SIROM

Exploitation Plan

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<td>Written</td>
<td>Youhua Li</td>
<td>The University of Strathclyde (US)</td>
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Pages: 24

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 730035.
### DOCUMENT CHANGE RECORD

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TABLE OF CONTENTS

1. OBJECTIVES ...................................................................................................................... 5
2. EXPLOITATION PLAN ........................................................................................................ 6
   2.1 Scientific exploitation ................................................................................................. 6
   2.2 Technical exploitation .............................................................................................. 9
      2.2.1 General technical exploitation .......................................................................... 9
      2.2.2 Technical exploitation within SIROM .............................................................. 11
      2.2.3 Technical Route Map and Potential Upgrades of the Thermal Interface .......... 11
   2.3 Intellectual Property Right exploitation and management ...................................... 12
   2.4 Commercial exploitation of the project results ....................................................... 13
      2.4.1 Pre-commercialisation technical improvements ............................................. 13
      2.4.2 Thermal If Potential Applications ................................................................... 16
   2.5 Research and development exploitation ................................................................. 18
   2.6 Impact and public engagement exploitation ............................................................ 18
   2.7 Follow-on activities ................................................................................................. 22
3. ACRONYMS LIST ............................................................................................................. 24
1. OBJECTIVES

Further to previous project exploitation plan, this update will build on the objectives of previous plan and only provide new and additional information since last update.

The objectives of the SIROM project remains the same and SIROM project aims to realize a first-of-its-kind standard, multi-functional intelligent interface (IF) between APMs in orbital and planetary environments. The project is very ambitious and its positive outcome will have strong impacts in the next few generations of spacecrafts. This novel IF design and its prototypes, and ambitious IF for a possible international design standard will create great opportunities for exploitation, in particular in scientific exploitation of its design methodology, multi-disciplinary design and optimisation in general in the applications of these techniques in other extreme robotic applications. These include but not limited to applications such as deep sea underwater exploitation, nuclear waste handling and agricultural exploitation. For this reason the consortium is very proud of the project and will do its best to exploit the research outcomes from the project findings in a coordinated and collaborative manner.

The objective of exploitation will be mostly on scientific perspective of the research investigation at the early stage of the project, although it is anticipated shortly after the project’s completion, the major project industrial partners will exploit the commercial benefits of the project too. The scientific exploitation is already taking place and early research findings from academic partners supported by industrial partners will be detailed later.

One of the instruments of the consortium in its exploitation plan is to maximise the potential commercial benefits of the design solution by protecting its design rights or patents so that the interests and Intellectual Property Rights are protected. Partners who made invention or creation of these new design solutions are encouraged to seek protection as part of this plan. To reach this goal, several Tools and Channels will be used, targeting both general and technical audience.
2. EXPLOITATION PLAN

Further to previous project exploitation plan, this update will build on the previous exploitation plan and provide new and final update information to SIROM project exploitation plan since last update.

2.1 Scientific exploitation

Scientific exploitation of the research findings of the SIROM project involves publication of the work in high impact journals or conferences so that funded work can be publicised widely to showcase the European leading research work in space connector. The success indicators include journal and conference paper published in suitable space engineering and mechatronics journals such as IEEE Mechatronics, and conferences such as International Astronautical Congress.

The other possible success includes wider adoption of a design procedure in and approach to multi-disciplinary robotic connector design and modelling by both academic community and industrial practitioners. This include the citation of this work and possible adoption of a computer supported design process modelling tool in teaching of next generation mechatronic designers.

Project partners, especially the academic partners have taken proactive role in exploit scientific research findings and have already submitted 7 conference paper to disseminate the project preliminary findings and some final design and test results to targeted important conferences, including Astra conference organised by European Space Agency in Netherland, and International Astronautical Congress (IAC) in Adelaide, Australia in 2017 and Breman, German in 2018 and two other conferences.

