

**UNIVERSITÀ DEGLI STUDI DI TRIESTE**  
**Dipartimento Universitario Clinico di Scienze**  
**mediche, chirurgiche e della salute**



Laurea Magistrale in Medicina e Chirurgia

**Cost-effectiveness of the italian screening protocol  
for international adoptees**

Ottobre 2018

Laureando  
**Sebastiano Genna**

Relatore  
**Prof. Egidio Barbi**

Anno Accademico 2017/2018

*"There are times when the adoption process is exhausting and painful and makes you want to scream. But, I am told, so does childbirth."*

- Scott Simon, journalist and radio broadcaster

## *Abstract (Italian)*

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras volutpat eu lorem et euismod. Vivamus ut elit volutpat augue dignissim condimentum vitae id ex. Praesent nunc turpis, facilisis nec risus eu, tristique cursus felis. Aenean finibus eros ut nulla dapibus euismod. Aliquam quis erat vel ligula suscipit venenatis id at est. Donec ornare suscipit lacus eget iaculis. Suspendisse a ex ut urna commodo pharetra et et nulla. In hac habitasse platea dictumst.

Donec eu sem vel nisl venenatis consequat sed at diam. Nullam sagittis tortor ex. Suspendisse pharetra nisl ac metus lacinia, suscipit semper neque posuere. Praesent finibus ornare ipsum ut consectetur. Vestibulum auctor suscipit libero eget vulputate. Aliquam odio magna, feugiat a vestibulum non, ultrices ut quam. Etiam facilisis et risus feugiat finibus. In eleifend ultrices libero, sed facilisis nulla pellentesque at. Aliquam erat volutpat. Quisque dictum eleifend dui eget feugiat. Nam molestie sed mauris non iaculis. Sed vel nisi commodo libero sollicitudin semper quis sit amet purus. Nam elementum a orci at rutrum. Vivamus sit amet lacus non quam rutrum tincidunt tristique id quam.

Sed et facilisis lorem. Sed aliquam pulvinar est ac dignissim. Mauris scelerisque risus ut quam molestie aliquam. Quisque ultrices orci nec purus semper suscipit. Donec eleifend augue vitae est sollicitudin, at commodo nisi pretium. Fusce sollicitudin nibh ut nulla interdum, ornare sagittis neque varius. Sed vulputate hendrerit ornare. Ut vehicula sapien ut efficitur congue.

# *Abstract*

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras volutpat eu lorem et euismod. Vivamus ut elit volutpat augue dignissim condimentum vitae id ex. Praesent nunc turpis, facilisis nec risus eu, tristique cursus felis. Aenean finibus eros ut nulla dapibus euismod. Aliquam quis erat vel ligula suscipit venenatis id at est. Donec ornare suscipit lacus eget iaculis. Suspendisse a ex ut urna commodo pharetra et et nulla. In hac habitasse platea dictumst.

Donec eu sem vel nisl venenatis consequat sed at diam. Nullam sagittis tortor ex. Suspendisse pharetra nisl ac metus lacinia, suscipit semper neque posuere. Praesent finibus ornare ipsum ut consectetur. Vestibulum auctor suscipit libero eget vulputate. Aliquam odio magna, feugiat a vestibulum non, ultrices ut quam. Etiam facilisis et risus feugiat finibus. In eleifend ultrices libero, sed facilisis nulla pellentesque at. Aliquam erat volutpat. Quisque dictum eleifend dui eget feugiat. Nam molestie sed mauris non iaculis. Sed vel nisi commodo libero sollicitudin semper quis sit amet purus. Nam elementum a orci at rutrum. Vivamus sit amet lacus non quam rutrum tincidunt tristique id quam.

Sed et facilisis lorem. Sed aliquam pulvinar est ac dignissim. Mauris scelerisque risus ut quam molestie aliquam. Quisque ultrices orci nec purus semper suscipit. Donec eleifend augue vitae est sollicitudin, at commodo nisi pretium. Fusce sollicitudin nibh ut nulla interdum, ornare sagittis neque varius. Sed vulputate hendrerit ornare. Ut vehicula sapien ut efficitur congue.

# *Acknowledgements*

To my friends *I Cazzilli*: Fede, Lorenz, Grismina and Ste, for always being worthy of being the family I chose for myself and for looking out for me day after day.

