**Implementation of a Navigation System for a Moving Sea Ice on an Android Device**

## **ABSTRACT**

To enhance the understanding of the regional and global consequences of Arctic climate change and sea-ice loss and improve weather and climate predictions, Alfred Wegener Institute (AWI) in coordination with its partners is undertaking the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition which will be the first year-round expedition into the central Arctic exploring the Arctic climate system. The MOSAiC expedition aims to monitor the movement of a large Sea Ice over an extended period of time. This would require different sensor measurements to be taken on the ice over the expedition period. Additionally, an expedition of this size would require a constant monitoring of the personnel and equipment on the Ice. A safety system would also be required to provide information about the dangers, such as mountains or crevasses present on the Sea Ice; which would enable the personnel to work in the safe zones. As the Sea Ice is a continuously moving platform, conventional mapping applications which are based on the Geographic Coordinate System (Latitude and Longitude) cannot be used on it. As a consequence of which there is currently no system in place to monitor the movement of people and equipment on the Sea Ice, store the location data for measurements/samples relative to the Sea Ice and create points of interest or waypoints on the Sea Ice.

AWI, being the lead partner for the MOSAiC expedition, desires to experiment by creating a customized system wherein to set up a coordinate system relative to the movement of Sea Ice. An adequate amount of research has been initiated to come up with a coordinate system which would be used to locate the positions of all the equipment with respect to the geographic coordinate system. The foremost challenge is to translate the geographic coordinate system to a customized coordinate system such that this system can accommodate the position of all points of interest with the added challenge of the drift of the Sea Ice. Such a coordinate system would be set up using the Automatic Identification System (AIS) transponders which are used globally for Maritime Navigation. AIS is an automatic tracking system which makes use of the transponders installed on ships which transmit navigational information. Each AIS Transponder is also able to receive the information transmitted by other vessels in the vicinity. For the MOSAiC expedition, these AIS transponders would be mounted in fixed positions on the Sea Ice.

The aim of this thesis is to develop an android application, which would use the periodic data from the AIS transponders installed on the Sea Ice to create a coordinate system which is fixed relative to it. The application would be installed on a custom-built tablet designed to withstand such severe conditions. It would create a visual representation of the coordinate system in the form of a grid which can be used by the MOSAiC personnel to navigate on the Sea Ice. Once the coordinate system is established, it will be independent of any particular AIS Station; instead, the application should be able to create the coordinate system using any two of the installed AIS Stations, so in case the Sea Ice breaks, the coordinate system will persist. The vehicles which will be used to move around on the Sea Ice will also be mounted with AIS transponders so that the established coordinate system can help to monitor their movement. The application would also utilize the built-in GPS sensor of the tablet to show its current position relative to the coordinate system, thereby providing the position of the personnel on the ice. The application would be able to extrapolate the coordinate system at a higher frequency than the incoming AIS data which can then be compared with each other to check the accuracy of the coordinate system calculations. The aforementioned provision will be used to check if the Sea Ice is breaking and notify the personnel. As there will be multiple tablets in use simultaneously, there is a necessity for data synchronization across all devices so that the coordinate system and other data is consistent throughout and all the personnel are working with same data. Additionally, the application will also be integrated with the AWI IT system to provide the location data of the Sample/Measurement taken on the Sea Ice.

## **MILESTONES:**

The main milestones of the thesis will be:

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| **Time** | **Task** |
| Week 1 | Selecting a suitable Android device for the expedition |
| Week 2 | Finalizing requirements and defining the tasks which will be available on the application. |
| Week 3 | Creating an application architecture for the entire system and designing a database schema for the application |
| Week 4 | Setting up the development environment and connecting the same with the tablet for debugging purposes |
| Week 5 | Connecting the tablet with the AIS Transponder by creating a telnet client |
| Week 6 | Decoding the AIS packets to get useful information such as position, speed, and course etc. from it |
| Week 7 | Researching a conceptual understanding of the Geographic Coordinate system and creating a translation of the Sea Ice Coordinate system from the Geographic coordinate system |
| Week 7 | Implementing the local database of the application |
| Week 8 - 9 | Implementing the background services (GPS service, Prediction Service, Validation Service etc.) which will be used in the application |
| Week 10 - 11 | Creating different layouts and user interfaces for each task of the system |
| Week 12 - 13 | Creating the visual representation of the coordinate system in the form of a Grid which will show all the AIS Stations (Fixed and Moving) and other points of interest on the Sea Ice |
| Week 14 | Setting up the Synchronization Server which will be responsible for synchronizing the data across all tablets running the application |
| Week 15 | Implementing the synchronization process from the tablet to the Sync Server |
| Week 16 | Integrating the system with the AWI IT system |
| Week 17 | Hardware in Loop testing with the Sea Ice Simulation Model |
| Week 18 - 19 | Code documentation and knowledge transfer to AWI |
| Week 20 - 22 | Documentation of the result and compiling thesis report |