As a result of SIROM consortium’s collective effort, the consortium is proud to report from scientific exploitation perspective, the SIROM project team has produced a total of two journal papers and nineteen conference papers. There is a separate deliverable D6.4 Six_Published_Paper Report has been produced and submitted to summarise the results of scientific exploitation. For further information of the detailed achievements and awards, please refer to that document. To continue the flow of this report showing the evolution and time based publication activities, it is felt that this report should retain the sequence of the publication over the project period as shown in the sections below.

The following full papers has been accepted and presented at the conferences.

1. “Mechanical, thermal, data and power transfer types for robotic space interfaces for orbital and planetary missions – A technical review”. The paper was submitted to and presented at Symposium on Advanced Space Technologies in Robotics and Automation (ASTRA), which was held on 20-22 June, 2017, Netherlands. The full paper and presentation file can be found at: https://robotics.estec.esa.int/ASTRA/Astra2017/

2. Four full papers have been accepted by and submitted to International Astronautical Congress (IAC), which was held on 25-29 September, 2017, Australia. Presentations were given during the conference. The details are:

   a. Palazzetti, Roberto, Wenzel, Wiebke, Bartsch, Donaldson, Karen, Sebastian, Yan, Xiu-Tian, “Toward a multifunctional interface for future planetary and orbital missions”, IAC-17.C2.2.7,

c. McMaster, Thomas, Xiu T Yan “A methodology for design of lightweight parts in harsh environments”, IAC-17.C2.9.5


Based on these work, a further paper has been submitted to Frontier in Robotics and Artificial Intelligence journal for consideration of publication. This paper has now been accepted and published in this high quality journal with the following details:


Project partners have also produced two new publications with details below and three further papers abstract have been planned, submitted to and accepted by International Astronautical Congress 2018 and one initially now two to Mechatronics 2018 International Conference:


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This brings the total publication of 15 papers, including 2 journal papers and 13 conference papers by July 2018.

At the 69th International Astronautical Congress (IAC 2018) conference, SIROM team has produced one journal paper and three conference papers published with the following details:


At Mechatronics 2018 conference, 3 conference papers has been presented with the following details:

1. Scott Brady and Xiu T Yan, “An engineering design tool capable of nurturing the development of new mechatronic actuators”.

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2. Thomas McMaster and Xiu Yan, “Development of a heat flow code to simulate production of a functionally graded material robotic gripper using the additive manufacture process”.

3. Xiu T. Yan, Mark A. Post, Alessandro Bianco, Cong Niu, Roberto Palazzetti, Ying Lu, Craig Melville, Aron Kisdi and Wayne Tubby, "The AgriRover: a Mechatronic Platform from Space Robotics for Precision Farming".

The consortium has also promoted and expanded the interest to SIROM work to younger generation, in particular to current PhD students in Germany and the UK. Working with these younger PhD students, one journal paper has been published and two conference papers have been published in these conferences on research work associated with SIROM project activities since July 2018.


Cuebong Wong, Erfu Yang, Xiu-Tian Yan, Dongbing Gu, “Optimal path planning based on a multi-tree T-RRT* approach for robotic task planning in continuous cost spaces”, DOI: 10.1109/MECATRONICS.2018.8495886, 12th France-Japan and 10th Europe-Asia Congress on Mechatronics, Tsu, Japan,10-12 Sept. 2018


The SIROM project team has produced a total of two journal papers and nineteen conference papers.

2.2 Technical exploitation

2.2.1 General technical exploitation

A key mechanism of technical exploitation of the research findings of the SIROM project is through the creation of an effective knowledge exchange platform for researchers, industrialists and other stakeholders to share their latest ideas, findings and knowledge.

