



JOHNS HOPKINS

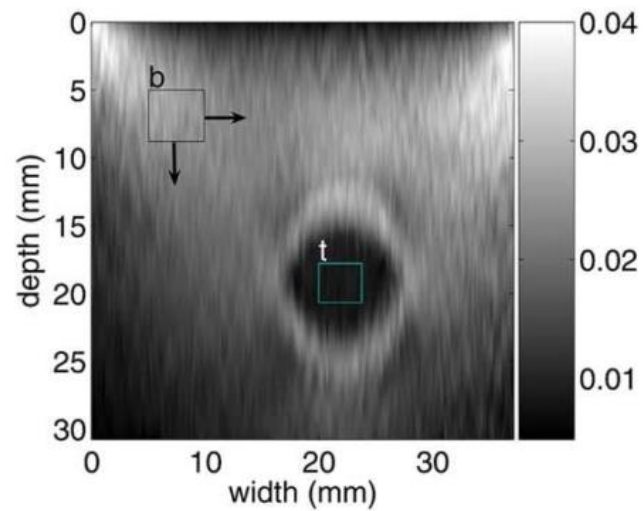
WHITING SCHOOL
of ENGINEERING

Checkpoint presentation

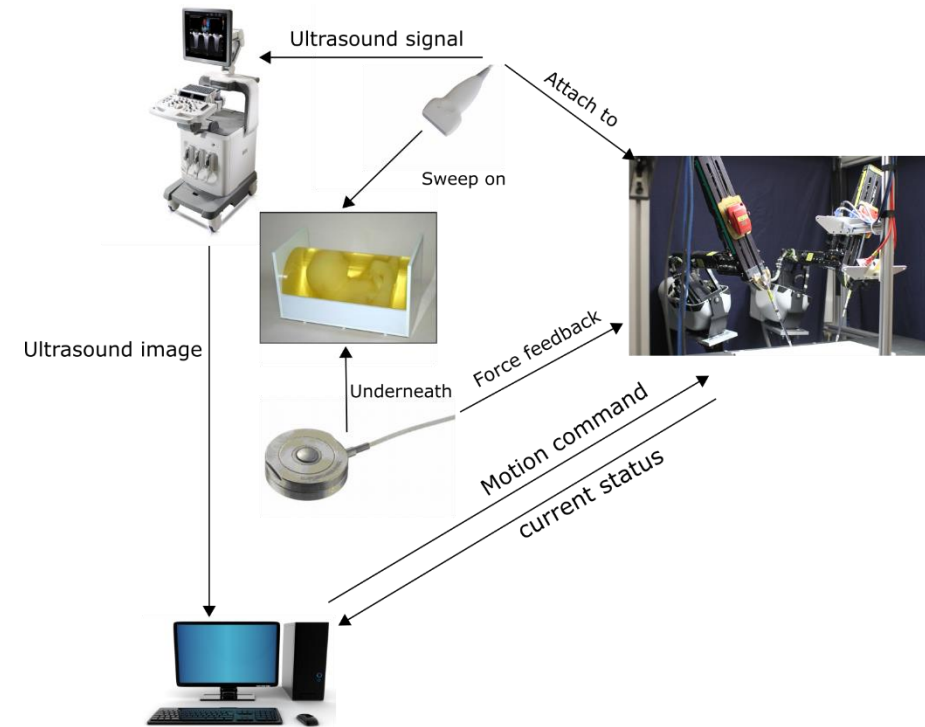
Xingtong Liu
04/04/2017

Mentor: Preetham Chalasani, Dr. Boctor, Dr. Taylor

- Goal**
- Integrate ultrasound probe and software into the DVRK robot system.
 - Use DVRK robot system to generate ultrasound elastography image and locate stiff features in a phantom based on that.



