7th Software Framework Meeting ICAM, Manchester 22 April, 2016.

Total 24; 20 attendance physically plus 4 remote sites.

Present 20

Martin Turner (Manchester) Kris Thielemans (UCL) Julian Matthews (Manchester) David Atkinson (UCL) Evgueni Ovtchinnikov (STFC RAL) Kinjiro Amano (Manchester) Nikos Efthimiou (Leeds) Giorgos Papanastasiou (Edinburgh) Harry Tsoumpas (Leeds) Tahereh Niknejad (LIP) Jose Anton (Manchester) Alaleh Rashidnasab (UCL) John McGowan (UCL) Rainer Hinz (Manchester) Marie-Claude Asselin (Manchester) Palak Wadhwa (Leeds) Ignacio Partarrieu (Manchester) Evangelos Raptis (Manchester) Erica Yang (STFC RAL), Philip Withers (Manchester)

Skype for Business 4

Claudia Prieto (KCL) Andrew Reader (KCL) Christoph Kolbitsch (PTB) Pawel Markiewicz (UCL)

Minutes: Martin Turner.

Welcome to all and introductions were given; as well welcome from the host to the ICAM centre (including HMXIF).

- http://www.icam-online.org/
- http://www.mxif.manchester.ac.uk/

Agenda items:

- Software status update, including MR recon with coil sensitivities (Evgueni Ovtchinnikov)

EO presented from the software framework files – showed a python implementation linking to a virtual machine. We can then reconstruct data (test and real) from the scanner (Siemens) – note more users needed (Siemens only to begin with).

- Demo 1:- Steps given for a fully working demo, with code items as objects. So allows reading an MR_Acquisition from HDF file and MR_Reconstruction.
- Demo 2:- Added coil_sensitivity_maps to the processing: doing Forward projection techniques to look at differences showed some anomalies to be checked. Full implementation awaiting discussions with Gadgetron team.

- Status update on PET extra capabilities in STIR (TOF and reading GATE ROOT files) Nikos Efthimiou

NE Presented a TOF (Time of Flight) implementation, including some speed-up operations (eg TOF-kernel elements > 3sd are not used in reconstruction interactions). Results given for example; 9 iterations; using MLEM/OSEM/ :- with and without TOF, and stated that TOF works better with some smaller shapes - and 'sparser' data).

Action this code is still being validated but is to be incorporated with the STIR library. Note: all features added to STIR will then become available to the CCP,

- How to implement SENSE reconstruction (Christoph Kolbitsch)

CK showed what Gadgetron already has and how it could be used (ie adding a SenseGadget). Two main options were presented; 1, BufferSensePrepGadget, 2. CartGrappaReconGadget . Discussion:

1. A CPU version would be useful as natively it is a GPU version.
2. Future action - what should we work on and rewrite ourselves? Specifically adding code for better synergistic operations.
3. Meet with Michael Hansen (gadgetron developers).

- Coordinate systems: Geometry PET-MR and DICOM (David Atkinson)

DA gave a series of possible errors in MR images related to geometry:

1. Description of the gradients not being perfectly linear, and local susceptibility to difference in phase (air tissue ...); and chemical shifts (e.g. fat is different from water). These can be orders of mm.
2. Coordinate system: Left-Posterior-Head for DICOM (ie this is patient centered) so origin may not relate to isocentres.
3. Pixel spacing and exact position (where is 1.5,0.5) as well as slice thickness parameters are at times unclear.

Q: Discussion on the use of a localiser - for technicians to acquire particular geometry - but thoughts were that this was mainly used for planning and not useful for us.

Possible experiments given: image structured phantom with repeated, different angulations/ rotate slice by single angles only and no offsets/ register using known angles and unknown rotation centre (rotation centre will be isocentre) Example question "Where is your magnet's isocentre"

Q/C: geometric info in raw data (and in particular alignment) is currently at least partially confidential. what to do, and how to extract this from manufacturers or create ourselves.