In April, 2017, Knowledge Transfer Network of the UK organised an Industrial Strategy Challenge Fund Robotics and Artificial Intelligence in London, at which Prof. Yan of University of Strathclyde has been invited to priority the funding for robotics. As a result, Prof. Yan has attended the workshop during which four themes of extreme environments have been identified for funding by both the UK’s Engineering and Physical Sciences Research Council (EPSRC) and InnovateUK in Robotics and Artificial Intelligence. UK partners of the SIROM project are planning to explore feasibility of applying for these funding when possible. It is hoped that through these enhanced funding, SIROM project and its project partners will benefit from further support to advance SIROM development.

Building on the SIROM work mostly from literature and preliminary design at Strathclyde, an outline proposal was submitted to the Oil, Gas Technology Centre, UK to exploit the concept of SIROM in oil, gas industry and this has received some interests and is being further evaluated. Due to interest in quick solutions and small funding pot, this was not successful. A UAV based inspection was however funded.
The Institution of Engineering and Technology working with Robotics, Autonomous System
Special Interest Group organise UK Robotics Week 30th June 2017. The organisation is
progressing well. Prof Yan is advising the organisation of this year's UK Robotics Week.
Consortium partners are invited to present the work so far to explore technical exploitation.

Scientific exploitation will also help the promotion of SIROM work to be considered to become
an international standard for much wider impact. Prof. Yan of University of Strathclyde has
been invited to be an observer, with a plan to join a committee member, to attend the next
British Standard Institution's ACE/68 Space System and Operations was held on 8th May
2017. At this meeting, we will learn how to work with organisations such as BSI to make
SIROM as a standard space robotic interface. Subsequently, Prof. Yan attended the meeting
as an observer and this gave him much better understanding of UK's involvement in standard
development and its process.

In addition to scientific exploitation, the University of Strathclyde has taken an academic lead
and has enhanced a mechatronic system design methodology entitled Tiv model, by
developing a web based Tiv design methodology which can be accessed by all project
partners and others using the following link. All project partners are encouraged to make use
of this model and system to support their part of the SIROM design. For further details, please
contact Prof. Xiu Yan (x.yan@strath.ac.uk) Dr. Andrew Lynn (andrew.lynn@strath.ac.uk) and
Mr. Craig Melville (craig.melville@strath.ac.uk).

https://onlinelearning.dmem.strath.ac.uk/tiv

Due to effective dissemination of SIROM, the consortium has attracted interests from two UK
companies. Ross Robotics Limited is a specialist robotic company which designs, build
modular, resilient, multi-mission robotics and is interested in working with SIROM consortium
to either support SIROM or exploit technical collaboration. An agreement of engagement is
being developed to exploit this opportunity. More info can be found at http://robosynthesis.com/

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Glenair UK Ltd is the second company from which A Manager has contacted Prof. Xiu Yan to exploit SIROM. Glenair UK Ltd supplies various connectors and connector assemblies for space applications and is interested in SIROM wishing to explore potential opportunities for collaboration. Further details of the company which has headquarter in California, USA, can be found at https://www.glenair.com/.

2.2.2 Technical exploitation within SIROM

Within SIROM consortium, a SIROM Concurrent Engineering Design (CED) session has been organised and hosted by SAS on 14th and 15th November 2017. During this two day CED, all partners discussed and explored technical alternatives for SIROM. More than 30 topics requiring a clarification have been discussed and the pro and con of proposed solutions were also exploited. This SIROM CED has proven to be productive, collaborative and technically exploitive.

SENER plans to provide a technical tour for delegates attending The International Symposium on Artificial Intelligence, Robotics and Automation in Space (i-SAIRAS) 2018 at SENER on 6th June 2018 and a SIROM presentation will also be given during the event. This event went very successfully and over 100 delegates from around the world attended the SIROM presentation and factory tour.

Partners have made effort in research and development exploitation by using the research findings from SIROM to apply future space robotics funding from Call 2 on Strategic Research Cluster in space robotic technologies 2018 H2020 programme. SENER applies design procedure for optimizing SIROM IF which was included in the call2 SRC 2018 proposals to be performed if successful. In addition, DFKI led a consortium and submitted a proposal supported by Strathclyde to exploit SIROM in planetary exploration. Space Application Services led an application for OG9 and SAS is congratulated to be successful in winning the bid along with some of existing SIROM partners.