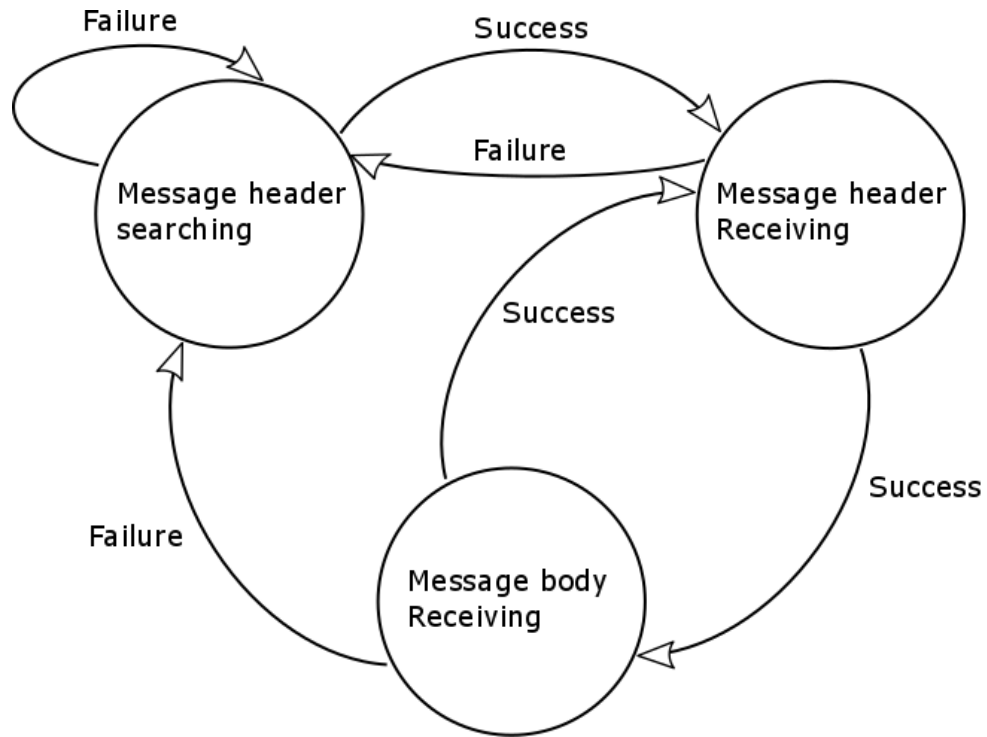
Ultrasound elastography



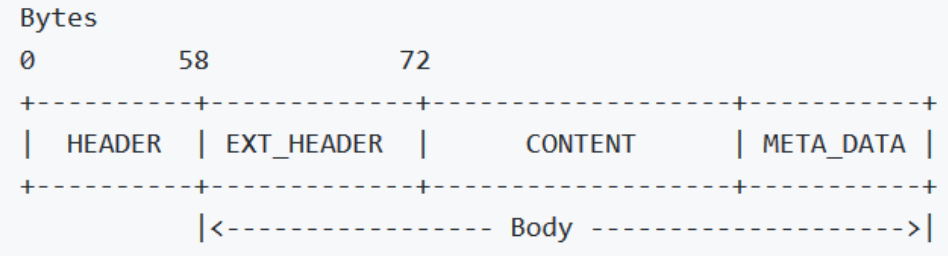
System diagram

	Requirements	Current status
Minimum deliverable	Integrating DaVinci ultrasound tool and ultrasound system into DVRK system	Have developed ultrasound data acquisition module and verified it with ultrasound machine.
Expected deliverable	Ultrasound imaging with force feedback control	Have completed kinematics configuration of DVRK compatible ultrasound probe.
Maximum deliverable	Ultrasound elastography with DVRK	Have transplanted and compiled cross-correlation elastography code.

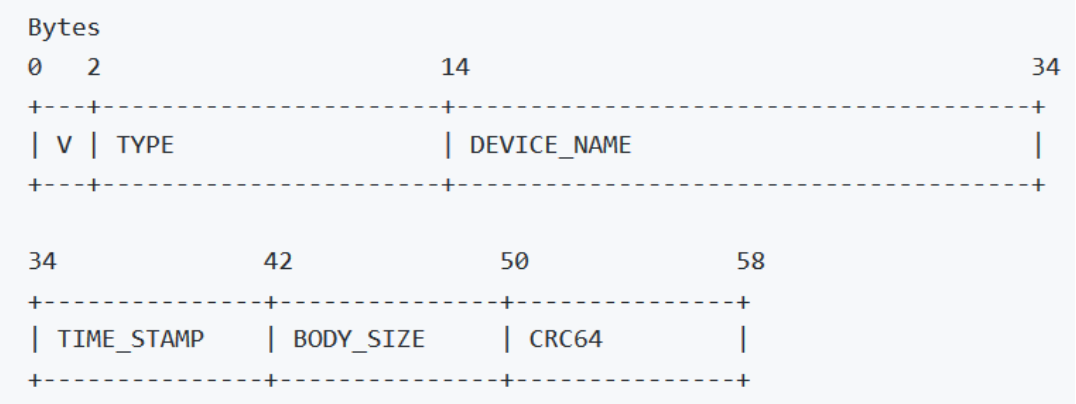
Dependency	Status	Fallback
Collaboration		
Ultrasound probe kinematics configuration with Preetham	Solved	
Ultrasound probe scan plane calibration with Alexis	In progress	
Hardware		
DVRK hardware	Solved	
Compatible ultrasound probe	Solved	
Ultrasound machine	Solved	
Elasticity ultrasound phantom with stiff features and proper weight	Need to make sure the existed phantom have a proper weight	Make one with gel on my own
Software		
DVRK software	Solved	
Ultrasound data acquisition API	Solved	
Visualization library	Solved	
Elastography code from MUSIIC group	Solved	



