

## Smart materials - based array of micro-actuators for micro-conveyance applications

### Post doc Advisor:

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### Context of the study:

Nowadays, two major challenges are identified as locks in advanced micro-mechatronic systems: management of energy and decrease/suppression of connections (by wires) into the workspace systems to make free the kinematics defined during the design.

Micro-conveyance of micro-mechanical parts, with remote control strategy, is one of the micro-mechatronics systems which can demonstrate the System of Systems (SoS) concept at the meso and/or microscale. SoS at these scales are rarely studied. To give some examples, the conveyed micro-mechanical parts come from watch industry or electronic micro-components industry.

More precisely, in the Roberval Laboratory, studied micro-conveyance systems are composed of several micro-actuators (arrays) that form smart surfaces based on the stick-slip principle. Sliders (Sheets of glass) can move freely and independently onto the smart-surface without the risk of collisions thanks to a communication method partly integrated into the micro-actuators principle.

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### Post doc description:

The applicant of this Post-doc fellowship will work on the integration of a network of remote controlled micro-actuators. These micro-actuators are multi-stable between several discrete positions; thus, no sensors are required to have an accurate control of their functioning. As a consequence, the control is easier and provided by functionalized smart materials (Shape Memory Alloys – SMA) that are integrated into the micro-actuators for power feeding and control purposes by wireless photonic means.

The micro-actuators are composed of quadric-stable silicon structures (flexible and thin beams) coupled with functionalized (optical selective) SMA components: the laser lighting at a specific wavelength of an SMA component makes possible the switch between two positions and the switch back is operated using the same principle by another wavelength to avoid wrong actuation in the control strategy.

In an optimized design, in particular for accelerating the actuators response time or for their autonomous functioning through integrated energy harvesting and storage, piezoelectric layers are deposited onto the flexible beams or SMA. In this case, mechanical energy harvesting from vibrations (due to input lighting) needs to be modeled in order to estimate the quantity of available energy that can be stored. Then, this energy can be used to make possible the communication of the position of the slider onto the micro-actuators array to a supervisor. This information is strategic to regulate the traffic onto the smart-surface.

The applicant will have to accomplish the following tasks:

- 1/ Review of the literature on micro-conveyance that uses the stick-slip principle,
- 2/ Modeling and integration of a 2x2 micro-actuators-based conveyance system (XY setup), including the integration of the optical selective SMA into the micro-actuators,
- 3/ Calibration of the field of views' MEMS membrane (opto-mechanical beam steering system) to allow the optical scan of the entire micro-conveyance system surface,
- 4/ Modeling and integration of an N x N array (N from 5 to 7) with piezoelectric-based micro-actuators.
- 5/ Proof of concept of the remote control and power feeding of the conveyance system (2 orthogonal translations + one rotation) used to actuate simultaneously 2 sliders without collisions.

### **Candidate's profile:**

The candidate must have a PhD degree in the domain of mechatronics. The candidate must have skills in actuation and control of mechatronic system and photonics.

Experience in piezoelectric effect and thermal modeling as well as on the use of SMA will be appreciated.

Candidates must have excellent scientific and organizational skills, open minded, teamwork experienced. A good English language skill for presentations and writing scientific papers is mandatory.

### **Documents required to apply:**

Send to frederic.lamarque@utc.fr and ayech.benjeddou@utc.fr

- Curriculum vitae
- Motivation letter
- At least two references and/or recommendation letters
- A statement of research experience and interests

### **Location:**

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