At last Project management meeting, SIROM controller was discussed in terms of radiation hardness of the electronic controller. It is also suggested that a plan should be in place to state how the controller’s electronics will be further developed from current TRL 3 to future ones with capability to be used for space radiation environment.

2.2.3 Technical Route Map and Potential Upgrades of the Thermal Interface

It is worth noting that MAG SOAR a key partner specialising the thermal interface design has made a great effort in exploiting its thermal design from technical to commercial perspectives. Below is the technical exploitation road map developed by MAG SOAR and in section 2.4.1 and 2.4.2 details of their pre-commercialization technical improvements plan and potential commercialisation applications are described.

Two thermal interfaces were developed and tested in SIROM: a low power thermal interface based on a thermal contact and a high power thermal interface consisting in a twin fluid connector. Although the first one may have some limited applications, the second one seems to be much more useful for different purposes. We will refer to the second one as IF by default.

This IF is in fact a twin fluid quick connector with capacity for 2.2 l/min each at a pressure drop of 0.6 bar at 40ºC in case of water. It may be used for transferring other fluids both in open circuit or close loop configurations. Pressure drop vs flow can be easily extrapolated to other fluids and temperature.
It has to be differentiated between the SIROM thermal IF, which consist mainly in the hydraulic fast connectors and the metallic bellows and the CL-FHEM module designed for SIROM performance demonstration. This is the first step in the route to thermal connection modularity.

The route to this modularity needs the following steps:

1. Multiple connection architecture development.
2. Improvement of performance tuned to the modular architecture
3. Space-compatibility adaptation. Demonstration in relevant environment
4. Development of Module with integrated connectors.
5. Demonstration in Space.

Step 1 requires the design and development of a multiple connector module architecture. This is a sort of extended CL-FHEM.

For step 2 the following issues have been identified. We will group them in two groups: IF and CL-FHEM as follows.

**SIROM THERMAL IF**

![SIROM Thermal IF](image)

Figure 1 SIROM Thermal IF

### 2.3 Intellectual Property Right exploitation and management

SIROM project involves nine partners of which majority are industrial partners. It is imperative to establish and fair, collaboration agreement (CA) among partners. Lambert Toolkit is used for university and business collaboration agreements.

The project partners selected one from seven model research collaboration agreements to define the ownership of any IPR resulted from a research project and their commercial exploitation.

The above has been defined in a similar format in the Section 3 Rights and Obligations Related to Background and Results of Chapter 4 Rights and obligations of the parties Grant Agreement for the project. Hence we will follow the definition of the Intellectual Property Right exploitation rules in the Grant Agreement closely, instead prepare another one.
Specifically, project partners have been reminded and encouraged to consider applying for patent for their new work. Strathclyde University is still considering to register their design right of its initial SIROM concept. SENER is also reminded and encouraged to consider to register their design either as a design right or a patent. MAGSOAR has been reminded and encouraged to register their IPR on thermal design and the company is considering to protect its IPR in its design.

2.4 Commercial exploitation of the project results

In addition to the above scientific and technological exploitation, the SIROM project partners are encouraged to exploit commercially their research findings for common benefits. These are especially the case after two successful tests for both orbital and planetary tests at AIRBUS DS and DLR. Space Applications Services has also been encouraged to explore SIROM controller design commercialisation in the context of their coordinating of OG9 MOSAR and other projects they are involved in the new group of OG grants.

As the commercial exploitation of the project findings will only be available recently and the project has shown promising results now, all project partners have been reminded and encouraged to exploit commercially their designs, evaluation and development work now and after the project completion.

