5 SUMMARY

To sum up, the thesis introduces a reader into orthosis modelling following digital data processing approach. Then, based on the database provided, the procedure of development is stated and followed. Even though several days were spent to empirically find a proper photogrammetry setup and printer settings, a prototype is designed and built, and the final procedure took about 90hrs including taking pictures, processing them, modelling and manufacturing. In total about a spool of plastic filament (1 Kg) was printed out which gives a price of approximately 30EUR for two versions. The plastic was the only investment made to the thesis since the PC setup and the camera appeared to be sufficient for the project. Thus, the total time and price for one version of a knee-orthosis can be estimated as about 10hrs for data input/processing, about 40hrs for manufacturing using the settings described in the manufacturing chapter and about 15EUR for the materials (filaments). According to one of the major world manufacturers of orthoses – 'Bracepimp', it takes about 12 days to get a first version of a custom orthosis [21]. Having this period shortened to only two days and 15EUR for a prototype, the main aim of the developing a cheap and fast rapid-prototyping procedure is achieved.

The first and the second of the introduced questions are described in the in the second and third chapters respectively. The third question about the setup is precisely described in the fourth chapter. In a nutshell, there are brief descriptions of scanning procedures, concepts of data processing and overview of manufacturing materials and corresponding manufacturing methods. Having this database in the first part of the thesis, a design and manufacturing procedure is developed and tested in the second.

Speaking about the procedure development, there are quite a lot of time spent for finding sufficient setup and settings for the photogrammetry scan, however once the correct light and camera's parameters were found, they resulted in surprisingly well constructed digital leg model. Post processing and orthosis design are the two most straightforward instances which took place in parametric and mesh modelling environments. Manufacturing required several test runs for finding appropriate printer's settings which were later used to manufacture the parts. Testing of the first prototype showed couple of design mistakes and leaded to some design changes and manufacturing the second prototype which appeared to fit nicely.

In the end the thesis project is considered to be successful, the main aim is met, and the raised questions are answered.

There are some contributions of the paper listed below:

1. An organized brief explanation of the technologies used in orthosis manufacturing.
2. Developed and tested procedure of an orthosis manufacturing.
3. An actual 3D printed prototype which showed real applicability of the procedure followed.

As for the improvements which can be made for the development procedure:

1. Scanning instance: better soft-light boxes in the photogrammetry setup to achieve more contrast in the datasets' pictures. An SL scanner instead of the photogrammetry is recommended since this technology provides the highest precision and used professionally in medicine.
2. Data processing: Eventually it was found that paid license photogrammetry software performs better then open source analogues, thus it stays to be recommended to use with a commercial-free or paid license. Meshing the model in blender was just fine, however as an improvement – spending more time adjusting the model is recommended since it will reduce number of vertices to work with and the processing time respectively.
3. Modelling: While the prototypes were designed made in Fusion 360, it is highly recommended to adjust the final shape in a mesh environment – this is the way to make a perfect-fit orthosis. Also, a skeletal structure with two braces on top and bottom is worth to be considered since it is a common design.
4. Manufacturing: 3D printing approach has a special feature – the layering of a model. It is recommended to setup a model to print in a way that the layers will have max cross-section in the direction of a force applied. Also to make the model light-weight it is recommended to use thick shell structure, lowering infill parameter.