The Alan Turing Institute

Development of theoretical sensor fusion model for an Integrated Chemical Sensing concept: Call for Proposals

Closing date: 30 September 2022

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Summary

The Alan Turing Institute's Defence and Security programme is inviting proposals to develop a data fusion model for an Integrated Chemical Sensing concept based on the use of person-worn distributed sensor networks and arrays. Using known mathematical models (e.g. Bayesian data fusion) a mathematical data fusion model is to be developed that allows for a theoretical evaluation of sensor performance requirements based on, for example, the number of sensors being fused, probabilities of detection and false positives, and the effect of correlated and un-correlated (e.g. orthogonal) sensors.

Available Funding

Funding will be available for one project over the duration of five months. The proposal should be defined such that the project can be completed by March 2023. The research will be funded at Full Economic Cost and VAT will apply.

Terms and conditions

The funding will be made available under The Alan Turing Institute's Defence & Security programme Research Service Agreement terms and conditions. For copy of the terms please contact Alaric Williams by emailing dsprogramme@turing.ac.uk.

You will be required to confirm your university's acceptance of these terms as part of this application process.

Eligible costs include:

- Salary of personnel working directly on the project – this could include, for example, PIs, postdoctoral research associates, research assistants, data managers, data scientists or software engineers.
- travel and subsistence for project researchers (e.g., attending conferences, travelling to/from the Turing/other collaborators).
- conference or event attendance fees (where conference/event is directly applicable to the research project).
- Cloud computing or other high performance computing costs.
- Other costs which are specifically justified for the project e.g., books, meeting room or catering costs, specific laptops.
- Open access publications.

Background

Our government partner's ChemSense project has an interest in the development and exploitation of low Size, Weight and Power (SWaP) sensor technologies for future Chemical Warfare Agent (CWA) sensing capability. Such low SWaP sensors may be deployed individually or as arrays that are integrated into existing equipment, and may be distributed across an individual and/or across a unit of a defined number of military personnel. Data fusion across different sensor arrangements/arrays is likely to be necessary in order to take advantage of the deployment of numerous low SWaP sensors and obtain the required sensing performance (for example, target specificity).

Requirement

The requirement is to conduct a literature review of data fusion concepts applicable to this challenge and to subsequently develop a theoretical data fusion model for an Integrated Chemical Sense concept. The literature review must contain information regarding:
- Evaluation of currently reported data fusion approaches (e.g. Bayesian data fusion) in the open literature and applicability to distributed chemical sensors;

- Identification of key performance parameters to be considered in data fusion models for chemical sensors (e.g. probability of detection, sensor correlation);
- Appropriate methods for representation of data fusion models, and how these can be extrapolated to support chemical sensor performance requirements.

The developed model must allow:
- Fusion of x number of sensors into a single system, where x is typically 1-10 sensors in a single system.
- Secondary data fusion of y sensor systems (where $y = 2$-8), comprised of fused systems of x sensors.
- Output of variation of sensor fusion performance, as indicated by probability of detection (P_D) and probability of false alarm (P_{FA}). Distribution of varying P_D and P_{FA} across sensor system comprised of x number of sensors within y systems.
- The effect of non-correlated (orthogonal; across the same sensitivity range) and partially-to-fully correlated sensors on overall sensor fusion performance.
- Consideration of spatial and temporal separation of sensor triggers.

Options or follow on work

Follow-on work may consider:
- Expansion of theoretical study of spatial and temporal separation of sensor triggers, based on the spread of a vapour of aerosol hazard.
- Application of the theoretical model to experimental data provided by our government partner (GFI).

Eligibility

To be eligible to apply you must:

- Be part of a UK university or research institute. Commercial organisations or overseas universities or institutes are not eligible.
- Have permission from your organisation to apply, i.e., ensure your organisation agrees to the Terms and Conditions provided and that you submit an approval of submission letter from your research/finance office stating this. An example of a letter is available on request.

How to apply

Applications must be submitted via the online portal at https://ati.flexigrant.com/. If you have not already done so, all applicants must first register on the system and provide basic details to create a profile. If you have any questions regarding the application form or using the online system, please contact the programme inbox dsprogramme@turing.ac.uk

Please use the budget template provided in the Flexigrant application form. Please note, applicants will also need to upload on Flexigrant an approval of submission letter from your research/finance office to confirm costs are correct. The Principal Investigator must ensure the same is received for all collaborators / universities on multi party applications.

We must receive your application by **1600 on Friday 30 September 2022**.

What should be in the proposal?

The proposal should:

- Be in Word or PDF format

- Describe the scope and technical approach of the proposed work - This should be a narrative description of the principals/solutions the project would aim to achieve and how those solutions may relate to the problem.
- Describe how the approach would lead to the desired results.
- Include a description of how the task is decomposed, thematically i.e. by work package. For each work package, what activities will be undertaken to produce the results.
- Answer questions such as: What is innovative about the proposed research? Why are you uniquely placed to undertake this task? What is the expected scientific impact?
- Include an outline of follow-on work that may continue or expand the work beyond the initial five month delivery period.
- Identify any key risks and mitigations.
- Reference related work or/and relevant experience.
- Include FEC cost.

If you are employed by one of the Institute's 13 university partners, please contact your University Liaison Manager (a list of University liaison managers is available on the Turing website) to make them aware of your application. They can provide support, answer questions and involve you as part of the Turing community at your university from now on.

