Global Water Futures 2021 Operations Team Meeting – Project Reporting Template

Instructions: All GWF projects are asked to provide a summary update on their activities and accomplishments in preparation for the upcoming Operations Team meeting. **Please submit these by email to chris.debeer@usask.ca by no later than December 2.** These will be used to help guide discussions and breakout synthesis activities and will be made generally accessible on our website in advance of the meeting.

Project Name:	Artificial Intelligence Applications for Rapid and Reliable Detection of Cryptosporidium oocysts and Giardia cysts

Our major accomplishments to date are:

- Investigated artificial intelligence (AI) algorithms for image recognition. (YKim)
- Conducted preliminary AI applications for algal cell recognition. (YKim)

- Literature and background study on the current status of in-field diagnostic technologies for Cryptosporidium and Giardia in remote indigenous communities in Canada. (QFang)
- Established protocols and required facilities to perform imaging experiments with Cryptosporidium oocysts and Giardia cysts samples. (QFang)
- Developed image processing algorithms to segment and track asymmetrical particles (e.g., oocysts) and their dynamic motion in a flowing channel. (QFang)
- Established a computational flow dynamic model for 3D particle distribution in microfluidics flow channel. (QFang)
- Development and optimization of device fabrication protocol. (QFang)
- Multimodality imaging flow-cytometer-on-a-chip system design. (QFang)

- Recruited one graduate student and one undergraduate student. (HSchellhorn)
- Established a collaboration with the Ontario Ministry of the Environment, Conservation and Parks (MECP). (HSchellhorn)
- Arranged for a team seminar given by Dr Susan Weir (MECP) who heads the Giardia/Cryptosporidium diagnostic laboratory for Ontario. (HSchellhorn)
- Recruited undergraduate thesis student to conduct literature review and bioinformatic studies. (HSchellhorn)

- Using genome sequences for Crytopsporidium and other apicomplexa species, multiple sequence alignments have been constructed for >2000 proteins. (RGupta)
- The alignments have been examined for the presence of conserved signature indels (CSIs) that are uniquely found in Crypotosporidium species and can be used as novel molecular markers for their identification in different settings. (RGupta)
- These studies have identified >20 CSIs that are specific for Cryotposporidium species. (RGupta)

- A new PhD student has been recruited to work on the project. (CQXu)
- Literature review has started. (CQXu)

Our current activities are:

- Literature review on AI applications on microscopic images. (YKim)

- Imaging experiments with Cryptosporidium oocysts and Giardia cysts samples. (QFang)
- Building an optimized optofluidics imaging device. (QFang)
- Development of AI based image processing and classification algorithms. (QFang)
- Develop multimodality imaging chip device with holographic and fluorescence imaging. (QFang)

- Developing diagnostic PCR tests for target organisms. (Giardia/Cryptosporidium) (HSchellhorn)
- Mining DNA databases to determine the feasibility of using indenfied DNA sequences. (HSchellhorn)
- Colloborating with Dr. Qiyin in supervision of one thesis student. (HSchellhorn)

- We are also analyzing genome sequences for Crytopsporidium and other apicomplexa species to identify conserved signature proteins whose homologs are only found in the Cryptosporidium species. The genes for these proteins, due to exclusive presence in Cryptosporidium species will provide particular useful probes for identification of Cryptosporidum species in water samples. (RGupta)

- Device design. (CQXu)
- Filtration process development. (CQXu)

The main accomplishments expected by the end of the project are:

- Suggest optimized AI algorithms for processing microscopic images of Cryptosporidium and Giardia cysts. (YKim)

- An integrated multimodality optofluidics imaging flowcytometer capable of detecting Cryptosporidium oocysts and Giardia cysts. (QFang)
- An AI based image processing and classification algorithm that can be integrated into a local device. (QFang)
- Performance characterization of the device and the algorithm in benchtop and field tests. (QFang)

- Development of new Giardia/Cryptosporidium PCR tests measured against the MECP standard test. (HSchellhorn)

- We will have novel validated molecular assays based on identified CSis and CSPs for detecting the presence of Cryptosporidium species in lake water or other samples with high degree of sensitivity and specificity. (RGupta)

- Filtration with reduced flocculation for separation of particles with similar size of *Giardia* cysts (10 μm), and *Cryptosporidium* oocysts (3-5 μm). (CQXu)
- Active filtration for both saltwater and freshwater sources of water. (CQXu)
- Development of a scattering-based detection method to supplement the imaging-based detection method for protozoan cysts. (CQXu)

Here is a key visual from the project (figure, photo, table, graph, etc.)