The project has already attracted attentions from two UK based companies for potential collaboration or exploitation. A commercial exploitation strategy and plan has been developed as follows. The SIROM final design is the results of multiple partners contributing to mechanical design and manufacture, thermal, data and electrical power interfaces design. It is therefore proposed that the project coordinator continues to coordinate the commercial exploitation after the project. It is also suggested the project partner Space Applications Services also have a key role in specially exploit its research, technical and commercial exploitation in the new group of Operational Grants as they are the partner who has high level of involvement in the new projects.

Within consortium, it is requested to show the exploitation plan, especially the commercial exploitation plan for the thermal design and testing. It is also suggested the SIROM controller is a relatively stand-alone development and has potential to be developed as a commercial system. Hence it is suggested to develop a commercialisation plan for the SIROM controller too. In supporting the commercial exploitation and in response to the above request, MAGSOAR has produced the following plan and identified a number of potential commercial applications of a key SIROM technology on thermal interface.

2.4.1 Pre-commercialisation technical improvements

Based on the routes of improvement identified in 2.2.3, MAG SOAR plans to improve a number of technical performance aspect further of the Thermal IF before the company will be ready for commercialisation.

The IF developed in SIROM allows a multiple quick connection-disconnection operation within the specifications of SIROM (Force required, size, small liquid losses and number of operations). However a large pressure drop/low flow capacity seems to be a handicap. Heat exchange between twin lines is another potential issue to be improved.

Therefore potential improvements that would make the device more efficient and useful are the following:
To improve thermal insulation between fluid lines of the SIROM IF: about 120 W are transferred through the metallic parts in direct contact in the SIROM in the nominal conditions of the tests. This heat transfer is detrimental for the whole system efficiency. It can be improved by providing isolation between the two fluid lines with an improved design.

To investigate other sealing materials and fluid compatibility: SIROM IF designed by MAGSOAR is compatible with most technical fluids. Some candidates for thermal management in space are summarized in the table below:

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Compatibility of the current quick connector from Staubli CDG03/C with Fluoro-silicone seals (JS3) should be reviewed in case by case basis with the manufacturer. The most sensitive component of the design is the Fluoro-silicon seal. This seals are typically not compatible with Ketones, Phospahte Esters, some acids, brake fluids and ammonia.

To increase fluid connector hydraulic diameter: with the current design, a relatively high fluid speed and pressure drop happen in the connectors. By slightly increasing the hydraulic diameter, the system can be done more efficient and transfer a larger amount of heat. Increasing the bore diameter of the connector to 5mm (currently is 3 mm) the pressure drop in the SIROM IF is estimated to be about one order of magnitude lower (0.06 bar) highly reducing the requirement in the pumping system.

¹¹ Extrapolated from data at higher temperatures
• To investigate behaviour under fatigue for full life cycle of the SIROM IF.  

A long test of aging and fatigue is recommended.

• To analyse in detail current design for compliance with the mechanical and temperature environment for planetary and orbit scenarios.

CL-FHEM

The CL-FHEM uses the IF to provide an integrated module for thermal exchange. The CL-FHEM tests show the following potential improvement issues.

• To improve thermal insulation of the components and generate thermal management system of the pump and active components. This is already included in IF improvement tasks.

• To design a specific expansion vessel. The expansion vessel is a key component to ensure the life of the device. A specific design is required to fit vacuum/space environments and to demonstrate the required life and compatibility with fluids.

• To improve current heat exchanger design to increase its efficiency against any fluid. The heat transfer coefficient has to be improved while fitting in the available space.

• To increase the hydraulic section of the ducts and components to minimize pressure drop of the system and minimize power requirements on the pump.

• To develop low power reduced size commutation valves and hydraulic components to minimize the envelope requirements of the CL-FHEM and power consumption. This is a key issue as a zero power consumption should be expected from components in order to create a really modular concept in which a module has several IF connections that can be chosen and activated at wish. Those not used should be sleeping with zero power consumption. Those activated should preferably be zero or low power consumption.