To Emme, for growing from my sweetheart to the woman of my life.

To Carol, the closest tea-brewing sister I could hope for. I'm proud of you.

To my Mom, for teaching me, among another thousand things, her own personal special way of calling somewhere "*home*".

To my Dad, for always trying to be the man he ought to be.

To the rest of my strange, enlarged family, for always supporting me in every possible way.

To Luca, my tireless desk-mate, who never called himself out of an all-nighter.

To Valentina, who helped me stand in times when I couldn't stand for myself.

To prof. Barbi and prof. Ventura, for remembering me that medicine can be how i dreamed it.

And lastly, to myself, for always believing that, even when your heart's lost all its hope, after dawn there will be sunshine.

# Contents

Abstract (Italian)	ii
Abstract	iii
Acknowledgements	iv
List of Figures	viii
List of Tables	ix
Abbreviations	x
<b>1 Introduction</b>	<b>1</b>
1.1 Objectives . . . . .	3
1.2 Project Management . . . . .	4
1.2.1 Time management . . . . .	4
1.2.2 Versioning and productivity tools . . . . .	5
1.2.2.1 Github . . . . .	5
1.2.2.2 Waffle . . . . .	5
<b>2 Materials and Methods</b>	<b>6</b>
2.1 Literature Review . . . . .	6
2.2 Technologies Used . . . . .	6
2.2.1 ParaView and VTK . . . . .	7
2.2.1.1 Virtual Reality Capabilities in ParaView . . . . .	7
2.2.2 Unity . . . . .	7
2.2.2.1 Object behaviors in Unity . . . . .	8
2.2.2.2 Virtual Reality Capabilities in Unity . . . . .	8
2.2.3 ParaUnity . . . . .	8
<b>3 Results</b>	<b>9</b>

---

3.1	Introduction . . . . .	9
3.1.1	Why Unity? . . . . .	9
3.2	Application Architecture . . . . .	10
3.2.1	Environment . . . . .	10
<b>4</b>	<b>Conclusions</b>	<b>11</b>
4.1	Final system architecture . . . . .	11
4.2	Objectives achieved . . . . .	12
4.3	Future work . . . . .	12
<b>5</b>	<b>How to Do</b>	<b>13</b>
5.1	Including Sections and Subsections . . . . .	13
5.1.1	I like myself . . . . .	13
5.1.2	but I'm weird . . . . .	13
5.1.2.1	LOST OF FUN! . . . . .	13
5.1.2.2	I'm calm and shit . . . . .	14
5.2	Including references and citations . . . . .	14
5.2.1	Referencing images and tables! . . . . .	14
5.2.2	Referencing chapters and subchapters . . . . .	14
5.2.3	Using footnotes . . . . .	14
5.3	Including quotes . . . . .	15
5.4	Including code . . . . .	15
5.5	Formatting Text . . . . .	17
5.6	Including bulleted list . . . . .	17
5.7	Including Figures . . . . .	18
5.8	Including Tables . . . . .	18
<b>A</b>	<b>Setup Instructions</b>	<b>21</b>
A.1	Building ParaView and ParaUnity . . . . .	21
A.1.1	Prerequisites . . . . .	21
A.1.2	Obtain the source code . . . . .	22
A.1.3	Compile Qt . . . . .	22
A.1.4	Compile ParaView . . . . .	22
A.1.5	Compile ParaUnity . . . . .	23
A.1.6	Loading the plug-in in ParaView . . . . .	24
A.2	Building the Unity Application . . . . .	24
A.2.1	Prerequisites . . . . .	24
A.2.2	Obtain the source code . . . . .	24
A.2.3	Compile the application . . . . .	24

---

A.2.4	Exporting an object from ParaView to Unity . . . . .	25
<b>B</b>	<b>Code of the Unity Application</b>	<b>26</b>
B.1	AnimationManager . . . . .	26
	<b>Bibliography</b>	<b>27</b>



# List of Figures

5.1	Living room as I imagine it . . . . .	19
-----	---------------------------------------	----

# List of Tables

5.1	Max and min temps recorded in the first two weeks of July . . . . .	19
5.2	ParaView-VTK Architecture (simplified) . . . . .	20

