ANKARA YILDIRIM BEYAZIT UNIVERSITY
GRADUATION PROJECT
CENG - 401

DEEP LEARNING BASED INTER-MODALITY IMAGE REGISTRATION SUPERVISED BY INTRA-MODALITY SIMILARITY

Muratcan Yıldız 16050111036
Berkan Yıldırım 16050111025
Oğuzhan Toklu 16050111026
Gürkan Altıntaş 16050111019

Department Of Computer Engineering
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Ankara

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A Proposal Submitted to
Faculty of Engineering and Natural Sciences of
Ankara Yıldırım Beyazıt University

In Partial Fulfillment of the Computer Engineering Graduation Project,
Department of Computer Engineering

by
Muratcan Yıldız 16050111036
Berkan Yıldırım 16050111025
Oğuzhan Toklu 16050111026
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CONTENTS

1. INTRODUCTION

Non-rigid inter-modality image registration is a concept that combines the information of images with a different principle in a single environment. Today, this concept is an important topic in the medical image industry and many articles are being written on it. This technique plays a major role in the diagnosis and intervention of diseases. Because there are different details in different imaging techniques such as MR and CT. Today, traditional image registration algorithms are often used for this feature. In this project, a deep learning based image registration project is aimed instead of traditional image registration algorithms. Because in the deep learning-based application, the image can be saved efficiently without iterative optimization and parameter settings. At the end of the day, it is desired to create a project with deep learning based image registration on medical images in a 6-month period. Within the scope of the proposal prepared for this project, firstly the literature reviews and similar projects will be specified, then why it is needed, its innovative and innovative aspects will be specified. Then, technical aspects and project development environment will be mentioned.

2. SIMILAR PRODUCTS AND PROJECTS

Xiaohuan Cao and friends implemented a non-rigid inter-modality image registration problem on registration of pelvic CT and MR images to fuse the information from two modalities [1]. They trained a non-rigid inter-modality image registration network, which can directly predict the transformation field from input CT and MR images. The training of their inter-modality registration network is supervised by intra-modality similarity metric based on the available paired data, which is derived from a pre-aligned CT and MRI dataset. Xiaohuan's experimental data set was collected from 15 prostate cancer patients, each with a CT image and a MR image and to evaluate the registration performance, the prostate, bladder and rectum in both CT and MR images are manually labeled by physicians. Table 1 shows the registration performance of their proposed method and all other methods under comparison.

Table 1.Comparison of DSCs(%) and ASDs (mm) on three pelvic organs after performing non-rigid registration based on SyNand the proposed deep learning based methods, where the network was trained by using the single-modality similarity and the dual-modality similarity, respectively. Affine registration results are used as the baseline.

Metric	Organ	Affine (MI)	SyN (MI)	Single-Modality		Dual-Modality
				CT	MR	Proposed
DSC (%)	Bladder	85.7±5.3	87.4±4.9	89.8±3.6	90.3±4.0	**90.5±3.8**
	Prostate	81.9±4.7	84.3±3.5	86.1±3.3	85.9±4.1	**87.3±4.2**
	Rectum	79.4±5.1	81.8±4.7	83.6±5.0	84.2±4.3	**85.4±4.5**
ASD (mm)	Bladder	1.83±0.71	1.69±0.63	1.51±0.57	1.47±0.51	**1.23±0.43**
	Prostate	1.91±0.55	1.75±0.41	1.63±0.40	1.72±0.42	**1.58±0.36**
	Rectum	2.28±0.68	2.06±0.62	1.94±0.43	1.83±0.44	**1.44±0.40**

Chengjia Wang and friends have done an unsupervised deep inter-modality registration network that can learn the optimal affine and non-rigid transformations simultaneously [2]. Their work points to important property commonly ignored in recent deep learning based inter-modality registration algorithms which is inverse-consistency. They addressed this issue

through the proposed multi-task architecture and the new comprehensive transformation network which is named FIRE. Chengjia Wang and friends's method has comparable state-of-the-art in both 3D and 2D registration tasks. They achieved better performances than the selected base-line on registration between IR and FLAIR brain data.

Moab Arar and friends worked on an unsupervised multimodal image regis-tration technique based on image-to-image translation network [3]. Specifically, they developed a geometry preserving image-to-image translation network which allows comparing the deformed and target image using simple mono-modality metrics. The geometric preserving translation network was made possible by a novel training scheme, which alternates and combines two different flows to train the spatial transformation. They believe that geometric preserving generators can be useful for applications other than image registration.