• To develop the architecture of an extended CL_FHEM for a Module with multiple connexions. To extend the architecture to enable different connectors in the same module to allow truly modularity.

Figure 2 - An extended CL_FHEM for a Module with multiple connexions
2.4.2 Thermal If Potential Applications

SIROM thermal interface design features a number of desirable properties. Its compact size, versatility to operate in a wide temperature range and its potential compatibility with different thermal management fluids provide SIROM thermal IF of unique properties. Potential applications for the SIROM thermal IF technology and CL-FHEM modules are extremely wide specially for low maintenance and autonomous systems, robots operating in extreme environments and other applications. In the list below, some potential commercial applications are identified and MAG SOAR intend to explore them confidentially in future:

• Refrigeration of any device (mechanisms, electronics, etc.). A cooler module with a heat radiator may be created.

• Heating of elements. A heater module may be created.

• Thermal management and liquid cooling of electronics and supercomputers centers.
  • **Military cooling system for power electronic racks:** Current standard of military vehicle thermal management systems\(^2\) are based on single phase air/liquid cooling.

![Figure 3 A potential application in military cooling system](image)

• **Thermal management of cryogenic systems:** Cryogenic thermal management systems large size market. Current solutions are mainly dominated by standard cold head helium cryocooler and open liquid nitrogen cooling systems mainly developed in a case by case basis. It would be interesting to evaluate the interest of the market in a modular solution that pumps liquid nitrogen into a vacuum chamber from the outside.

• **Re-fueling module concept:** A satellite including SIROM thermal IFs can be equipped with a re-fueling system and a fuel tank to extend operational life of future space missions and re—fueling of in-orbit satellites. Current SIROM IF would need a specific design for such application. The concept is schematized in Figure 4 below.

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\(^2\) X.Tang et al. “DEVELOPMENT OF HEAT PIPE LOOP TECHNOLOGY FOR MILITARY VEHICLE ELECTRONICS COOLING” 2010 NDIA GROUND VEHICLE SYSTEMS ENGINEERING AND TECHNOLOGY SYMPOSIUM AUGUST 17-19 DEARBORN, MICHIGAN.
Management control of mechanical components of robots in extreme environments: such as heating of gearbox in aerospace applications, robots operating in deep see and radioactive environments.

Thermal Management of solar panels cooling\(^3\): Efficiency of solar panels is known to be temperature dependent and cooling systems have demonstrated to improve efficiency of the photovoltaic cells in some operational conditions.

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2.5 Research and development exploitation

The project partners discuss the exploitation at the project management meetings. All project partners are encouraged to exploit their novel and leading research findings and build on this for future research funding applications. These include application of future space robotics funding from H2020 programme; and potential funding from national government funding bodies. At a recent telecom meeting, the consortium discussed future call on further operational grants to be announced by the European Commission and all partners showed great interests in developing SIROM such that it will truly become a standard robotic interface for future missions, for which further funding will be announced and all the partners are interested in getting involved. In addition, the project partners have explored potentials and interests for next group of operational grants.

UK partners are considering using the work from SIROM to support and agree to continue the work beyond what has been done in UK’s Industrial Strategy Challenge Fund Robotics and Artificial Intelligence to be announced this year. UK Partners have registered for an Innovation Lab to be held in September for wave 2 call on Robotics and Artificial Intelligence in Extreme Environments led by InnovateUK.

In response to the UK initiatives in robotics and artificial intelligence, specifically a call for Robotics and Artificial Intelligence in extreme environments by EPSRC, the University of Strathclyde led a consortium of 8 UK higher education and research institutions and submitted an expression of Interest. The call solicits expertise and interests from the UK organisations to develop solutions to address the challenges from four extreme environments: nuclear, offshore, space, mining. The competition was very high and time was short to formulate a stronger consortium. Unfortunately, this bid was not selected for full proposal development. However, the review panel considered the proposed research of high importance.

