SINBAD 2008 Project Overview

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To whom it may concern,

UBC's Seismic Laboratory for Imaging and Modeling (SLIM) invites parties with an interest in exploration seismology to become members (membership is annual and renewable) of our Consortium in support of the five-year SINBAD II project. This new project builds on breakthroughs from the original SINBAD: Seismic Imaging by Next-Generation Basis Functions Decomposition project in areas ranging from acquisition, to wavefield reconstruction, separation, and modeling. Each of these innovations were made possible by our ability to adapt compressive sensing (CS) towards tangible solutions in exploration seismology.

Our main focus in SINBAD II will be to leverage these insights from CS towards the design and implementation of an imaging technology for severely sub-Nyquist sampled data. The main outcome of this approach will be a new model for seismic imaging where the costs of acquisition and processing are no longer determined by the overly pessimistic classical sampling criteria. Instead, the costs will depend on the sparsity of the final image and will therefore no longer grow uncontrollably with the dimensionality of the imaging problem.

SINBAD's core team consists of three dynamic faculty members from the Department of Earth & Ocean Sciences, Computer Science, and Mathematics including their students and post-docs. Research is disseminated through reproducible reports, annual Consortium meetings, Software releases, the SLIM web site and through coordinated internships.

We ask the original SINBAD members (BG-group, BP, Chevron, ExxonMobil, and Shell) to renew and new oil and contractor companies to also join. For details on past accomplishments, and the detailed proposal for SINBAD II, please contact Manjit Dosanjh (mailto:slim-assist@eos.ubc.ca) or Felix J. Herrmann (mailto:fherrmann@eos.ubc.ca).

Outcomes of SINBAD I

The SINBAD project made important contributions that have sparked wide-spread interest from industry, judged by multiple calls for commercialization, and academia, resulting in numerous invitations for presentations at conferences. Amongst our major contributions we count our random sub-sampling scheme for curvelet-based recovery; our large-scale one-norm solvers; our primary-multiple separation method, based on a combination of curvelet-domain matching and sparsity promotion; and our recent simultaneous acquisition design. We achieved these successes by developing a deep understanding of sparsity promotion, nonlinear optimization, and phase-space methods. With SINBAD II, we plan to continue this line of research, and blend a deep theoretical understanding with real applications.

Why join SINBAD II?

The SINBAD Consortium is built around a young dynamic and ambitious research team consisting of three faculty members, several post-docs, and students with various back-

grounds and expertise across a wide-range of disciplines, including Electrical Engineering, Engineering Physics, Earth & Ocean Sciences, Computer Science, and Mathematics. This diversity makes the SINBAD Consortium unique for the following reasons:

- our ability to give you a fresh perspective on open problems in exploration seismology by leveraging our cross-disciplinary backgrounds;
- our ability to push the envelope and to conduct transformative research by implementing our deep theoretical understanding to solve applied problems;
- our ability to be a conduit for new developments in compressive sampling and apply these to solve problems in exploration seismology;
- our ability to implement and test our algorithms on real problems involving real data;
- our ability to spark world-wide interest from industry and academia in seismic applications of CS, which enables us to attract the best graduate students.

The unique composition of our team has resulted in fundamental contributions in sparse-recovery with practical applications such as seismic regularization, multiple removal, and simultaneous-source acquisition designed to reduce acquisition and processing related costs. We successfully used this latter methodology to speed up simulations with our preconditioned time-harmonic Helmholtz solver. Since its inception in 2005, SINBAD has resulted in eleven journal publications (five in review) and more than fifty (C)SEG/EAGE talks.

By becoming a sponsor, your organization will receive the following:

- early access to our publications, including theses, technical reports, publication preprints, and slides of presentations;
- access to our software releases using MADAGASCAR and SLIM's extensions including our reproducible-research environment Repro, our Python interface for out-of-core operations SLIMPy, manuals, tutorials, demos, and reproducible-research documents;
- access to basic assistance with the installation and use of our software;
- access to specialized assistance for our software at additional costs;
- invitations to our annual Consortium Meetings where we present our latest research;
- access to our coordinated graduate internship program to get to know our graduate students and to embark on projects to evaluate our technology.

Terms & Conditions

UBC does not permit secrecy in research. The director of SLIM determines the research direction and will seek advice from the Advisory Committee. There will be procedures in place for industry visitors. UBC's intellectual property (IP) policies apply to research conducted as part of SINBAD. The membership fees are inclusive of all costs, including all licenses to use the technology commercially, including third party intellectual property rights. The membership fees also include all overhead (25 %) and access fees. In addition, members will gain access to all background and foreground IP for the duration of the project and will have the option to buy a perpetual royalty-free license at the end of the project. The UBC Liaison Office (UILO) will draw up a detailed research agreement. For details on this agreement please contact Roger Miller (mailto:Roger.miller@uilo.ubc.ca).