3. JUSTIFICATION OF THE PROPOSAL

Non-rigid inter-modality image registration is an active topic in medical image analysis, as it allows for the use of the complementary multimodal information provided by different imaging protocols. The technique is of great importance in many clinical applications such as image guided intervention, disease diagnosis and treatment planning. With this project, we aim to provide a solution that is deep learning based inter-modality image registration supervised by intra-modality similarity for medical images such as CT and MR.

4. TECHNICAL ASPECTS OF THE PROJECT

In this project, the **waterfall** was determined as the management method. Because, our requirements are very well known, clear and fixed. There is no change or add-on in the future and product definition is stable and short. The targeted waterfall model scheme can be seen below ;

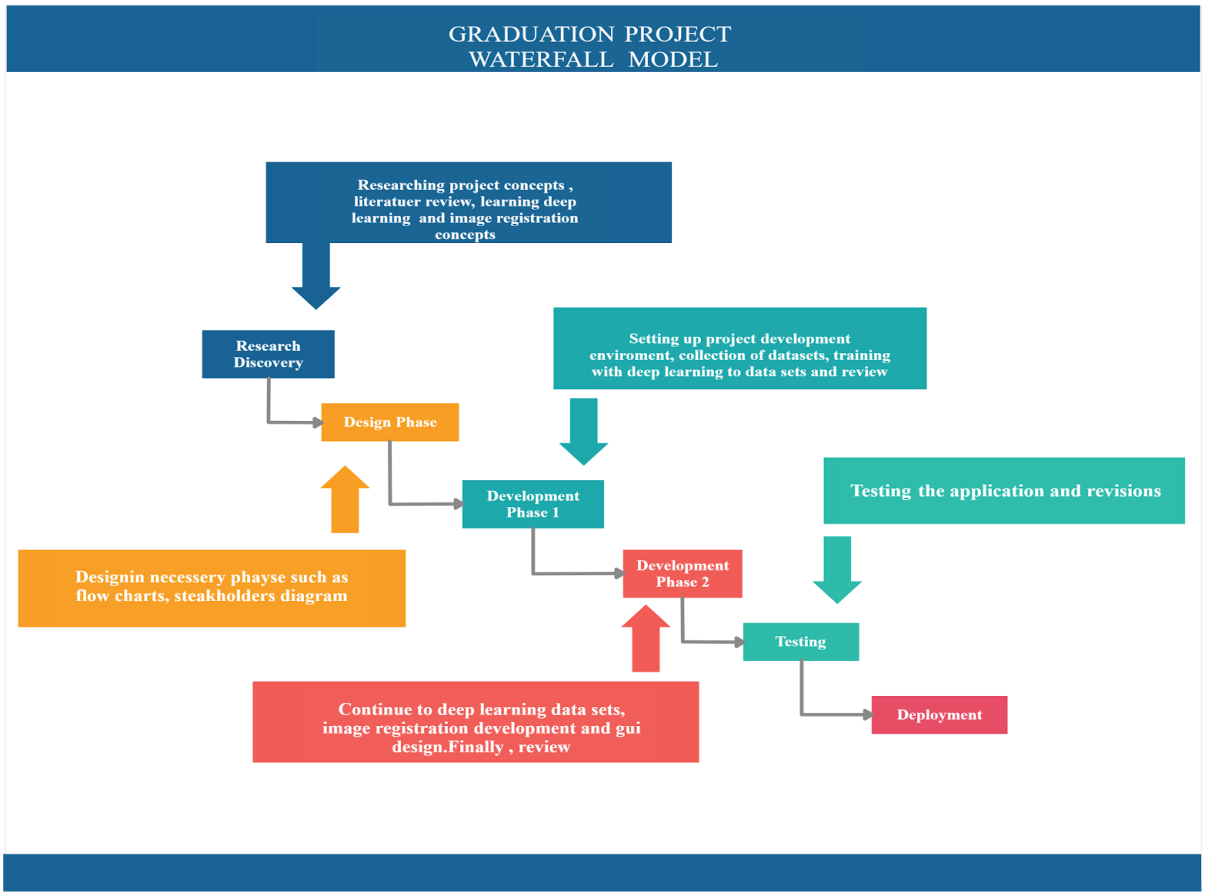

Figure 1.0

The project is aimed to be completed in 3 + 3 months. The gantt chart in figure 2.0 can be examined for the specified roadmap.

