Androids for Remote Access

Kick-off meeting @ CERN

During two days (March 23-24th, 2023) scientists and engineers of the LEAPS laboratories met the CERN colleagues in Geneva to start a collaboration within the frame of Digital LEAPS. The subject was about robotics to be deployed in the harsh accelerator environment to improve access and maintainability of the instrumentations. After a welcome from the LEAPS coordinator Marco Calvi and an introduction on the activities of the CERN hosting group (BE-CEM) by Alessandro Masi (slides), the workshop started with a round table where all invited speakers gave a summary of the activities ongoing in their relative institutes, followed by the visit of the CERN laboratories. The program and the presentations can be found in https://indico.psi.ch/event/14358/ while here below the executive summary and conclusions are reported.

Executive summary

INFN - Remote handling of radioactive targets at the SPES facility

Presented by Giordano Lilli

The activities at the INFN laboratories in Legnaro (SPES) required the development of advanced remote handling. One of the critical activities is the exchange of radioactive targets where they have developed automatic procedures and new coupling tools. More details on this last feature could be of general interest for the community. They are working on procedures for recovery scenarios in case of problem: mandatory for any remote interventions (things might go wrong).

ELETTRA - Robotics and Imaging at the Elettra Sincrotrone Trieste

Presented by Andrey Vukolov and Francesco Guzzi

They have invested in robotics for telepresence: for instance beamline scientists (as well as external users) can ask for tools which can be delivered to them in a fully automated way, etc. They have gained a large experience in navigation: investing on AI and image processing. They are interested in having, if existing, point clouds/digital reconstruction of other labs accelerator/tunnel to test their own navigation algorithms. They could be invited to present their activities at the Machine Learning Community at CERN.

ASPERON - Status quo on the semi-autonomous maintenance robot at the EUXFEL

Presented by André Dehne

MARWIN (born in 2015) is a robotic platform who can carry sensors and equipment during the operation of the accelerator (~4km, linac + undulator galleries) to perform maintenance and inspection tasks. At the EUXEFL, a driving license is required to operate MARWIN in the tunnel. Are these certifications needed also in other labs? Efforts are ongoing to improve the positioning accuracy and to plans exists to upgrade MARVIN for more general inspection tasks. Presently, no plans exists to test MARWIN in other laboratories and in different environments (e.g. Storage Rings), but this could be considered for the future.

CERN – Developing Electronics for Radiation Environments

Presented by Salvatore Danzeca

CERN constituted in the last decades a large COTS[1] components database of radiation tested devices which might be shared with LEAPS laboratories (importance of a MoU). Additionally, the radiation facilities like CHARM and Cobalt60 could be open to LEAPS to test novel COTS components (as well as full systems) under radiation. Experience of COTS testing under radiation and electronic design for RAD-TOL[2] devices might be shared and presented to LEAPS. New in-house built communication protocol can improve communication efficiency, is this the right way to go? What about 5G?

MAXIV Laboratories - A Review of Automated and Self-Operating Processes

Presented by Alina Andersson

Lots of robotic developments not always converging on common approach on hardware and software. Robots for bluelining[3] tasks have been developed because industrial solutions are precise as best as 1 mm, insufficient for facility needs. Example of BORIS, a robot made of two distinct parts: the “taxi” and the manipulator, where the taxi can carry different manipulators. Much effort has been put into the precise relative position of the taxi and manipulator, using three conical points of fixation. They have a strong wish to have a centralised automation/robotic service/support within MAXIV.

DESY - Androids for remote access

Presented by Rainer Wanzenberg

DESY is operating three light sources: a storage ring, PETRA III, and two free electron lasers, Flash in the EUV (14-310eV) and EUXFEL in the soft and hard X-rays (0.26-25keV). At PETRA IIIsolutions for protein crystallography using robots exists. User experience could be shared with other laboratories (i.e. SOLEIL, MAXIV, PSI, ELETTRA etc.). There are remote maintenance needs and the will to use more and more remote systems. Can existing solutions used in other labs being tested at PETRA III? Could LEAPS support this?

SOLEIL - Status and challenge on automation and robotic

presented by Laura Muñoz

Strong operational experience in using robotic arms (both SW/HW). Built API for Staubli in TANGO, could it be shared with other laboratories? Discussion on common robotic framework that might be started (generic to be coupled with different accelerator operational control systems, e.g. TANGO, TINE, EPICS, FESA Etc.). Which is the best robotic operational system? (ROS, custom etc.). Centralised engineering support (why not present in other labs? Funds, trust in automation?)

PSI - Undulator control systems installed inside the accelerator tunnel

Presented by Marc Brügger

[1] Commercially available Of The Shelf
[2] Radiation Tolerant
[3] Technique of transferring a three-dimensional (3D) computer model into real space.

PSI is operating two light sources, SLS storage ring based (now undergoing a major upgrade) and SwissFEL, a free electron laser with two beamline, Aramis and Athos, respectively for hard and soft x-rays. They develop robotic solutions for repetitive tasks implementing COTS (Beckhoff and FAULHABER) for the optimisation of the magnetic field of the undulators. To achieve a high degree of automation the design of the undulator had to be made compatible with the robotic intervention. They have large experience with electronics implemented in tunnel and controversial results: excellent in SLS while in SwissFEL two systems run smoothly and one (at the Athos beamline) with weekly communication breakdown. Not clear if it is an EMC or single event issue (the problem is recovered only with hardware reset). They are interested to use CERN RADMON to investigate the problem. They call for precise positioning sensors RAD-TOL to substitute current absolute optical encoders (i.e. Heidenhein): problem experienced with PSI Apple X afterburners installed at the SASE3 beamline of the EUXFEL.

CERN - Robotic Solutions for Maintenance and Quality Assurance

Presented by Luca Rosario Buonocore

They have experience in using robots in harsh and semi-structured environment. There are developments ongoing to improve current solutions to other accelerator areas. They are interested to exchange feedbacks on sample exchangers (I.e. SOLEIL) and coupling tools (i.e. INFN). They might benchmark and improve current solutions (ROV for remote inspection and RP measurements) in other labs. Could LEAPS support this? They propose an open HW and open SW strategy to be envisage.

CONCLUSIONS

This workshop has been extremely useful to know each other. A first step to get an overview of the robotic activities ongoing at the LEAPS light sources. It would be important to involve key partners like ESRF, ALBA and Diamond: please if you personally know people there, try to get them in the loop and next time we will invite them. The Inputs from CERN are very precious, they have a large experience in highly activated environments which could be transferred to our facilities to run robots (like MARWIN does today at the EUXFEL) in the accelerator bunker during its operation. Moreover, CERN is a strategic partner also considering the new eligibility criteria of some EU call (like for instance the next INFRATEC-2024 and -2025).

LEAPS is transforming into a legal entity (Belgian AISBL), the decision was taken and the schedule is for the end of the year, lasting until the beginning of 2024. At that time an MoU should be established between LEAPS and CERN to clarify the collaboration and acknowledge who is doing what. In the meantime, other bilateral collaboration agreements can be organised if time is pressing.

After the success of the LEAPS-INNOV[4] project (European Union´s Horizon 2020 research and innovation programme, grant agreement no. 101004728), LEAPS is organising a proposal for infratech 2024 and a third for infratech 2025. We will suggest considering the activity “androids for remote access” in the infratech 2025, as a working package of approx. 1.5MEUR size.

[4] https://www.leaps-innov.eu/