1. Problem Analysis
   1. Problem Definition

(move some of this to preamble?)

Third Faculty of Medicine at Charles University in Prague is a successful, established educational institution. Its Department of Anatomy is continuously looking to improve its teaching methods and keep the study materials up to date in terms of both content and form. As many others before, they have realized the great potential of computer technologies in education and started numerous projects to transfer knowledge from traditional printed sources to a much more flexible online domain. One of these projects and the topic of this thesis is an online atlas of human bones.

This project aims to develop and implement an online atlas of bones, which would be an exhaustive yet illustrative source of information for medical students. The online form would make it readily accessible to students without the drawbacks and limitations of printed publications. Ideally this application would be accessible from a range of devices and operating systems, while also being multilingual or at least bilingual (Czech and English). The application aims to be useful to as large a number of students as possible.

The core of this project will be a database of 3D models of human bones. The models will include labels indicating important parts, locations and structures of each bone. The goal is to display detailed models and detailed information in common Internet browsers without the need of specialized software or installation to make the data both relevant and accessible.

The user should be able to rotate, shift and zoom the view. There should be different modes including a blank model, a model with unlabeled pins and a model with full labels. The labels should provide further detailed information when selected by the user.

In addition to a 3D model, each bone will have a page containing further textual or visual information including examples of related pathologies, links to other sources and more. Anything the editors decide to publish about the bone will be available there.

The atlas will allow upload of new models, editing of pages and model labels by a selected group of users in a special editorial interface not accessible to most users, allowing the database to grow without the necessity of consulting a programmer.

The project is not entirely new. However, the existing version is incomplete, imperfect and should be reworked. If nothing else, it served its purpose of allowing data input, enabling reuse of its partially filled-in data content. See chapter ??? for more information about the current version.

* 1. Existing Solutions and Alternatives

The following list is by no means complete. These are just several examples of the most relevant solutions and alternatives found online.

<http://skelet3d.lf3.cuni.cz/>

Skelet 3D is the previous version of our project, further discussed in chapter ???. Our intention is to rework and upgrade this solution.

<http://skeletopedia.sk>

Skeletopedia seems to be the closest independent solution available. It provides interactive 3D models of bones in browser environment as well as simple labeling of certain parts, unfortunately not in great detail. The contribution of our project in comparison to this solution should be more detailed and far more numerous labeling of the models as well as further information about each label and each bone in general.

<http://www.zygotebody.com>

<http://www.anatronica.com>

Zygote Body, Anatronica and many other systems include 3D models of the human skeleton. However, they provide little to no additional information besides the name of each bone.

<http://www.3dscience.com/3D_Models/Human_Anatomy/Skeletal/>

3D Science provides extremely detailed 3D models. However, these are not free, most likely not suitable for online display and most importantly provide no additional information.

<http://www.atlascloveka.upol.cz/cs/cs02/cs0201/cs020100.html>

Palacký University in Olomouc provides information on most bones in their online human anatomy as well as photography of human bones, sometimes including labels with short descriptions. The information, however, seems incomplete. Moreover, there is no 3D material available, which is the trademark of our project.

<http://en.wikipedia.org/wiki/List_of_bones_of_the_human_skeleton>

Wikipedia provides rather detailed information on human bones. English version includes simple 3D animations of most bones, but it doesn’t provide any connection of 3D models with labels and descriptions, which is the intended contribution of our project.

* 1. Current Version of the Atlas

The atlas project is not beginning with this thesis. It was initiated in 2012 and most of the development of the existing version happened in 2013.

The current version is a publicly available website running on the servers of the Third Faculty of Medicine, Charles University. It consists of a list of bones sorted in a hierarchy of groups based on parts of the human body, a 3D viewer of models of bones and a very simple editing page which isn’t public. An as-of-yet unreleased bilingual version allows editing in Czech and English (as opposed to Czech only).