Action: Need to start a discussion on how to incorporate geometric info in the CCP classes (KT suggests to do this via the pseudo-code document).

- Phantom acquisitions to obtain alignment between PET and MR (Pawel Markiewicz)

PM showed brain scan examples (T1w) and stated that human scans are 'easier' to coregister then phantoms; but issue is also on registration/location of the bed and coils; and the gantry offset (PET vs MR alignment) value. Examples shows PET image shapes then aligned to MR to demonstrate noticeable differences (see pdf on one-drive)

In addition to alignment between PET and MR, there are “hardware mu-map” problems, e.g. head coil, bed. Template files are on the scanner, not sure if we can redistribute as-is. Their position needs to be taken into account. Currently no open source software for this.

Q: on how to access private tags from manufacturers and release.

Remarks from Pawel: ‘Forget about a phantom data scan and do patient only data’ ‘Combined PET and MR phantoms are very difficult’ (comment KT: phantom use for illustration was not ideal for testing alignment, we should do something else)

Action: Pawel to add some of this to an online document such that we can start to make concrete proposals.

Action: Kris to ask Siemens and GE about alignment, mu-maps etc.

Instructions for downloading and using VM with Lubuntu and CCP-PETMR software (Evgueni)

- Software for xSTIR, XGadgetron etc. is on github https://github.com/CCPPETMR
- Also have a virtual machine version. https://github.com/CCPPETMR/CCPPETMR_VM
- Instructions will also be on the CCP website: http://www.ccppetmr.ac.uk/ that include how to run the demonstrations.

Brief update on licensing (Kris) Comment on Apache license briefly mentioned with discussion on email notices that have been sent.

Discussion on future steps (Kris) Items *(covering next year plus)* and comments. initial list:

1. MR SENSE reconstruction – *has some issues that needs Gadgetron-developer input (see above).*
2. Coreg PET and MR – *need further clarification on type of phantom*
3. PET randoms/scatter/etc – *on KCL current to do list to check STIR scripts.*
4. PET reconstruction and MR anatomical priors – *need alignment.*
5. Functions to compute gradients and values of object functions –*this is doable using functionality shown today.*
6. MR reconstruction with PET prior – *this may require more thought*
7. Joint PET-MR reconstruction using MATLAB or Python tools/toolboxes – *build on top of existing platforms*
8. Implementation of a few generic optimisation algorithms -
9. Motion guided reconstruction -
    a. Spatial only or time as well?
    b. How to get motion – *need access to registration software*

Q/C: delay item 1 depending on feedback from Gadgetron-developers.

Q/C: items 6-9 could be done in a different order and alternative machines included

Q/C: need to prioritise reconstructing data from actual scanners, including the GE system.

Action: Exec Committee needs to propose list order to Working Group (meeting 6th of June). Including some estimates of timing. In very short term: concentrate on 2 and 3

Research exchanges:- funds for travel etc are available please see the website.

https://www.ccppetmr.ac.uk/exchange.html

Dates for Future Meetings etc:

- Date for the **next Software Meeting #8 in London** is to be combined (before) with the Working Group 10:30am-12:30pm 6 June 2016

- There is a **Working Group meeting for the CCP PET-MR:** in 6 June - London LMS with link to Manchester (ICAM) https://www.ccppetmr.ac.uk/node/31 - planned for after lunch.

- Date for the *"next next"* Software Meeting #9 is to be in July and held in Edinburgh. Exact date and location is TBA.

- 7 September 2016 - British Chapter of the ISMRM – will include a half-day workshop in the afternoon

- STIR user's meeting at IEEE MIC will be ~4 November and held in Strasbourg

-PSMR 2016 will be May 23rd – 25th 2016 Maritim Hotel Cologne / Germany http://psmr.hut-gmbh.net/ CCP PET-MR has a poster so there is a request for Images / content.