SIROM project partners have also started to exploit the findings from current SIROM project with a view to apply and exploit them from research perspective in applying for next group of Operational Grants (OGs). SIROM project partners have been active in searching new partners to form consortium for next OG applications. More on this will be reported in the next report once it is clearer on which organisation has managed to participate in which OG applications.

Prof. Yan of Strathclyde represents the University of Strathclyde at the Scottish Research Partnership in engineering (SRPe) in a newly established Leadership Group on Robotics and autonomous Systems. He leads some initiative of the University in collaborating with other Scottish Universities e.g. Edinburgh, Heriot-Watt, and Glasgow University in running several workshops on Heath and Aging Challenge to be ready for Industrial Strategy Challenge Fund being offered by the UK government.

2.6 Impact and public engagement exploitation

It is planned by the consortium to using exhibition events as a useful platform for the project team to exploit its potential applications in other industrial sectors and application fields.

The UK Robotics, Autonomous Systems Special Interest Group (RAS-SIG) in collaboration with Robotics and Mechatronics TPN of the Institution of Engineering and Technology of which Prof. Xiu Yan Chairs, organises annual UK Robotics Week. It is planned to offer an SIROM exhibition at this annual robotic week once the prototype system is made available, estimated in 2018. The consortium will also explore other platforms such as Euro Robotics Forum.
Prof. Yan has been invited by the Mechatronics, Informatics and Control Group of the Institution of Mechanical Engineers (IMEchE) to deliver a prestige Mechatronics Lecture at the Headquarters of IMechE in London. He has used this platform to promote the research work undertaken within SIROM. There were 67 registrations for the event and it was very well received.

At this Prestige lecture, Prof. Yan introduced the space exploration challenges in both planetary missions and in-orbit servicing. He then briefly introduced the European Commission funded six major projects in Strategic Research Cluster in space robotics technologies research. In the lecture, he provided an overview of SIROM project and the progress made so far; further in-depth development of SIROM project for a standard robotic interface, which is intended to be a building block to the future space robotics research. Finally he discussed future space robotic challenges. More details can be found at: https://events.imeche.org/ViewEvent?code=TLE6541

SIROM project coordinator SENER has organised an Industrial and International Engagement and dissemination event in Madrid on 6th June 2018. SIROM has attracted a wider audience interests from over 100 international delegates attending The International Symposium on Artificial Intelligence, Robotics and Automation in Space (i-SAIRAS 2018). The symposium is devoted to the technologies of Artificial Intelligence, Automation and Robotics and their application in space. A partially assembled prototype system has been on display for delegates to view the future European space robotic connector. This event truly promoted the SIROM to international experts from USA, Europe, Japan, China and other space nations.

Figure 6 International delegate attending one of the three talks at SENER

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 730035.
During the visit, SIROM project Coordinator Mr. Javier Vinals and the Manager Mr Eduardo Urgoiti gave an extensive talk on both the company and the SIROM project. At the event, SIROM components and their sub-assemblies were shown to all international delegates and these have attracted much interest from these delegates.

The 69th International Astronautical Congress (IAC) was a great success for SIROM project, which was held at Bremen, Germany, from 1-5 OCT 2018. A well-represented SIROM consortium team supported and participated the conference by manning a stand at a booth exhibition led by DFKI, which showcase all six Operational Grant projects. SIROM team joined PERSPEARA team and other Operational Grant (OG) teams to promote the research and development outcomes of all six OG’s achievements so far in a dedicated exhibition booth. This exhibition booth has attracted a lot of interests from both IAC delegates and general public on Germany’s national holiday on Wednesday 3rd Oct 2018. The whole team’s effort received appreciation from the Programmer Officer Dr. Christos AMPATZIS with a thumb up in the photo below.

It is also worth noting that the consortium has received many enquiries from delegates and it is hoped these enquires will lead to some benefits to SIROM and other OG’s consortium members.

