EPSRC HiFFUT Fellowship Project Meeting Minutes

Date of Meeting: *28 September 2017*

Location of Meeting: *Department of Physics, University of Warwick*

Present: Colin Edge[CE] (DynOptic Systems), Noel Kerr[NK] (EES Research), Rob Turner[RT] (Katronic), Gary Bolton[GB] (NNL), Steve Dixon[SD] (University of Warwick), Andrew Feeney[AF] (University of Warwick), Lei Kang[LK] (University of Warwick), *Daniel Fratzscher[DF] (FLEXIM – Telephone)*

12 October 2017

Dear project partners,

Thank you for your attendance at the meeting, I hope you found it both informative and useful. The key points from the meeting are summarised below.

- AF gave an update presentation on the research which has been completed since the April 2017 meeting.
- A general discussion followed on the key developments from this work, including feedback from each of the project partners.
- A general discussion of the work packages and key deliverables followed.
    - CE asked about how the mechanical analog model presented will correlate to a transducer response spectrum generated using a square-wave input signal. AF responded that since the mechanical analog model is formed through a convolution of a sinusoidal signal with a unit step function, there should be full capability to model the response of a resonant device operating with a square-wave input signal. It will be interesting to investigate this further.
    - CE also suggested the mechanical analog model could be extended to take into account the response of the receive device, since there are often differences in the dynamic properties between the two devices. AF confirmed that this will be investigated, and that all mathematical and mechanical analog model data, derivations, and equations can be made available to all those who require them.
    - SD and CE both suggested the undertaking of directivity measurement of the (1,0) mode of the flexural transducer, in a transmit-receive setup using two FUTs. AF confirmed this experiment can be conducted in the forthcoming quarter.

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- NK asked about how the influence of nonlinearity in the amplitude-frequency response spectra can be differentiated between temperature, and from dynamic or material nonlinearities as measured and reported in the September 2017 report. AF responded that one way to do this would be to analyse the amplitude-frequency response of the high-temperature HiFFUT over a defined temperature range at a single drive amplitude, and then conduct the same experiment for a range of drive amplitudes. The first set of experimental results would provide an indication of the effect of temperature on the resonance frequency, and the analysis of the second set of results would determine the similarity of the change in resonance with the first set of results.

- A demonstration from AF of the measurement of high frequencies using two FUTs in a transmit-receive configuration followed. It was shown that the commercial FUT is capable of measuring frequencies with sufficient resolution up to around 200 kHz, and even above 300 kHz, although at this frequency magnitude, signal processing would be required to ensure the amplitude-time spectrum could be used for practical purposes.
- LK then gave a presentation of his research up to September 2017, including an overview of phased arrays based on the FUT for industrial flow measurement. The principles of this research will be utilised in this project, of which LK is now a member.
- A discussion of the research programme followed, and it was confirmed that LK would investigate wider band transducer designs, through material and geometry considerations. It was acknowledged that there is an inevitable compromise between frequency and bandwidth. NK also emphasised the need for intrinsic safety, particularly when prototype devices are to be used in application testing.
- The meeting concluded where a Wednesday in January or February 2018 was proposed as the optimal time for the next HiFFUT meeting. AF will issue a poll before the end of 2017 to arrange this meeting.

Actions

1. AF to adapt the mechanical analog model to account for the receive FUT, demonstrating the ability of the analog to represent a complete transmit-receive system.
2. AF will complete the fabrication of a high temperature HiFFUT and conduct the testing referenced in the minutes of the April 2017 report, and disseminate the results to the project collaborators.
3. AF to assemble and test the pressure vessel upon delivery.

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4. AF will undertake further experiments on the high frequency measurement of FUTs, including directivity measurements.
5. LK to develop a number of demonstrator devices for outreach purposes.
6. AF to coordinate a suitable date and send out arrangements for the January or February 2018 meeting at the University of Warwick.

Let us know if there are any questions, or if there is something specific you would like to see in development which would be applicable to your own line of work. Also, contact me if you see anything here which has been recorded in error so I can amend it.

Kind regards,

Andrew

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