# Abbreviations

<b>CFD</b>	<b>C</b> omputational <b>F</b> luid <b>D</b> ynamics
<b>VR</b>	<b>V</b> irtual <b>R</b> eality
<b>AIRC</b>	<b>A</b> erospace <b>I</b> ntegration <b>R</b> esearch <b>C</b> entre
<b>SATM</b>	<b>S</b> chool of <b>A</b> erospace, <b>T</b> echnology and <b>M</b> anufacturing
<b>HMD</b>	<b>H</b> ead <b>M</b> ounted <b>D</b> isplay
<b>API</b>	<b>A</b> pplication <b>P</b> rogramming <b>I</b> nterface
<b>OS</b>	<b>O</b> perating <b>S</b> ystem
<b>VRTK</b>	<b>V</b> irtual <b>R</b> eality <b>T</b> ool <b>K</b> it
<b>GUI</b>	<b>G</b> raphical <b>U</b> ser <b>I</b> nterface
<b>OOP</b>	<b>O</b> bject <b>O</b> riented <b>P</b> rogramming
<b>OOD</b>	<b>O</b> bject <b>O</b> riented <b>D</b> esign
<b>UI</b>	<b>U</b> ser <b>I</b> nterface
<b>TCP</b>	<b>T</b> ransfer <b>C</b> ommunication <b>P</b> rotocol
<b>RAM</b>	<b>R</b> andom <b>A</b> ccess <b>M</b> emory
<b>XML</b>	<b>E</b> xtensible <b>M</b> arkup <b>L</b> anguage
<b>UML</b>	<b>U</b> nified <b>M</b> odeling <b>L</b> anguage

# Chapter 1

## Introduction

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis ut congue orci. Cras blandit erat nulla, quis ultrices augue porta a. Ut non ante vel nunc feugiat consequat vel ac ex. Praesent mattis odio et magna laoreet scelerisque. Sed tempus vel ante et volutpat. Nulla pharetra ante nisi, ac tempus sem malesuada non. Integer quis facilisis tellus.

Vivamus et tortor sit amet diam tristique tincidunt quis et sapien. Praesent nec bibendum est. Aenean maximus consectetur elit, et euismod neque aliquet non. Vestibulum ac malesuada magna. Etiam aliquet nec ante ac vulputate. Nullam ut dui tempus, sollicitudin enim in, vestibulum dolor. Sed aliquam elementum nisl rhoncus rutrum. Vestibulum eget arcu non ipsum consequat bibendum non sit amet ligula.

Sed vel auctor urna, vitae consequat ligula. Morbi vel porttitor turpis. Cras ac arcu nulla. Fusce nec posuere nunc. Maecenas et lacus vel sem rhoncus facilisis. Donec vestibulum lorem sit amet tortor finibus dapibus. Duis convallis nisl ac molestie aliquet. Sed ut magna nec lacus pellentesque malesuada. Mauris lacinia vulputate finibus. Aenean est orci, auctor non consequat id, tempor ut ex. Nulla pretium lectus vulputate, rutrum diam non, placerat justo. Aenean mi sapien, viverra sed accumsan at, vehicula aliquam est. Morbi convallis dictum ante in lobortis.

Ut sed dolor orci. Morbi congue elementum suscipit. Proin tempus turpis nec odio euismod fermentum. Praesent ornare dui quis egestas porta. Donec at consectetur orci. Proin ornare convallis libero et feugiat. Quisque sed fringilla justo. Etiam tempus nibh lectus, ut imperdiet ex ultrices tincidunt. Mauris lobortis nulla tortor, non aliquet urna suscipit a. Maecenas non lobortis augue, pulvinar ornare mi. Maecenas euismod nunc lacus, eu ultricies magna rhoncus ut. Donec sit amet sem pretium libero efficitur molestie.