![Photo 1. Team photo of PSA members and representatives from all OGs manning the booth for five days.](image)

Mr. Javier Vinals gave an overview of SIROM project by presenting a paper entitled Future space missions with reconfigurable modular payload modules and standard interface - an overview of the SIROM project. His presentation was well received and appreciated by audience.
Photo 2 Mr. Vinals is presenting a paper entitled Future space missions with reconfigurable modular payload modules and standard interface - an overview of the SIROM project.

Mr. Gonzalo Guerra Franco delivered the interactive presentation on Multi-functional interface for flexibility and reconfigurability of Future European Space Robotic Systems. A number of questions were asked and a really good interaction took place during this presentation using the state of the art presentation facilities, including videos, animations and audio and more importantly live presentation. The interactive presentation paper has also received a nomination as one of the three finalists shortlisted for the best paper award in Category D Infrastructure. It is unfortunate that in the end our paper was not selected to be the best paper prize, however this nomination nevertheless represents a very good achievement of the SIROM team and received an appreciation from the organizing Committee and the Prize and Award Committee. This is a result of selection process in which 341 entries were received and 69 interactive presentations have been shortlisted, and finally SIROM paper was shortlisted as one of the three finalists for the award.
Photo 3. Interactive Presentation for paper entitled future space missions with reconfigurable modular payload modules and standard interface – an overview of the SIROM project

Mechatronics 2018: Reinventing Mechatronics, was held successfully in Sept, 2018. The conference was organised by University of Strathclyde, with the support of Institution of Mechanical Engineers (I MechE) and Intuition of Engineering and Technology (IET) Robotics & Mechatronics TPN.

The three days conference was attended by around 60 delegates. Delegates are from Europe, USA, China, South Korea, and Middle East. One e-book entitled REINVENTING MECHATRONICS Proceedings of MECHATRONICS 2018 with an ISBN number: 978-1-909522-37-4 (e-Book) was published. Another book is to be published by Springer based on selected papers with extended and new materials in 2019. SIROM project was discussed among the delegates.

2.7 Follow-on activities

All project partners have already established good working relationships and have strong and complementary skill set for further research and development projects. SIROM project consortium is well placed and prepares to exploit future research funding for space robotics as the consortium to be launch by the European Commissions through Strategic Space Robotics programme within Horizon 2020.

The WP leader is also exploring the possibility of publishing a book on this topic and this will be explored with all partners. Springer has agreed to publish the book to be edited by Dr. Gianfranco Visentin and Prof. Xiu Yan, with all project partners from SIROM and other partners from other OGs invited to contribute.
UK partners including the University of Strathclyde and Airbus-UK also explore to secure further funding to support the continued research in broad robotics research. UK Space Agency recently announced a call for proposal for space robotics. Strathclyde University and Airbus UK has explored this potential, however it was deemed not to be suitable at this time.
3. ACRONYMS LIST

<table>
<thead>
<tr>
<th>Acronyms</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>SENER</td>
<td>SENER INGENIERIA Y SISTEMAS S.A.</td>
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<td>ADS-UK</td>
<td>Airbus Defence and Space Limited</td>
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<td>ADS-D</td>
<td>AIRBUS DS GmbH</td>
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<td>DFKI</td>
<td>Deutsches Forschungszentrum für Künstliche Intelligenz</td>
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<tr>
<td>TIC</td>
<td>Technology and Innovation Centre</td>
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<tr>
<td>RIC</td>
<td>DFKI Robotics Innovation Center</td>
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<tr>
<td>ESTEC</td>
<td>European Space Technological Centre</td>
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<tr>
<td>EAC</td>
<td>European Astronaut Training Centre</td>
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<tr>
<td>i-SAIRAS</td>
<td>International Symposium on Artificial Intelligence, Robotics and Automation in Space</td>
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<tr>
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<td>Advanced Space Technologies in Robotics and Automation</td>
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<td>IAF</td>
<td>International Astronautical Federation</td>
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Table 1-1 Acronyms list

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