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Development of a D-SPECT myocardial perfusion phantom

Gijs de Vries, s1854526

Revision 0.1

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Preface

The project plan outlines an introduction and literature of the topic along with organisational information including a detailed planning.

Gijs de Vries
Enschede, 3$^{\text{rd}}$ December 2018

Contents

1 Introduction

[done] Read into background information on D-SPECT

[done] Write global background information

[inpr] Introduce the rest of the document

There are various types of scanners that use different techniques. Examples are Computed Tomography (CT), Magnetic Resonance Imaging (MRI), or Scintigraphy (SPECT/PET) scanners. In cardiology, the SPECT scanner is widely employed for coronary and myocardial perfusion measurements (Rahmim and Zaidi, 2008). It is known that PET scans are generally more expensive (Hlatky et al., 2014; Goel et al., 2014). Hlatky et al. (2014) followed patients for two years, recording the costs and concluded that PET costs are 22% higher than the costs for SPECT for patients with suspected Coronary Artery Disease (CAD).

The imaging method in a typical SPECT scanner are scintillator-based gamma cameras, also known as Anger cameras. Gamma cameras use a scintillator to "transduce" gamma radiation, originating from an injected tracer, to photons. Part of these photons are directed towards a series of dynodes in Photomultiplier Tubes(PMTs), directly behind the scintillator, via a focusing electrode. Electrons that hit a dynode trigger the process of secondary emission (photoelectric effect), multiplying the number of electrons travelling through the tube. Electrons hitting the last dynode, also known as the anode, cause a current pulse which can be detected by measuring equipment. It is proportional to the amount of gamma ray photons entering the scintillator(GE Healthcare, 2009).

Developments in imaging systems gave rise to the Digital SPECT scanner. In contrast to the analogue Anger cameras, the D-SPECT scanner utilises a direct conversion semiconductor: Cadmium Zinc Telluride (CZT). Wagenaar (2004) used CZT to develop pixelated detector units which can be used for medical imaging. In a recent study, it is shown that a Digital SPECT scanner, using multiple pixelated CZT detectors, showed significant improvements in image sharpness and contrast(Goshen et al., 2018). These detector units do not require PMTs and thus allow for a more compact and flexible design (Erlandsson et al., 2009). The D-SPECT scanner, developed by Spectrum Dynamics[1], offers improvements in sensitivity and energy resolution (Spectrum Dynamics, 2016) over Anger camera systems. However, these digital systems are relatively new and require proper validation to convince medical personnel of its value.

1.1 Document overview

The project plan consists of a (short) literature review of existing myocardial perfusion phantoms and more extensive information on D-SPECT scanners (their technical background, limitations, and so forth). The literature is followed by the research methodology containing the research questions and goals of the project. The detailed planning is the last section of the project plan.

[1] https://www.spectrum-dynamics.com/

2 Literature

[todo] Read available literature

[todo] Write literature review to more accurately define research questions

[todo] Read available literature over D-SPECT (for requirements)

3 Research methodology

[todo] Define research questions

4 Planning

[inpr] Create graphical planning

[inpr] Create workday overview

[todo] Create week overview

[todo] Define deadlines

[todo] Define meetings: frequency, type, and already planned

The final thesis is a 40ECTS assignment. Each ECTS corresponds to approximately 28 hours of work.

4.1 Work weeks

- Discuss work days between christmas and new-year
- Discuss work days on holidays

The works weeks can be found in table A.1 in appendix A.

The project planning spans 35 weeks. Activities are planned from week 49 of 2018 up until, and including, week 28 of 2019. Week 29 will be used to finalise practical aspects, handing in material, documentation, printing and so forth. The graduation presentation (and ceremony) will take place in week 29. Weeks 30 and 31 of 2019 will can act as an extension if, and only if, approved by the assessment- and exam committee.

The planning takes into account spring break ("voorjaarsvakantie") of Gijs de Vries, taking place in week 4 of 2019.

4.2 Workdays

Day	Start time	End time	Productive hours
Monday	08:30	16:00	7
Tuesday	08:30	17:00	8
Wednesday	08:30	16:00	7
Thursday	08:30	17:00	8
Friday	08:30	17:00	8
Miscellaneous*			2
Total:			40

** Miscellaneous hours are in evenings, weekends or during train rides.*

Table 4.1: Workdays and -hours

4.3 off-days

Holiday	Date	Working	Note
Monday	08:30	16:00	7
Tuesday	08:30	17:00	8
Wednesday	08:30	16:00	7
Thursday	08:30	17:00	8
Friday	08:30	17:00	8
Miscellaneous*			2
Total:			40

** Miscellaneous hours are in evenings, weekends or during train rides.*

Table 4.2: Off-days

A Appendix 1: Work weeks

Week	Monday	Working	Note
49	2018 December 3	Yes	
50	2018 December 10	Yes	
51	2018 December 17	Yes	
52	2018 December 24	Partly	*See off-days*
1	2018 December 31	Mostly	*See off-days*
2	2019 January 7	Mostly	*CT college*
3	2019 January 14	Mostly	*PET college*
4	2019 January 21	No	*Vacation*
5	2019 January 28	Yes	
6	2019 February 4	Yes	
7	2019 February 11	Yes	
8	2019 February 18	Yes	
9	2019 February 25	Yes	
10	2019 March 4	Yes	
11	2019 March 11	Yes	
12	2019 March 18	Yes	
13	2019 March 25	Yes	
14	2019 April 1	Yes	
15	2019 April 8	Yes	
16	2019 April 15	Mostly	*See off-days*
17	2019 April 22	Mostly	*See off-days*
18	2019 April 29	Yes	
19	2019 May 6	Yes	
20	2019 May 13	Yes	
21	2019 May 20	Yes	
22	2019 May 27	Mostly	*See off-days*
23	2019 June 3	Yes	
24	2019 June 10	Mostly	*See off-days*
25	2019 June 17	Yes	
26	2019 June 24	Yes	
27	2019 July 1	Yes	
28	2019 July 8	Yes	
29	2019 July 15	Yes	
30	2019 July 22	No	*Extension when needed*
31	2019 July 29	No	*Extension when needed*

Table A.1: Work weeks

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