Pellentesque eleifend justo aliquet diam condimentum, accumsan varius lorem pharetra. Nam eu nunc convallis, sodales nisi a, finibus est. Nullam dapibus non tortor eu dapibus. In ut lorem ultrices, blandit dui in, bibendum purus. Aenean finibus non nisl nec maximus. Morbi aliquam tellus eget turpis ultrices, sit amet volutpat felis posuere. Cras a sollicitudin quam. Sed faucibus, ante suscipit iaculis lacinia, metus nisl blandit diam, et egestas nulla lectus sed sapien. Morbi in ex quis leo commodo convallis. Vestibulum diam sapien, finibus a massa sed, gravida fringilla ligula. Curabitur congue odio ut eros suscipit pellentesque. Etiam ut rutrum ipsum. Mauris nunc enim, porttitor at commodo nec, auctor id libero. Maecenas gravida pellentesque felis, ac luctus purus mollis in. Quisque porttitor ultrices nunc id pellentesque.

Suspendisse enim libero, lobortis vitae turpis sed, lacinia dignissim odio. Fusce ultrices scelerisque turpis et lobortis. Integer sapien mauris, luctus sed blandit eget, rutrum vitae dui. Suspendisse imperdiet ornare nibh eget imperdiet. Suspendisse potenti. Donec a elit arcu. Maecenas ac nisi et eros elementum luctus. Donec tempor, nisi ut sagittis laoreet, lorem massa pharetra nulla, vitae consectetur dolor sapien ut lacus. Maecenas a ligula metus. Praesent at augue sem. Quisque faucibus velit vitae tincidunt tempor. Curabitur urna neque, mollis sit amet mi ac, hendrerit tempor ex.

Curabitur in turpis congue, facilisis ligula at, lacinia lectus. Nunc viverra ex sit amet sollicitudin tincidunt. Ut congue iaculis leo, cursus mattis augue elementum sed. Cras varius tortor sed gravida pellentesque. Cras vitae arcu condimentum, feugiat velit a, sagittis ipsum. Donec consequat lobortis lectus et vestibulum. Mauris

pharetra tincidunt justo, porta vestibulum arcu mollis id. Nunc euismod lectus nec urna mollis maximus. Nullam ut tortor in nibh luctus feugiat vel sed elit.

Proin tincidunt varius orci. Nunc finibus diam vitae erat suscipit, et vulputate nulla pulvinar. Praesent orci neque, dignissim a fermentum eu, ultricies non ante. Donec ultricies nunc volutpat, sollicitudin sapien sed, imperdiet libero. Mauris finibus, diam quis consectetur ultricies, orci odio dapibus massa, id tristique lectus felis sit amet leo. Sed in tortor pellentesque, laoreet nisi id, imperdiet leo. Sed vehicula dolor at mollis laoreet. Aliquam quis lectus fringilla, ornare turpis vestibulum, faucibus orci. Pellentesque metus velit, iaculis non consequat sit amet, laoreet sit amet est. Suspendisse fringilla viverra risus, ut bibendum mauris dignissim id.

## 1.1 Objectives

Being a rather open-ended project, i.e. a project in which there is no strict and well-defined set of software requirement specifications, the objectives of the development have been purposefully kept wide and general, as to reflect the idea that the project could follow an exploratory approach.

Nonetheless, there are still some guidelines that have been followed from the beginning to the end of the project:

- The project shall result in a working prototype of a Virtual Reality application.
- The application shall allow the handling of CFD data; in particular, it shall provide:
  - visualization of the data,
  - interaction with the data,
  - some basic forms of manipulation of the data.
- The application shall allow the import of data from ParaView.

- The application shall run compatibly at least on Windows (version 7 or greater), and optionally on Linux.
- The application shall support a HTC Vive kit.
- The code should be designed to be maintainable, flexible and expandable.
- The application should be easy to use, being it aimed at CFD scientists with little to no prior VR experience.

In Section 1.2 these objectives will be discussed in light of the work done.

## 1.2 Project Management

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 1.2.1 Time management

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 1.2.2 Versioning and productivity tools

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 1.2.2.1 Github

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 1.2.2.2 Waffle

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.



# Chapter 2

## Materials and Methods

### 2.1 Literature Review

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 2.2 Technologies Used

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer

nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 2.2.1 ParaView and VTK

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 2.2.1.1 Virtual Reality Capabilities in ParaView

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 2.2.2 Unity

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer

nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

#### 2.2.2.1 Object behaviors in Unity

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

#### 2.2.2.2 Virtual Reality Capabilities in Unity

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

#### 2.2.3 ParaUnity

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

# Chapter 3

## Results

### 3.1 Introduction

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

#### 3.1.1 Why Unity?

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 3.2 Application Architecture

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 3.2.1 Environment

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

# Chapter 4

## Conclusions

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 4.1 Final system architecture

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 4.2 Objectives achieved

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 4.3 Future work

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

# Chapter 5

## How to Do

This is all I know on LaTeX up to now.

