

# Appendix - second year internship

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## 1 Context

The summer holidays provided me with the opportunity to do work experience. I looked for an internship which would combine the fields of mathematics and healthcare. I have kept this idea in mind since the end of college, I remember having hesitate a lot between medicine and mathematics. I have finally chose mathematics not without regrets, although I was really interested by scientific questions. When I entered into engineering school I realized that it is possible to kill two birds with one stone by using my technical skills in the healthcare sector. Since I'm specialized in imaging, I decided to do my internship within the TIMC-IMAG Laboratory (Techniques for biomedical engineering and complexity management – informatics, mathematics and applications – Grenoble ).

The TIMC-IMAG is a collaboration of scientists and clinicians using computer science and applied mathematics with the aim of understanding and controlling normal and pathological processes in biology and healthcare. I worked in the GMCAO team (Biomechanical modeling, image processing, data fusion and robotics for computer-assisted medical interventions) and more specifically in the field of image processing. I was supervised by Laurent Desbats, researcher in medical imaging. He works on a project with the company “Surgivisio”, which is focused on research and development of advanced solutions for surgeons, using 3D imaging and surgical navigation technologies. It empowers the surgeons with innovative and efficient tools, reducing surgical time, reducing x-ray exposure, and increasing safety and accuracy of complex interventions.

## 2 Problem

I was interested by the reconstruction part of this project, and in particular the point was to reduce the x-ray exposure by decreasing the trajectory of the scanner around the patient. But this point implies a lot of modifications in the classical reconstruction way. To start with, I had to understand principles of tomography and the mathematic theory which hides behind them. I spent a lot of time learning different ways of reconstruction. There are two schools of thought : reconstruction by analytical methods and by algebraic methods. I considered both, but since another student developed algorithms based on algebraic methods, I decided then to focus mine on analytical methods.

I read several research papers relating the state of the art of medical imaging research in the last few years. We decided to develop a Matlab program which implements reconstruction of a specific region (called region of interest) when the scanner moves on a short trajectory. I made the effort to produce a Matlab program which could be a teaching aid. Indeed it enables us to choose a mode which correspond to a particular step in the tomography process. In fact, I'm glad to know that Laurent Desbats will use what I produce to illustrate his course.

## 3 Personal record

What I found difficult is to work alone on a problem, because my supervisor was absent more than a half of my internship. I was compelled to understand the state of the art without any help. I often had the impression of losing much precious time on some points which would had been solved in few minutes if someone could explain it to me. Anyway, I walked in researcher's shoes! Now I know what to expect, and actually, I liked taking up a challenge and having the feeling of advancing science. However I was a little bit disappointed about the team work, I imagined the collaboration between researchers as being closer, whilst in fact they used to work most of time independently. I thought clinicians and engineers would work together intensively, whereas they meet seldom, in order to explain what they would need and to plan future improvements. From these specifications, engineers don't really work on medical points anymore but focus themselves on technical points. Having said that, what I appreciated is that a majority of projects realize very useful tools for people health care in a couple of years. I couldn't work on such abstract and theoretical problems with no application. The advantage of the TIMC laboratory is that members work with companies, that's why there is a real dynamism in the work flow. I gained valuable in-

sights into the corporate world and I discovered all the business problems its implications : the economic dimension takes a very big part in a corporate development plan, too much to my mind. First we have to find funds before we can launch a project, and this administrative task is generally tedious, to say the least. I also observe the competition between companies and the question of confidentiality : patents must be taken very seriously. I didn't realize all of that during my university studies. I would prefer gathering people in the name of the scientific advance, rather than the benefit, but it's another question...

## 4 Working atmosphere

To go back to the TIMC laboratory, I appreciated working within a team whose members come from a variety of backgrounds. That point was very interesting, and I liked being plunged in the mix of mathematics, informatics, robotics and medicine. Moreover there was a very pleasant working atmosphere. Every morning researchers and engineers got together to discuss over a cup of coffee. They are really amiable, for instance they asked me from the beginning to use the familiar form, and in spite of having tried, I didn't succeed in doing this. The PhD students gave me a lot of precious advice concerning as well courses I should choose or the choice of a thesis. I measured too the difficulty of obtaining finances to be able to prepare a thesis. Since I am very conscientious (certainly too much) when it is about my professional project, I will follow their advice carefully. For that reason I have visited as recently as today the CEA laboratory with the aim of finding an internship and why not after a thesis. I find great too what they call "GT" (for "Get Together" ) which consists of bringing together all researchers and students. During this meeting they present what they are working on, and sometimes the questions raised help them to improve their way of solving their problem. I really enjoyed these regular brainstorming!

I assume that this good atmosphere results from the management style, which is flexible, in particular concerning working hours. The hierarchy isn't remarkable, if nobody had told me that Jocelyne Troccaz is the team leader I would never have guessed.

To conclude, I have spent all the summer working on an interesting project in pretty good conditions. I keep in touch with these researchers and from now I'm looking for my future internship which, I hope, will go as well as the last one.