance of structures subject to noise and environmental perturbations are important research topics in engineering. On the one hand, such structures are equipped with more and more sensors for health monitoring. On the other hand, detailed physical models are developed as part of their system design. These models involve for example the dynamics of vibrations, thermodynamics, aerodynamics or other physical aspects.

Relevant monitoring solutions require system identification and damage diagnosis tools robust to environmental variations. They should also be capable to handle both complex physical models and a diversified sensor instrumentation. In particular, new sensor types and topologies require new algorithms, for example, for handling hundreds of sensors automatically during long periods of time, wired or wireless, or using new fiber optical or image-based sensing technologies. Complex and heavily instrumented structures with a diversity of sensors ask for new monitoring methods.

This implies new statistical and numerical techniques as well as improvements of the underlying physical models. On the one hand, many methods are based on mechanical principles, taking into account the underlying physics of a structure. On the other hand, system identification and change detection methods are grounded in the control community. They are related to the processing of measurement data, taking into account its underlying random nature, e.g. related to excitation and measurement noises. It is our goal to bring both communities together for the development of methods with a strong theoretical background and relevance in applications.

More informations : <https://www.inria.fr/en/teams/i4s>

Context

The I4S team develops real-time vibration analysis methods for the monitoring of civil engineering structures (bridges, buildings, etc.), usually based on mechanical sensors integrated into the monitored structures. In parallel, the team works also on image processing techniques for non-destructive testing of civil engineering construction materials.

The proposed PhD project aims to combine the two approaches in order to develop a method of vibration analysis based on image processing. A video camera provides a sequence of images of the structure to be monitored, the motion signal of the structure is derived from video image analysis, methods of vibration analysis are then applied to this motion signal. Such a solution will have the advantage of avoiding the

General Information

- **Theme/Domain :** Optimization and control of dynamic systems
- **Town/city :** Rennes et Nantes
- **Inria Center :** CRI Rennes - Bretagne Atlantique
- **Starting date :** 2018-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2018-06-30

Contacts

- **Inria Team :** I4S
- **Recruiter :**
Zhang Qinghua /
qinghua.zhang@inria.fr

The keys to success

Master of science degree in image and signal processing, with good skills in applied mathematics. Knowledge of mechanical vibrations would also be appreciated.

Conditions for application

Thank you to send us these documents by applying online :

- updated CV
- cover letter
- letters of recommendation
- eventually, degree transcripts

Defence Security :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

integration of mechanical sensors into monitored structures and simplifying the maintenance of the monitoring system.

Thesis supervisor: Qinghua Zhang. <http://people.rennes.inria.fr/Qinghua.Zhang/>

Co-supervisor: Vincent Baltazart.

Assignment

The PhD project will include the following tasks:

- Establish a bibliographic study on vibration analysis using contactless optical, acoustic and microwave methods.
- Elaborate new methods for video image segmentation, based on the experiences of the team in this field.
- Design and develop new vibration monitoring methods by combining image processing and vibration analysis.
- Implement developed algorithms on GPUs (Graphical Processing Units) for real time applications.
- Experiment on simple laboratory structures and on real applications. Compare with methods based on conventional sensors (accelerometers) and with other emerging methods.

Main activities

- Determination of the contours of the monitored structures on video images. The first studies will consist in adapting and testing existing methods, in particular an algorithm already developed by the team in other application contexts, particularly suitable for low-resolution images.
- Estimation of the motion signal of the structure to be monitored.
- Vibration analysis, including robustness analysis in case of low signal-to-noise ratio.
- Experiments in an IFSTTAR laboratory in Nantes, as well as on real world structures (wind turbine mast, gantry, bridge).

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Sports facilities

Remuneration

Gross salary : 1982 euros

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.