### 5.1 Including Sections and Subsections

This is my first section.

#### 5.1.1 I like myself

I'm nice.

#### 5.1.2 but I'm weird

but fun.

##### 5.1.2.1 LOST OF FUN!

Writing writing and writing.



### 5.1.2.2 I'm calm and shit

I write stuff in subsubsections.

**And lastly this is new and amazing PARAGRAPH:** You can write whatever you want and it's pretty cool and new. I still like subsubsections more.

## 5.2 Including references and citations

This is pretty simple to cite: developed as open-source C++ software by Rudolf Biczok [23]. We'll learn more about this as we go.

### 5.2.1 Referencing images and tables!

So you can see figure 5.1 at page ??. AMAZING  
OR you can also see the table 5.1 at page 19!

### 5.2.2 Referencing chapters and subchapters

You can also ref chapters, as Chapter Results 3.

### 5.2.3 Using footnotes

Let's try this out.<sup>1</sup> And another one to see if it is progressive and shit.<sup>2</sup>

I'll try now to "place them manually". This is were the sign is.<sup>3</sup>

Somewhere else in the text. I insert what it contains.

---

<sup>1</sup>This is my first footnote.

<sup>2</sup>CAREFUL! Don't leave any spaces before the command or they will be rendered.

<sup>3</sup>This is my footnote!

## 5.3 Including quotes

This is how a quote looks.

From an evolutionary perspective, virtual reality is seen as a way to overcome limitations of standard human-computer interfaces; from a revolutionary perspective, virtual reality technology opens the door to new types of applications that exploit the possibilities offered by presence simulation.

And also in text quotes: “[by] immersing the user in the solution, virtual reality reveals the spatially complex structures in computational science in a way that makes them easy to understand and study”.

And dots...

## 5.4 Including code

The following code is written by Lorenzo:

```
=IF(
  OR(
    E68 = "Russia";
    E68 = "Albania";
    E68 = "Bulgaria";
    E68 = "Ungheria";
    E68 = "Ucraina";
    E68 = "Moldavia";
    E68 = "Romania"
  );
  "Europa dell'Est";
  IF(
    OR(
      E68 = "Burkina Faso";
      E68 = "Etiopia";
      E68 = "Costa d'Avorio";
      E68 = "Congo";
      E68 = "Guinea Bissau";
      E68 = "Africa";
      E68 = "Ghana";
      E68 = "Benin"
    );
    "Africa";
    IF(
      OR(
        E68 = "Colombia";
        E68 = "Brasile";
        E68 = "Guatemala";
        E68 = "Peru";
        E68 = "Costa Rica"
      );
      "America del Sud";
      IF(
        OR(
          E68 = "Armenia";
          E68 = "India";
          E68 = "Cina";
          E68 = "Vietnam";
          E68 = "Sri Lanka";
          E68 = "Siberia";
          E68 = "Nepal";
          E68 = "Filippine"
        );
        "Asia";
        ""
      )
    )
  )
)
```

## 5.5 Formatting Text

This is **BOLD** *This is ITALIC* This is SANS SERIF This is TRUE TYPE

In this sentence THIS IS TINY. THIS WHOLE SENCE IS TINY.

I go back to normal.

Then I can go for large, or Large, or Larger, or Huge and even HUGE.

## 5.6 Including bulleted list

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nam quam tellus, venenatis a consectetur non, pretium ac nunc. Nullam eu tellus sed augue laoreet scelerisque.

- The first item of your list
- The second item of your list
- The third item of your list

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nam quam tellus, venenatis a consectetur non, pretium ac nunc. Nullam eu tellus sed augue laoreet scelerisque. Curabitur efficitur, dolor ut pretium fermentum, nisi enim pulvinar nunc, non bibendum urna odio nec neque. Cras tellus turpis, posuere in dictum vitae, vestibulum quis velit.

