

Software-Project 2017

# Review Document

## Real-Time Mesh Utilities

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## 1 Introduction

The review document grants insight into the progress of the project and covers the decisions the team made during development.

It serves as an extension to the design and developer documents, which describe the structure and code of the software in more detail.

The document is divided into three segments, each representing a phase of the project. Each phase stands for specific tasks and gives a time frame for when they have to be finished.

Thus, after every phase progress gets documented and reflected and a lookout for further work on the project is provided.

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## 2 First Phase: Planning

This segment of the review document is divided into two parts.

The progress of the first phase of the project is described.

It contains the results of planning as well as the outcomes of the design process. Results of planning include development model, cost and risk estimation, milestones and organization. The design process contains the outcomes of the current iteration, arrangements for the next iteration and a list of tools.

### 2.1 Result of Planning

A large part of the first phase of the project (i.e. scheduling and draft) is reflected on the functional specification document. The requirement analysis is registered, the objectives are declared, whereas the decisions and the product information is written down.

#### 2.1.1 Software Development Model

This section contains information about the software model chosen, based on the requirements of the project. The principals of the group, client requirement and knowledge about the project play an important role in choosing the development model. Based on the latter, the development team decides its work flow.

**Agile Development Model: SCRUM** The group chose SCRUM because it is an iterative and incremental agile software development framework for managing product development. The duration of each sprint was set to two weeks. Each phase of the software development has two sprints.

Every sprint ends with a presentation by the relevant working group about the developments and progress during the sprint. The end of the respective phase of the project is marked by a working prototype and a presentation which includes a summary of the work done by the entire team.

**Projects specific adaptation to the model:** Every person in the team has multiple roles. All group members work on both the document and the code.

##### 2.1.1.1 Software Development Specific Content

Since the group decided for the agile development project, the milestones need to be stated and agreed upon by the team. Milestones are the aim or the expected output of each development phase. They help the team to specify what features should be completed by which deadline.

### 2.1.2 Effort Estimate

The main purpose in the effort estimation section is the categorization of the different parts of the project regarding their complexity and effort criteria. (see figure 1)

Total: 220 man days

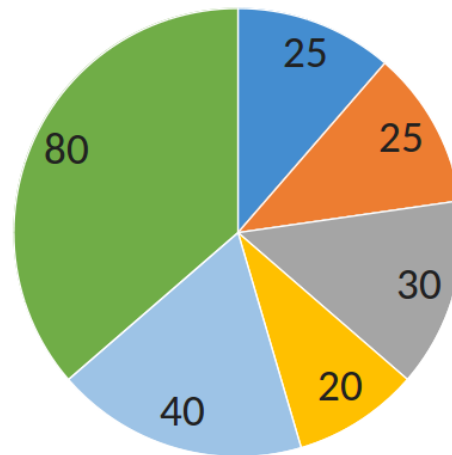
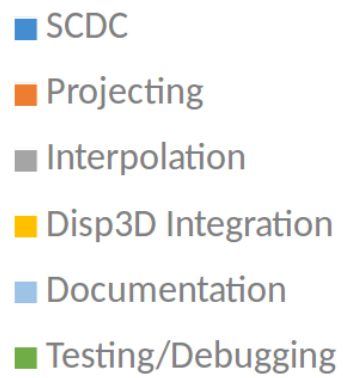


Figure 1: Effort estimate

### 2.1.3 Risk Estimate

In this section, the probabilities of the different risks involved in the project are listed. This will help the team to determine what aspects of the implementation should get a higher priority.

**RE1:** Communication problems in the team

**RE2:** Coverage is too extensive

**RE3:** Framework does not provide the needed functionality

**RE4:** Resource bottleneck derived from team members temporary absence

**RE5:** Change of the requirements due to miscommunication with the product owner

**RE6:** Hidden complexity

**RE7:** Acceptable computation time takes a lot more effort than expected

Impact ↑	catastrophic					
	crucial			RE2, RE6	RE7	
	moderate		RE3	RE5		
	minor				RE1, RE4	
	negligible					
		almost impossible	improbable	possible	likely	almost certain
Probability of problem →						

Figure 2: Risk estimate

#### 2.1.3.1 Handling Risks

In case one of the risks occurs, certain strategies for solving the issue are provided. Only the ones having a crucial impact on the project are dealt with in the following section.

**RE2:** Optional requirements will only be addressed after every mandatory criteria is fulfilled.

**RE6:** The team communicates with the product owners to eradicate all ambiguities.

**RE7:** To keep the computation time as low as possible, changes to the software will be tested constantly to determine even minor impacts on efficiency.

### 2.1.4 Milestones

These Milestones provide major dates for significant events during the time of the project. Furthermore they serve as a guideline for the amount of progress that is desired at a certain point of the development process.