If you are employed at a university that received a Turing Network Development Award, please contact your Award lead (a list of Turing Network Development Award Leads - scroll to the bottom of the page) – to make them aware of your application.

Deliverables

Ref.	Deliverable	Due by Start Date = T0	Format	Description
D0a	Project Kick off Meeting	T0+1M	Meeting	Meeting to initiate the project
D0b	Progress update meetings	Monthly	Meeting	technical update meetings
D1	Literature review on the evaluation of known data fusion models and application to the Integrated Chemical Sense concept	T0+1M	Technical report (Word or pdf)	Literature review on the evaluation of known data fusion models and application to the Integrated Chemical Sense concept
D2	Delivery of theoretical model for data fusion in the Integrated Chemical Sensing concept	T0+5M	Technical report (word or pdf)	Delivery of a theoretical model which allows an understanding of key relationships between predicted data fusion performance and factors including probabilities of detection and false alarms, sensor correlation, number of sensors, and spatial distribution of sensors.

D0b	Project Closure Meeting	T0+5M	Meeting	Meeting to close the project or agree follow on steps

Assessment and review

The assessment and review will follow the following stages:

1) Stage 1.0: Eligibility and triage
2) Stage 2.0: Expert review

Following eligibility checks, proposals will be reviewed by an assessment panel who will rank the proposals based on score.

The assessment panel will consider the following criteria:

- Quality: This will consider the method and concepts for the proposed research. This will assess if the methods are suitable for delivering the desired outputs and pushing forward fundamental understanding in the field.
- Viability: This will assess how feasible it is to practically carry out the proposed research, and if it can be delivered in the time frame. This will account for the difficulty of the tasks, logistical factors surrounding delivery, and the track record of the proposed research team.
- Significance: This will consider the relevance to the call and the themes that are represented.
- Justification of resources: This will consider whether the proposal is appropriately resourced and suitable expenditure has been included in the budget.

Each of the criteria will be scored and while all criteria will have equal weighting in evaluation, there will be a minimum requirement on significance to be considered for approval.

Key Dates
Deadlines are as follows

Activity	Date
Proposals to be Submitted*	Friday 30 September 2022
Announcement of Results	Monday 10 October 2022
Research Project Starts by**	Tuesday 01 November
Research Completed and deliverables submitted	Friday 31 March 2022

*Proposals must be submitted via Flexigrant by 16:00 Friday 30 September 2022.

**Any project agreements not signed by Friday 28 October 2022 may result in funding offer being withdrawn and going to an application on the reserve list.

Post-award information
Project meetings

Successful applicants will be expected to attend a kick-off meeting and a project close meeting, with a Technical Partner from the D&S programme Partner/s. These may take place online, at the Turing, at NCSC, or at the project lead's university.

Screening of researchers

This research is not at a classified level so formal security clearance (see https://www.gov.uk/guidance/security-vetting-and-clearance) is not required. Successful applicants will however be required to complete a 'Personal Particulars - Research Workers & Dstl Sponsored PhD Students form' for all staff working on their project. A sample form can be requested by emailing dsprogramme@turing.ac.uk or found **here** (this is an example and the actual form may differ).

Outputs required

We require that the project will produce the following:

- If applicable, the application to and approval from the relevant research ethics committee.
- Progress summaries (up to one page) / meetings.
- Literature review on the evaluation of known data fusion models and application to the Integrated Chemical Sense concept after the first month
- Delivery of theoretical model for data fusion in the Integrated at the end of the project.
- If applicable, any source code, compilation, use documentation and material associated with the outputs delivered.

Outputs acceptance criteria

Delivered research outputs must be commensurate with those standards expected in peer-review, open literature publications. Must include methodological details and examples of the use of the model sufficient to be reproduced. The theoretical model developed must be accompanied by clear explanations of its use and implementation suitable to allow non-data scientists/mathematicians to implement (e.g. Sensing SMEs). If outputs do not meet the acceptance criteria, re-work will be requested before final acceptance.

Publications

Please note, approval from the D&S programme is sometimes required prior to publication; in such cases, approval will not be unreasonably withheld.

The funders are committed to full and open publication of the research outputs in line with academic practices.

We encourage researchers to submit their findings to a high-quality peer-reviewed journal or conference, on an open-access basis (funding for open-access fees will be available on a case-by-case basis).

 We expect a 'green' open access version of any papers to be published (if allowed by journal/conference - please check http://www.sherpa.ac.uk/romeo/index.php) either as a pre-print on (e.g.) the ArXiv (https://arxiv.org/) or in an institutional repository.

We also encourage datasets and research code to be openly shared too where possible - for example on the Turing's Github repository. All publications, reports and code should reference the support of the Turing Defence & Security programme.

Reporting and dissemination

Extracts from reports may be collated into update papers for the D&S Programme Board, Strategic Partners Board, Turing Innovations Ltd Board, and the Turing's Trustee Board.

Awardees may also be required to present their work to members of the D&S programme, the D&S Programme Board and/or other invited audience during the award period.

Reporting allows further identification and signposting of potential additional opportunities for the benefit of the awardees and the Turing; for example, opportunities from across the Turing's network such as new collaborations, external/public engagement, media/press, other funding availability, speaking slots at or invitations to events/conferences/seminars.

Queries

Please contact Alaric Williams, The Alan Turing Institute, Programme Manager dsprogramme@turing.ac.uk.