The list of bones is a Flash application written in ActionScript 3 that allows selection of a model and filtering using a hierarchy of predefined groups. It does what it’s supposed to do, although the layout might not be the most intuitive and there are no additional features such as “search”. The loading time is longer than expected.

The model viewer is another Flash (ActionScript 3) application using a simple 3D engine called Sandy with two basic modes: view and edit. It allows the user to manipulate view freely, although not in the most intuitive way. It allows users to display or hide labels and pins without any trouble. However, it suffers from graphical errors, most notably seeing labels through a bone while they should be behind it and vice versa. It is also missing some minor tweaks such as adjusting the label width to fit the length of the text. The edit mode is working, although not pretty to look at. The rendering speed of the application is subpar, greatly limiting the use on mobile devices and the quality of models. The technology used doesn’t provide easy solutions to some of the aforementioned flaws.

The web page which is used to upload new models and enter the editing mode is implemented as a series of simple PHP scripts. Other PHP scripts are called by the Flash application to handle XML files on the server.

There are two versions of the application, a public version with editing disabled and a separate version for editing only, whose location is not known to public, but which is not protected in any other way. The live version is updated manually by transferring data files from the editable version.

The application was developed on the fly and suffers from a variety of flaws some of which are listed below. The technologies used seem to be inefficient and possibly outdated. Implementation details of the existing version might be discussed and compared in respective implementation sections of this thesis.

The models and labels entered by medical students into the existing version should be valid and reusable in the new implementation.

* + 1. Identified Flaws

Graphical errors: There are numerous minor graphical glitches. Most of these are related to displaying parts of models or labels at the wrong depth. Current implementation is using too primitive depth sorting to display the scene correctly at all times.

Lack of authentication: There is currently no login system to protect the data from vandalism. It would allow better sustainability through direct editing by privileged users as opposed to transfers by the website administrator.

Hardware demands: Rendering the models is too computationally intensive in current implementation. Some of the more complex models are reaching low FPS even on average desktop computers, while being virtually unusable on older machines and mobile devices. A tradeoff between model complexity and rendering speed is to be expected, but current application’s performance is nevertheless underwhelming.

Slow loading of “groups”: It can take several seconds to load the tree of groups. This might be due to inefficient use of XML files.

Imperfect user interface: The GUI is not fine tuned. It might not be particularly intuitive for a first time user and the editor GUI was apparently a temporary solution.

Imperfect internal structure: Current version was written on the fly and its internal structure reflects the fact. While it might be sufficient for now, the lack of order and proper organization makes sustainability and further development an issue.

Lack of documentation: Current version doesn’t provide proper documentation.

* 1. Project’s Contributions

The main goal is to help medical students acquire knowledge of human bones. There are numerous sources available, ranging from lectures and printed textbooks to aforementioned online solutions. Our application cannot compete with the experience and insights of lecturers and it is not likely to replace textbooks because of the sheer volume of information included in those. But it can be a great study material, available anytime, hopefully better than other online sources.

None of the known sources (other than the previous iteration of our atlas) provide what we hope to achieve in this project: Exhaustive information linked to illustrative 3D models. There are 3D models and there is information. This project’s contribution is linking the two in an interactive manner, allowing students easy navigation and a mental link between spatial and textual information.

This was attempted in the current version of the atlas in a clumsy and imperfect manner. This version strives to be a more professional solution of the problem without all the flaws of the last version.

The aim is to develop the application in an organized, orderly and documented way, using the best available technologies and methods chosen after careful consideration. We need to avoid the glitches and imperfections of the previous iteration, to make the display module more efficient, the interface more user-friendly. We need sustainability, most notably a proper editorial system with authentication to allow the application to grow and fill up with useful information.

Moreover, there will be the new feature of web pages with additional information. They will contain any information seen fit by the editors, giving this project the potential to be a truly exhaustive source of knowledge regarding human bones, ranging from anatomy to pathology. Other new features might be added as well, given a time reserve.

* 1. Target group
  2. Requirements

1. Technology Research