State machine for data acquisition

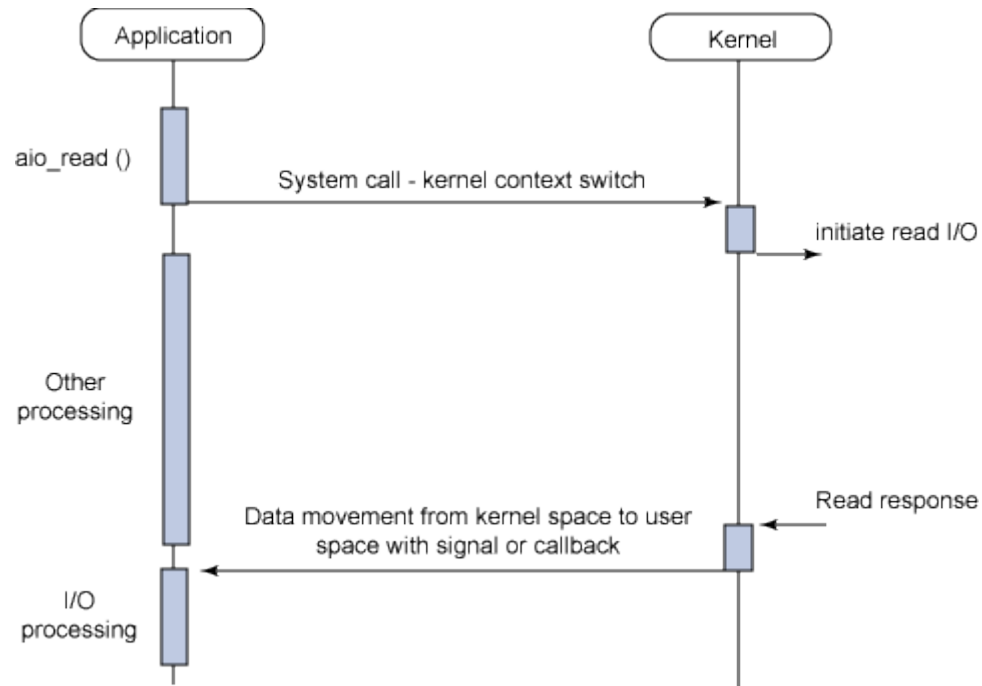


Message Structure

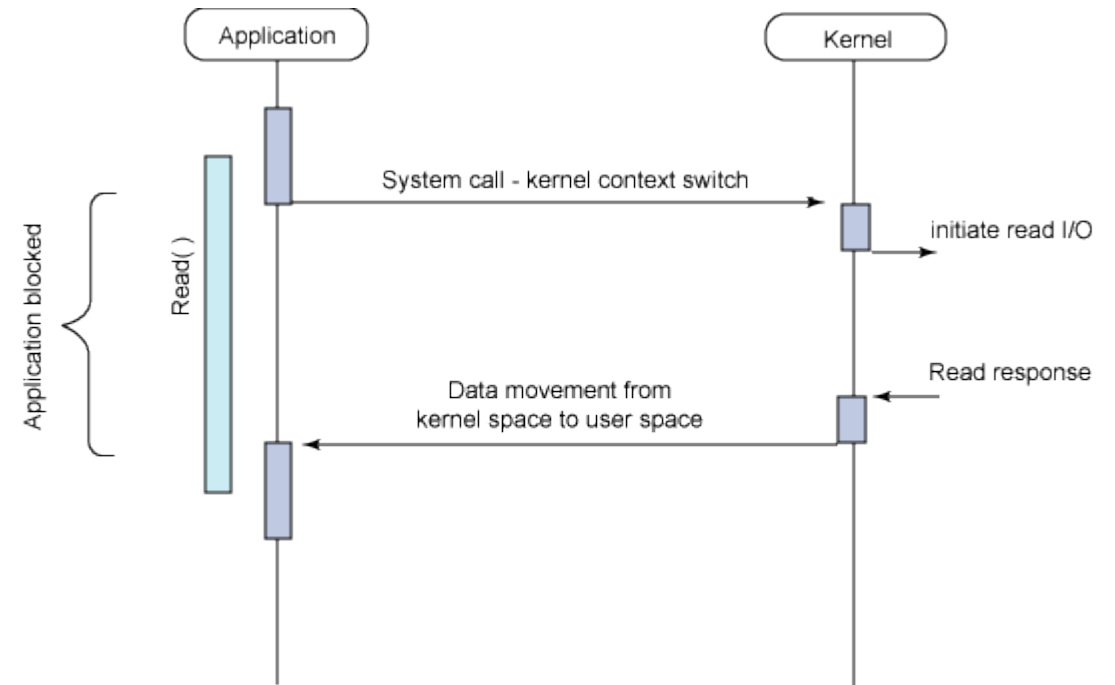


Header Structure

- Multi-thread programming, which is necessary when the program needs to process multiple tasks.
- Asynchronous non-blocking I/O model for socket programming, in order to get rid of the need of blocking one thread to wait for data transmission.

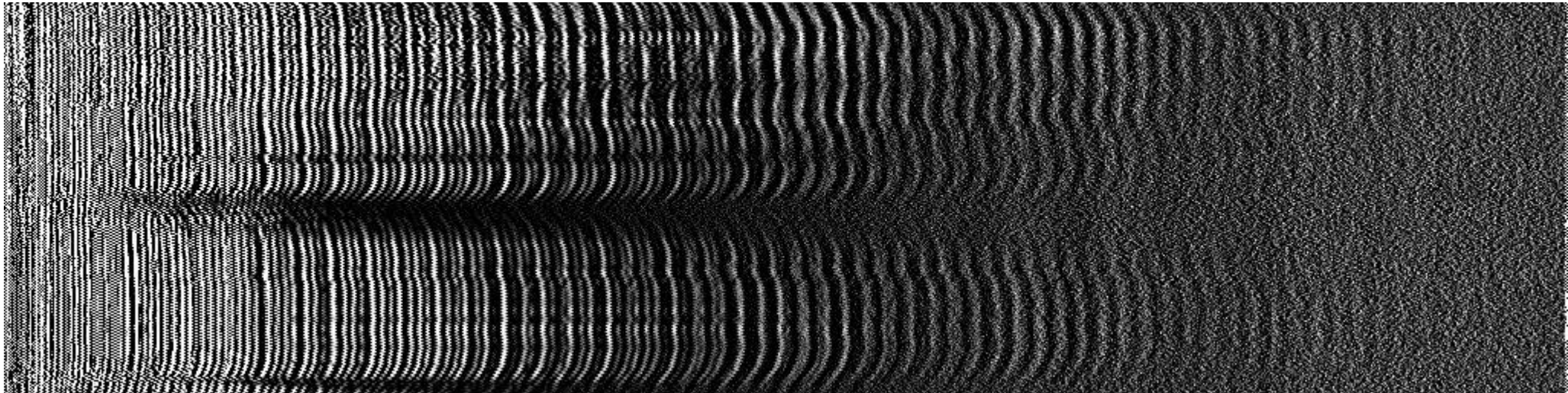


Typical flow of asynchronous non-blocking I/O model



Typical flow of synchronous blocking I/O model

Pre-compressed and post-compressed RF data samples obtained from ultrasound machine



Kinematics configuration

- The ultrasound probe is a 12mm DaVinci tool and its kinematics is the same as the 5mm tool with snake-like end effector.
- Previously, the DVRK didn't have support for 5mm tools and now the configuration for this kind of tool is completed by Preetham and Anton.
- Haven't tested the kinematics configuration directly with the ultrasound probe.

Scanplane calibration

- Will discuss details with Alexis and Preetham after class and start working on calibration this week.

- Have transplanted the cross-correlation ultrasound elastography code from Windows to Linux and compiled it. Have studied relevant literature to better understand the source code.
- Need to reorganize the source code to integrate it to the DVRK framework.
- Haven't got the dynamic programming ultrasound elastography code yet. I plan to first use the cross-correlation method instead, which is more robust to hyperparameters based on the comments from Nishikant.