Financial structure

Industry funding: The funding for the SINBAD I project was acquired by winning the competition "High Resolution Imaging of Hydrocarbon Reservoirs—A Step Change", issued by Industry Technology Facilitator and funded by: BG Group (Canada), BP Production Company, Chevron, ExxonMobil and Shell Canada Ltd. In year two of this project, we matched this industry contribution with the CRD Grant DNOISE: Dynamic nonlinear optimization for imaging in seismic exploration, involving two additional faculty members and an average additional annual support of CAN $ 231 k.

SINBAD II will be financed based on renewals from the original companies and new oil and contractor companies. New sponsors will gain access to the IP and software that were developed as part of SINBAD I and available at the SLIM web site. All sponsors will have representation in the Advisory committee.

Additional funding sources: We plan to renew our NSERC CRD Grant DNOISE that matches the contributions from industry with Canadian subsidiaries towards the operational research budget. This additional CRD funding approximately offsets overhead and other unmatchable project-related costs so that each and every dollar from industry goes towards research.

Annual consortium-fee structure: The annual research fee[1] for SINBAD II will be CAN $ 72.5k for existing SINBAD members. The fee for new oil company members is CAN $ 78.5k and includes a CAN $ 6k annual entry fee to gain access to the IP and software from SINBAD I. The fee for contractor companies will be CAN $ 83.5k with a $ 11 k annual entry fee to gain access to the IP and software from SINBAD I. These figures[2] are based on an annual budget of app. CAN $ 800k including the NSERC matching of CAN $ 345k annually. For questions regarding the fee structure, please contact Mario Kasapi (mario.kasapi@uilo.ubc.ca) of the UILO.

Research highlights[3]

Phase-space methods: Seismic data and images contain multi-directional wavefront-like features. Successful methods in exploration seismology hinge on our ability to design multiscale and location & local-dip dependent transforms and filters. We will work on rigorous criteria for the selection and adaptation of existing multiscale signal representations (such as controurlets, shearlets, curvelets, and wave atoms) to achieve optimal task-based performance. We will also leverage recent work in the numerical computation of pseudodifferential operators for the next generation of adaptive phase-space matched-filters.

Sparse recovery and acquisition design: To push the envelope of sparse recovery, we will work on (i) non-convex sparsity promotion ℓ_p $(0 < p < 1)$; (ii) the design of CS matrices, e.g., seismic acquisition grid and simultaneous source design; (iii) joint sparsity promotion for multiple measurement and sparsity vectors; and (iv) sparsity-promoting solvers for compressively-sampled PDE-constrained optimization problems.

[1] Our budget and fee structure is based on a renewal by all existing SINBAD members, 3 new oil-company members (two with Canadian subsidiaries), and 2 service companies.

[2] Subject to big changes in the anticipated number of participating companies.

[3] The DNOISE II proposal serves as the detailed research plan for SINBAD II and is available upon request.

Seismic data processing with sparsity promotion: We will continue to develop techniques for processing that exploit transform-domain sparsity with applications in multiple and surface-wave removal. Because compressive samples are taken linearly, we will also exploit possibilities for seismic-processing in the compressely-sampled (or blended) domain.

Full-waveform modeling and preconditioning: We will further develop our preconditioned implicit time-harmonic Helmholtz solver, including a parallel implementation. To better model the physics, we will include density-variations and extend our solver to elastic media. We base our approach on a scalable iterative method that includes preconditioners for multiple shots (i.e., right-hand sides) and simultaneous simulations.

Imaging and inversion: We will develop a compressive formulation for imaging and inversion for heavily subsampled simultaneously acquired data. Our formulation extends CS to full-waveform inversion and leverages our work on simultaneous acquisition design.

The research is carried out by a diverse research team at the University of British Columbia:

Dr. Felix J. Herrmann (director of SLIM and principal investigator), Seismic Laboratory for Imaging and Modeling (SLIM), Department of Earth and Ocean Sciences;

Dr. Michael P. Friedlander (co-principal investigator), Scientific Computing Laboratory, Department of Computer Science;

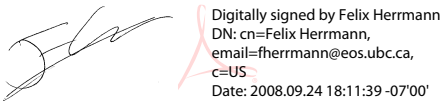
Dr. Özgür Yılmaz, (co-principal investigator), Department of Mathematics.

These researchers will, with input from industry, determine the research objectives, budget and overall organization of the project. The research and administration of this research project will be conducted in accordance with the rules and regulations of the Department of Earth and Ocean Sciences under its head Dr. Paul Smith, and the terms and regulations of the University of British Columbia.

This project as outlined in the DNOISE II proposal will support a number of existing and future undergraduate and graduate students (including six new PhDs and 4 MScs) who are and will continued to be supervised by the principal investigators. The project also includes two additional post-doctoral fellows to strengthen the current team.

If you have questions please feel free to contact me or Manjit Dosanjh (mailto:slim-assist@eos.ubc.ca), phone 1 (604) 822-5674).

Sincerely,



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