1. The first item of your list
2. The second item of your list
3. The third item of your list

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nam quam tellus, venenatis a consectetur non, pretium ac nunc. Nullam eu tellus sed augue laoreet scelerisque. Curabitur efficitur, dolor ut pretium fermentum, nisi enim pulvinar nunc, non bibendum urna odio nec neque. Cras tellus turpis, posuere in dictum vitae, vestibulum quis velit.

- a) The first item of your list
- b) The second item of your list
- c) The third item of your list

## 5.7 Including Figures

Orci varius natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Nam vulputate finibus malesuada. Praesent at egestas turpis. Vivamus vitae tellus malesuada, laoreet ex ac, venenatis est. Aliquam dictum tincidunt libero, cursus posuere arcu sodales non. In sed metus sit amet arcu vestibulum mollis ut vel nibh. Nam non velit tortor. Integer ac sapien a purus porta convallis. In vestibulum aliquam nunc vitae faucibus. Etiam tristique iaculis orci, vel aliquam felis accumsan et. Nulla ultricies, nisl eu malesuada lobortis, ante metus faucibus libero, vitae blandit odio enim sit amet tortor.

## 5.8 Including Tables

Orci varius natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Nam vulputate finibus malesuada. Praesent at egestas turpis. Vivamus vitae tellus malesuada, laoreet ex ac, venenatis est. Aliquam dictum tincidunt libero, cursus posuere arcu sodales non. In sed metus sit amet arcu vestibulum mollis ut vel nibh. Nam non velit tortor. Integer ac sapien a purus porta convallis. In vestibulum aliquam nunc vitae faucibus. Etiam tristique iaculis orci, vel aliquam



FIGURE 5.1: Living room as I imagine it

*Source: Photo courtesy of HTC*

felis accumsan et. Nulla ultricies, nisl eu malesuada lobortis, ante metus faucibus libero, vitae blandit odio enim sit amet tortor.

Day	Max Temp	Min Temp
Mon	20	13
Tue	22	14
Wed	23	12
Thurs	25	13
Fri	18	7
Sat	15	13
Sun	20	13

(A) First Week

Day	Max Temp	Min Temp
Mon	17	11
Tue	16	10
Wed	14	8
Thurs	12	5
Fri	15	7
Sat	16	12
Sun	15	9

(B) Second Week

TABLE 5.1: Max and min temps recorded in the first two weeks of July

ParaView			
VTK			
OpenGL	MPI	OpenVR	Etc.

TABLE 5.2: ParaView-VTK Architecture (simplified)

# Appendix A

## Setup Instructions

This appendix provides the instructions to setup, install and run the software system described in this thesis. They refer to a machine with VR-ready hardware running Windows 10.

### A.1 Building ParaView and ParaUnity

This section provides the instructions for building a working copy of ParaView with the ParaUnity plug-in. It is a simplified and adapted version of the *readme* file of the official ParaUnity repository [23].

#### A.1.1 Prerequisites

- CMake 3.8.1
- Visual Studio 2015 x64 Community Edition



### A.1.2 Obtain the source code

To obtain a patched, pre-prepared version of the source code for Qt, ParaView and ParaUnity, clone the repository available at <https://github.com/vrcranfield/paraviewunity>. Unless specified otherwise, all the following instructions refer to the files contained in this repository.

### A.1.3 Compile Qt

The files in Qt4.8.6 are a patched version of Qt that allows compilation with Visual Studio 2015 x64.

In order to build it do the following:

1. Move the content of Qt4.8.6 in C:\Qt\4.8.6
2. Open the VS2015 x64 Native Tools Command Prompt from Start.
3. `cd C:\Qt\4.8.6`
4. `./configure.exe -make nmake -platform win32-msvc2015 -prefix C:\Qt\4.8.6 -opensource -confirm-license -nomake examples -nomake tests -nomake demos -debug-and-release`
5. `nmake`
6. `nmake install`
7. Add C:\Qt\4.8.6\bin to the Path environment variable.

### A.1.4 Compile ParaView

The files in ParaView-v.5.2.0 consist in the official source code of ParaView.