<b>First Phase</b>	03.05.2017	First Phase Finished
<b>Second Phase</b>	04.06.2017	Detailed Design and Features Implemented
	08.06.2017	Second Phase Finished
<b>Third Phase</b>	21.06.2017	Features Tested and Optimized
	02.07.2017	Portation to MNE Scan
	05.07.2017	End of Project

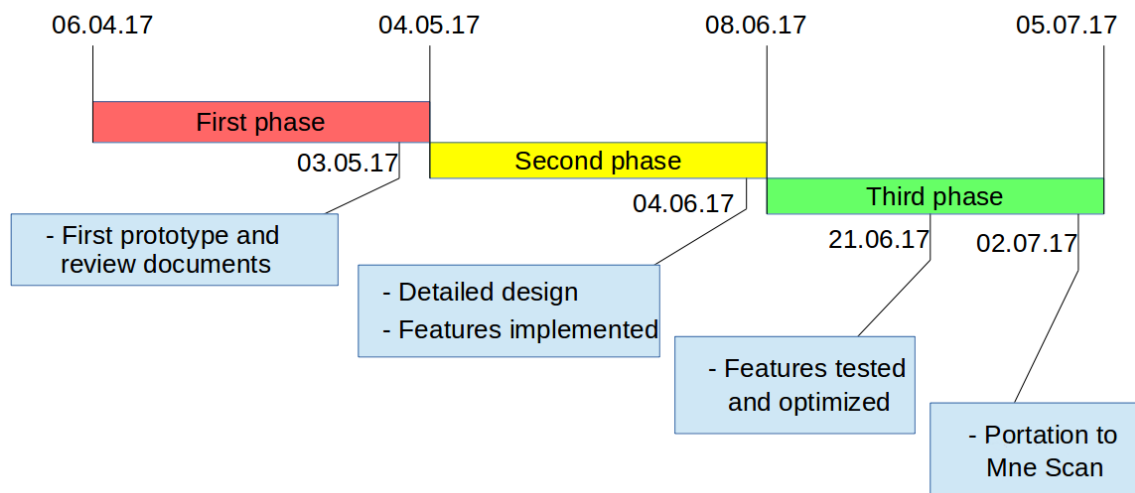


Figure 3: Timeline

#### 2.1.4.1 Checklist

**03.05.2017** First Phase Finished

1. Functional Specification
2. Preliminary Design
3. Review Document
4. First Prototype
5. Presentation

**04.06.2017** Detailed Design and Features Implemented

1. Detailed Design



2. SCDC (operational)
3. Projecting Algorithm (operational)
4. Interpolation Algorithm (operational)

**08.06.2017** Second Phase Finished

1. Presentation
2. Review Document
3. Integration into Disp3D

**21.06.2017** Features Tested and Optimized

1. SCDC (tested)
2. Projecting Algorithm (tested)

**02.07.2017** Portation to MNE Scan

**05.07.2017** End of Project

1. Review Document
2. Presentation
3. Interpolation Optimized

### 2.1.5 Organization

This section concerns to the rules, agreements and the partitioning regarding the team-work in the project, so the work itself will be efficient and organized.

#### 2.1.5.1 Ways of Communication

**Telegram:** Used for quick and direct team communication so that possible misunderstandings will be solved in no time.

**E-mail distribution list:** Used for scheduling the team meetings and communications with the extended team, including the product owners.

**Team meetings:** Used for the review and direct discussion of the encountered problems.

**Skype:** Used in the cases of the absence of a team member.

**Jira:** Used for scheduling tasks and keeping track of the progress done by each member of the team.

**Dropbox:** Used for exchanging documents and file sharing.

#### 2.1.5.2 Additional Agreements

- Internal team meetings (without product owners): Tuesdays and Thursdays at 19:00
- External team meeting (with the product owners): Wednesdays at 17:00
- Meeting of subgroups : upon consultation and demand

#### 2.1.5.3 Role Assignment in SCRUM

**Product Owner:** Thomas Jochmann, Lorenz Esch

**Scrum Master:** Simon Heinke

**Development team:** Blerta Hamzallari, Felix Griesau, Julius Lerm, Lars Debor, Marco Klamke, Simon Heinke, Sugandha Sachdeva, Petros Simidyan

**Client, User:** Participants of the MNE CPP project of Boston Children's Hospital

#### 2.1.5.4 Role Assignment Organization

**Advisor:** Thomas Jochmann, Lorenz Esch

**Team leader:** Simon Heinke

**Build master:** Lars Debor

**Version management:** Felix Griesau

## 2.2 Result of Design

The results of design can be found in the preliminary design document. The connections between different packages, components and classes are explained and visualized using UML-diagrams.

### 2.2.1 Tools

The used tools are programs which facilitate the different aspects of the organization and development.

