

## Monthly Meeting (March 2020)

Date: March 31, 2020  
Time: 2:15pm - 3:24pm  
Location: Park Seismic Office  
Attendees:

In the office: Choon Park and Jin Park  
Via Skype: Josefin Starkhammar and Nils Ryden

### Topics regarding Administrative work

#### 1. Invoice and Payment

- We have finally received the first payment from MnDOT.
- February Invoice has been submitted.
- We need to well prepare March invoice
  - i. Prepare three usual forms for the invoice. They are invoice form, Progress report form, and Worked Hours Breakdown form.
  - ii. Since NI refused to provide the offer and invoice in English version, we need to prepare a document to provide to MnDOT for the proof of hardware purchase: the list of all the items to purchase and the total amount of items in Swedish Krona that, when converted into Us dollar, should match the amount we charge to Mn DOT.
- For preparing March invoice, Jin will provide the forms.

#### 2. Blog

- It seems not 100% meeting with our need. It is not easy to post already made documents like in pdf files or word files etc.
- Jin stated that we need a platform which can serve as a very convenient method of communication, should not be complicated but very convenient to use so that we can visit as often as possible.
- Jin will look for other better ways (e.g., a platform like Slack) so that we could more easily communicate and share our work materials.

#### 3. Quarterly Report

- We will have to submit the first quarterly report by the end of April
- Choon will prepare a draft version and then ask each member to add or fill out certain section(s) as needed within 2-3 weeks.

### Topics regarding Technical work

#### 1. Hardware Design (MEMS Microphone Receiver Array) - how many channels will be the most optimum per array and what is the channel spacing for the optimum distance

- Choon stressed it is most critical at this moment to determine the optimum number of channels per array (NCH-opt) and the channel spacing (dCH-opt) so that Josefin can start building the system. Based on the results from a series of

tests Choon executed by using the data set collected with the most recent system at LTH, he recommended  $NCH=16$  and  $dCH=3$  cm with 4 of current MEMS microphones connected in parallel to make one channel (each microphone spaced in 0.75-cm interval).

- Choon asked about the circuit board design in terms of how freely these parameters can be adjusted during the design and building stages. Josefin stated all of them can be changed relatively freely within certain practical limits. However, she also stated changing the  $dx$  (microphone spacing) may take a whole new design of the board. She also speculated if simple connection of 4 microphones in parallel ( $4dx$ ) will be enough, or if it will need separate amplifiers before summing the signals from each microphone.
- Choon stated the simple connection will be enough as this approach has been used in the exploration seismic surveys for a long time. Nils also mentioned a recent article from a German PhD student that showed using a sophisticated MEMS microphone array for single channel significantly reduced the air wave energy in the Impact-Echo (IE) measurement. All agreed it also supports the potential effectiveness of the  $4dx$  for our project. Choon and Nils agreed that the multiple-receiver-connection approach for further signal-to-noise (SN) ratio improvement will be a big R&D topic for the future more advanced version of this project.
- Josefin stated there will be a total of 256 ( $=4 \times 4 \times 16$ ) MEMS microphones we have to buy to complete a set of 4 of such linear arrays at the end. This will be overbudget. But, all agreed we will seek for the way to fund it as the potential impact on the overall effectiveness is significant.
- Choon mentioned the total length of the array ( $L$ ) will be about 48 cm and will be enough to resolve a thickness ( $H$ ) up to 20 cm as a maximum. But, Nils indicated the ratio between  $L$  and  $H$  may be close to 1.0 (rather than 2.0 or 3.0 as with the common soil surface waves) in pavement measurement and therefore  $L = 30$  cm may be enough. In addition, he stated that, because of the elevated level of attenuation on the asphalt pavement, there is usually no useful energy existing at distances further than about 30 cm from the source. He stated the high temperature (e.g., 20 degrees and higher in Celcius) will further shorten this distance.
- Choon stated that he thought the data set he analyzed so far was from an asphalt pavement and therefore there would be no such attenuation issue involved when making one array as long as 48 cm. Choon stated we need to test with more field data sets from asphalt pavement.

## 2. Conclusions for Now

- Nils will collect more data sets from asphalt pavement using the most recent MEMS microphone array and send them to Choon.
- Choon will use them to see if we have to modify the optimum configuration for one array. Until then, we all assume that  $NCH=16$  and  $dCH=4dx=3$  cm with 4 microphones connected in parallel are the optimum parameters for one array.

**Agreed to do:**

1. Jin will send the forms for March Invoice to team Sweden.
2. Josefin will send the invoice forms for including the proof of Hardware purchase by next weekend (4/10).
3. Choon will prepare the draft of the first Quarterly Report and send the draft to each member to fill out as needed
4. Nils will send more of real data sets so that Choon can have experiment with them.

The meeting adjourned at 3:24 pm.