Basic idea of cross-correlation method

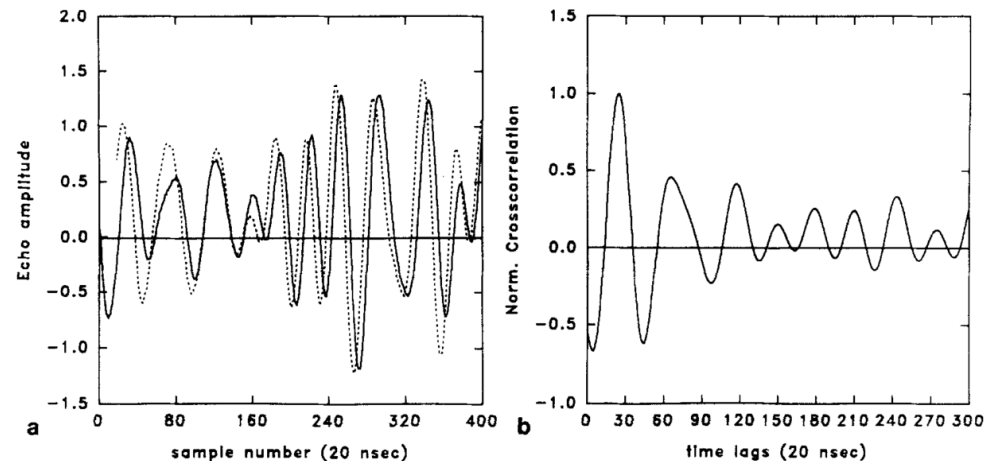


Fig. 3. (a) A typical segment pair; (b) resulting cross-correlation function between segments in (a).



Task Name	Start Date	End Date	Duration	Status
Milestone 1 - Ultrasound data acquisition integration	02/28/17	03/14/17	11d	Complete
Learn DVRK software framework	02/28/17	03/06/17	5d	Complete
Learn ultrasound data acquisition API	03/07/17	03/08/17	2d	Complete
Integrate API into DVRK framework	03/09/17	03/10/17	2d	Complete
Ultrasound image display in DVRK framework	03/13/17	03/14/17	2d	Complete
Milestone 2 - Ultrasound probe calibration	03/15/17	03/28/17	10d	In progress
Ultrasound probe install	03/15/17	03/15/17	1d	Complete
Ultrasound kinematics configuration	03/16/17	03/20/17	3d	Complete
Ultrasound scan plane calibration	03/21/17	03/24/17	4d	In progress
Calibration results verification	03/27/17	03/28/17	2d	Not Started
Milestone 3 - Hybrid force feedback control with ultrasound probe	03/29/17	04/07/17	8d	In progress
Learn force sensor data acquisition API and force control in DVRK	03/29/17	03/30/17	2d	In progress
Get a ready-to-use elasticity phantom or make a proper one	03/31/17	04/03/17	2d	In progress
Install force sensor underneath phantom and test force sensor data acquisition	04/04/17	04/04/17	1d	Not Started
Move ultrasound probe on phantom surface with constant force	04/05/17	04/07/17	3d	Not Started
Milestone 4 - Ultrasound Elastography integration	04/10/17	04/25/17	12d	In progress
Obtain Ultrasound Elastography source code or implement one	04/10/17	04/14/17	5d	Complete
Integrate Ultrasound Elastography into DVRK software framework	04/17/17	04/20/17	4d	In progress
Test Ultrasound Elastography on phantom	04/21/17	04/25/17	3d	Not Started
Project refinement and further verification	04/26/17	05/12/17	13d	Not Started
Seminar presentation	03/06/17	03/08/17	3d	Complete
Checkpoint presentation	04/03/17	04/05/17	3d	Complete
Final presentation	05/13/17	05/17/17	4d	Not Started



Revised plan

Task name	Start date	End date	Duration	Status
Reorganize and unit test on ultrasound elastography code	04/04/17	04/09/17	6d	In progress
Ultrasound scan plane calibration	04/04/17	04/09/17	6d	Not started
Develop force sensor data acquisition ROS node	04/08/17	04/11/17	4d	Not started
Integrating developed modules to DVRK system	04/12/17	04/27/17	14d	Not started
Conduct experiments on ultrasound imaging with force feedback control and ultrasound elastography on DVRK platform	04/28/17	05/05/17	8d	Not started
Refinement on developed modules, verification and analysis on experiment results	05/06/17	05/12/17	7d	Not started
Final presentation	05/13/17	05/17/17	5d	Not started