#### 2.2.1.1 Organization Tools

**Code versioning:** The source code will be managed via *Git* to ensure a convenient exchange and tracking of code.

**LaTeX:** *LaTeX* is used for editing review documents and documentation.

**Doxygen:** This program will automatically document source code comments.

**Visual Paradigm:** Used for creating UML-diagrams and other aspects of visual documentation.

#### 2.2.1.2 Development Tools

**Development environment:** Since it is already established within MNE-CPP, *QtCreator* will be used for code editing and compiling.

**Program language:** *C++* will be used hence it is the main language of MNE-CPP

**Operating systems:** The software will be developed on Linux and Microsoft Windows.

**Libraries:** Besides standard libraries from the *C++ 11* standard, the MNE-CPP framework is based on Eigen, OpenGL and Qt.

### 2.2.2 Results of first iteration design:

The results of the first iteration correlate with the respective milestone.

**Functional specification:** The requirements specification is transferred into the corresponding functional specification.

**Preliminary design:** The preliminary design includes a first overview of the main features and structure (see preliminary design document).

**Implementation:** A first executable prototype is created.

**Planning:** Milestones for the next iteration are declared.

### 2.2.3 Tasks for next iteration

**Refining the preliminary design:** The preliminary design is extended with diagrams and more detailed descriptions. This will be done according to milestones progress.

**Further implementation:** The mentioned features will be implemented and tested.

### **3 Second Phase: Implementation**

This section of the document contains the outcome of the second phase of the project. Basic concepts and decisions of the final design are mentioned and looked upon. Further the final design and a corresponding developer documentation are available in separate documents.

Alongside the achievements, problems that arose during this iteration are covered and some issues have to be revisited throughout the third phase.

Lastly a prospect for the next phase is given, with all the tasks that have to be taken care until the end of the project.

### **3.1 Goals for Third Phase**

In this section the goals for the following phase are outlined.

#### **3.1.1 Testing of SCDC**

The correctness of the SCDC-feature has to be tested in order to guarantee realistic results. Additionally if any possibility to optimize the speed of the SCDC comes up, the performance will be improved further.

#### **3.1.2 Testing of Projecting**

If any other data-structure will be used, the results can be checked via comparing them to the ones gained by the linear search.

#### **3.1.3 Portation to MNE Scan**

The MNE Scan application is the front-end in which the features ultimately should be integrated. In this phase we aim to achieve this concomitant with the completion of the features.

#### **3.1.4 Optimization of the Interpolation**

Interpolating the sensor data works quite well at this point of time. In the upcoming phase we try to further improve its performance via using compute shaders. This could speed up the calculation as well as it has the advantage of having the data already on the graphics card for further output.

#### **3.1.5 Bad Channels**

#### **3.1.6 Fibonacci Heap**

## 3.2 Bugreview

Due to encountering some problems during implementation, not all features are finished and ready for testing. Nevertheless we were able to fix the majority of the occurring issues.

The following aspects and features need further processing in phase three.

### 3.2.1 Missing Feature

Until the end of the project this feature has to be implemented and tested.

**Integration into Disp3D:** After successfully implementing all algorithmic features into the MNE-CPP library a further integration is needed to make the newly created functions usable. Disp3D provides the GUI for visualizing the interpolated data, while enabling the user to change settings like the color table.

A new *sensorDataTreeItem* is needed to integrate functions from the library. Due to high complexity and needed time investment to fully understand the existing code more time is needed to finish implementation.

To fix this problem the task will have the highest priority at the beginning of the third phase, to quickly finish its implementation and start with further testing and optimization.

### 3.2.2 Missing Mandatory Function

This function is mandatory and thus has to be completed during the third phase.

**Bad Channels:** Sometimes sensors do not deliver correct data and are marked as bad channels. These sensors should not have any impact on the weight matrix and the following interpolation.

Currently this information is not utilized during computation. Therefore misleading data is used and the results are not completely correct.

Bad channels are to be detected and considered during calculations.

### 3.2.3 Missing Optional Functions

After finishing the implementation of all mandatory functions these extensions are to be considered. Furthermore methods for further improvements are mentioned.

**Computation on GPU:** To further increase the efficiency of the interpolation, calculations are done using compute shaders, utilizing the GPU.

**Portation to MNE Scan:** All new features are accessible through the front-end application MNE Scan.

### 3.3 Results of Second Phase

In this sections the achievements of the second phase are documented.

**Detailed Design:** A document for the detailed design of the software was created. It covers implemented classes and their structures, while giving explanations for all functions and components.

Further design choices made during development are described.

**Developer Documentation:** A developer documentation was created by using Doxygen. It is available as a separate document.

**Implementation:** Implementations of the first phase were continued and refined. The first three major features are operational and optimized to a certain degree.

This results in computation times within the limits of agreements with the product owners.

The software is able to project sensors onto a surface, calculate the distances of vertices on a mesh and create the weight matrix for later interpolation, which is also implemented and runnable.

**Planning:** All remaining tasks are known and next steps for the coming iteration were discussed within the team.