In order to build it do the following:

1. Open CMake and set source in `ParaView-v5.2.0` and build in `ParaView-v5.2.0\build`
2. Configure with “Visual Studio 14 2015 Win64” as a generator.
3. Check that `PARAVIEW_QT_VERSION` is 4 and that `QT_QMAKE_EXECUTABLE` points to `C:\Qt\4.8.6\bin\qmake.exe`. If necessary, configure again.
4. Generate.
5. Open with VS2015.
6. Build solution.

### A.1.5 Compile ParaUnity

The files in `ParaUnity` are the developed and improved version of the official `ParaUnity` plugin, as described in Chapter ??.

In order to build `ParaUnity` do the following:

1. Open a terminal in `\ParaUnity\Unity3DPlugin`
2. `mkdir build`
3. `cd build`
4. `cmake -G "Visual Studio 14 2015 Win64" -DParaView_DIR="<PARAVIEW_DIR>\build" ..`
5. Open `\ParaUnity\Unity3DPlugin\build\Project.sln` in Visual Studio
6. Right click on the project `Unity3D`, go to `C/C++ > Additional Include Directories` and add `\verC:\Qt\4.8.6\include\QtNetwork`
7. Build.
8. You now have some files (most importantly a `Unity3D.dll` file) in `\build\Debug`. Remember their location.

### A.1.6 Loading the plug-in in ParaView

To load the plug-in in ParaView, do the following:

1. Open ParaView 5.2.0 (from `paraview.exe` in the `\build\bin\Debug` folder, or from Visual Studio).
2. Go to `Tools > Manage Plugins`, click `Load New` and locate `Unity3D.dll`
3. Open the dropdown entry from `Unity3D` and select `Auto Load`.

## A.2 Building the Unity Application

This section provides the instruction for obtaining and building a working copy of the Unity Application described in Chapter ??.

### A.2.1 Prerequisites

- Unity 5.6.1f1

### A.2.2 Obtain the source code

To obtain the source code of the Unity Application, clone the repository available at <https://github.com/vrcranfield/UnityApplication>. Unless specified otherwise, all the following instructions refer to the files contained in this repository.

### A.2.3 Compile the application

In order to build the Unity Application do the following:

1. Open the root directory of the project in the Unity editor.

2. File > Build Settings
3. Uncheck all scenes apart from the Main scene.
4. Set Target Platform as Windows and Architecture as x86\_64.
5. Click build.
6. Choose the same location as the Unity3D.dll (see previous section).
7. Save the file as `unity_player.exe`

#### A.2.4 Exporting an object from ParaView to Unity

To test if the system is working correctly, do the following:

1. Load any file in ParaView (e.g. a simple sphere)
2. Click the button with the Unity logo and the P
3. You should see your Unity scene with the ParaView object in the middle.

# Appendix B

## Code of the Unity Application

In this section the code of the scripts of the Unity Application is provided. The appendix is divided in sections, each containing the source code of one class, in alphabetical order.

### B.1 AnimationManager

Stuff maybe goes here?

# Bibliography

- [1] Gobbetti E, Scateni R. *Virtual reality: Past, present and future*. Virtual Environments in Clinical Psychology and Neuroscience, pp. 3-20. Amsterdam: IOS; November 1998.
- [2] Anderson JD, Degroote J, Degrez G, Dick E, Grundmann R, Vierendeels J. *Computational Fluid Dynamics: An Introduction*. Heidelberg: Berlin; 2009.
- [3] Bryson S. *Virtual reality in scientific visualization*. Communications of the ACM, Vol. 39, No. 5, pp. 62–71. May 1996.
- [4] Bouvier P, Sorbier F, Chaudeyrac P, Biri V. *Cross benefits between virtual reality and games*. International Conference on Computer Games, Multimedia and Allied Technology (CGAT'08) 2008.
- [5] Rolfe JM, Staple KJ. *Flight Simulation*. p. 154. Cambridge: Cambridge University Press; 1985.
- [6] Greenfield RP. *Navy VR Flight Simulator*. Virtual Reality Special Report, Vol. 1, No. 3, pp. 61–64. Fall 1994.
- [7] Moshell M. *Virtual Environments in the U.S. Military*. Computer, Vol. 26, pp. 81-82. February 1993.
- [8] Zajtchuk R, Satava RM. *Medical applications of virtual reality*. Communications of the ACM, Vol. 40, No. 9, pp. 63-64. September 1997.
- [9] Yagel R, Stredney D, Wiet GJ, Schmalbrock P, Rosenberg L, Sessanna DJ, Kurzion Y, King S. *Multisensory platform for surgical simulation*. IEEE Virtual

- Reality Annual International Symposium 1996 (VRAIS'96), pp. 72–78. March 1996.
- [10] Rosen JM, Laub D. *Virtual reality and medicine: From training systems to performing machines*. Proceedings of the IEEE 1996 Virtual Reality Annual International Symposium, pp. 5-13. 1996.
- [11] Abulrub AG, Attrige AN, Williams MA. *Virtual Reality in Engineering Education*. Proceedings of IEEE Global Engineering Education Conference (EDUCON), p. 751-777. 2011.
- [12] Hosokawa M, Fukuda T, Yabuki N, Michikawa T, Motamedi A. *Integrating CFD and VR for indoor thermal environment design feedback*. CAADRIA 2016, 21st International Conference on Computer-Aided Architectural Design Research in Asia - Living Systems and Micro-Utopias: Towards Continuous Designing. 2016.
- [13] Fukuda T, Mori K, Imaizumi J. *Integration of CFD, VR, AR and BIM for Design Feedback in a Design Process An Experimental Study*. Real Time - Proceedings of the 33rd eCAADe Conference, Vienna, 2015. The 33rd eCAADe Conference, At Vienna University of Technology, Vienna, Austria, Volume: Volume 1, pp. 665-672. 2015.
- [14] Su S, Chaudhary A, O'Leary P, Geveci B, Sherman W, Nieto H, Francisco-Revilla L. *Virtual reality enabled scientific visualization workflow*. IEEE 1st Workshop on Everyday Virtual Reality (WEVR), pp. 29–32. March 2015.
- [15] *HTC Vive Website*. Available at: <https://www.vive.com/uk/> [accessed 09 August 2017].
- [16] D'Orazion D, Savov V *Valve's VR headset is called the Vive and it's made by HTC*. The Verge; March 2015. Available at: <https://www.theverge.com/2015/3/1/8127445/htc-vive-valve-vr-headset> [accessed 09 August 2017].
- [17] *OpenVR official GitHub repository*. Available at: <https://github.com/ValveSoftware/openvr> [accessed 09 August 2017].

- 
- [18] *ParaView Website*. Available at: <http://www.paraview.org/> [accessed 9 April 2017].
  - [19] Shetty N, Chaudhary A, Coming D, Sherman W, O’Leary P, Whiting E, Su S. *Immersive ParaView: A community-based, immersive, universal scientific visualization application*. IEEE Virtual Reality Conference, pp. 239–240. March 2011.
  - [20] *Immersive ParaView page on ParaView official Wiki*. Available at: [http://www.paraview.org/Wiki/Immersive\\_ParaView](http://www.paraview.org/Wiki/Immersive_ParaView) [accessed 11 April 2017].
  - [21] *Official ParaView Tutorial*. Available at: [http://www.paraview.org/Wiki/The\\_ParaView\\_Tutorial](http://www.paraview.org/Wiki/The_ParaView_Tutorial) [accessed 05 August 2017].
  - [22] *Visualization Toolkit Website*. Available at: <http://www.vtk.org> [accessed 05 August 2017].
  - [23] *ParaUnity official GitHub repository*. Available at: <https://github.com/RCBiczok> [accessed 09 August 2017].
  - [24] Sutherland IE. *The ultimate display*. Proceedings of IFIPS Congress, Vol. 2, pp. 506–508. New York City, NY; May 1965.
  - [25] Oloruntoba S. *S.O.L.I.D: The First 5 Principles of Object Oriented Design*. Scotch; 2016. Available at: <https://scotch.io/bar-talk/s-o-l-i-d-the-first-five-principles-of-object-oriented-design> [accessed 10 August 2017].
  - [26] Jacobs A. *The Pathologies of Big Data*. ACM Queue, Vol. 7, No. 6, pp. 21–32. July 2009.
  - [27] *Microsoft Developer Network’s page about named shared memory*. Available at: [https://msdn.microsoft.com/en-us/library/windows/desktop/aa366878\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/windows/desktop/aa366878(v=vs.85).aspx) [accessed 12 August 2017]