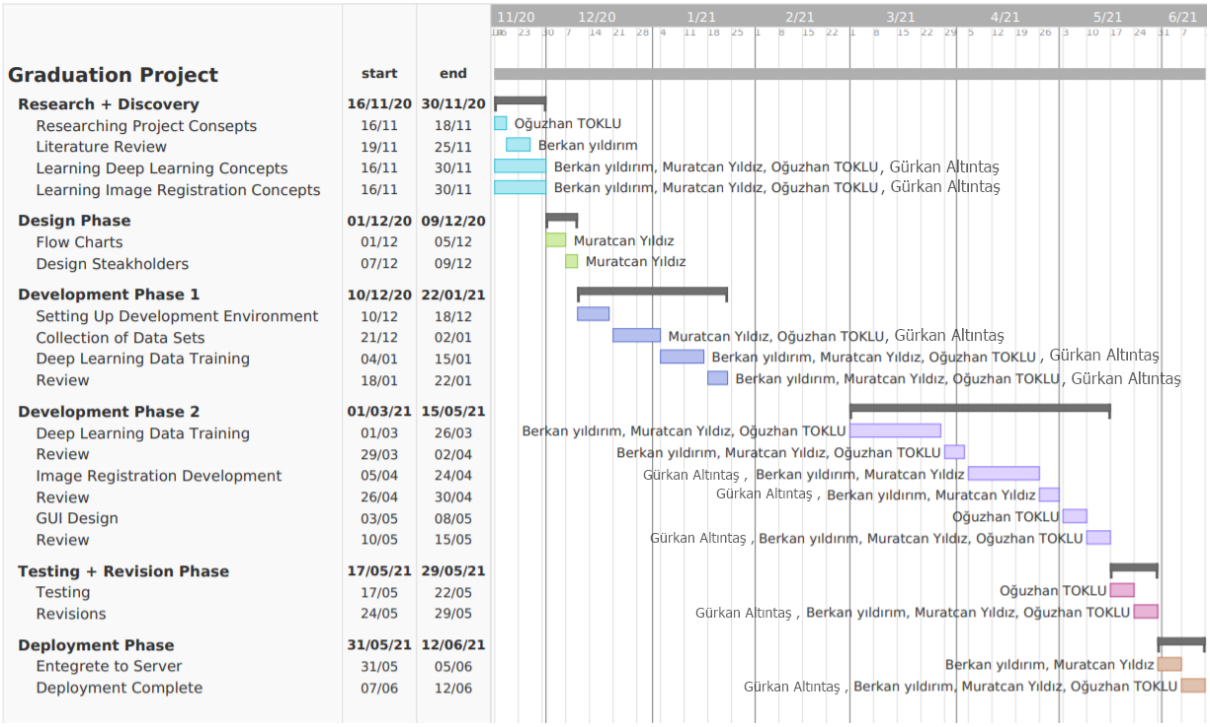

Figure 2.0

The people to take part in the project and their duties are as follows ;

- Muratcan Yıldız: Project Management, Devops Processes, System Management
- Berkan Yıldırım: Deep Learning, Image Registration Development
- Gürkan Altıntaş: Deep Learning, Image Registration Development
- Oğuzhan Toklu: Data Processing, Gui Design , Testing

5. TARGETED OUTPUT, TARGETED USER/DOMAIN PROFILE

Targeted output is an agent that should estimate medical results according to given input such as, patient's disease.

There are many domains that can use this product such as Doctors, Disease Researchers, Medical Scientists etc.

6. PROJECT DEVELOPMENT ENVIRONMENT

For that project will use **Anaconda3 Spyder IDE** because **Spyder** provides more convenience for the data processing, such as Data Visualization, Variable Tracking. **Keras**, **Tensorflow** libraries and Deep Learning modules will be used for the Image Registration. For the desktop application, **PyQt** library will be used. If the project finished ahead of time, **Spring** and **React** framework will be used for the Web Environment. Project will be processed on GitHub and the project will be managed on Redmine.

7. CONCLUSION

As a result, non-rigid inter-modality image registration is an important topic for medical image. Within the scope of the graduation project, it is aimed to implement this model with deep learning algorithms. For this, the literature, similar projects and articles were searched. Then, the main reason for the emergence of the project and its target audience were determined. After the general research, the planning of the project, the distribution of tasks, the technologies to be used, the requirements and the method were determined. At the end of the day, it is aimed to produce a highly successful software package that performs the task of deep learning based inter-modality image registration supervised by intra-modality similarity.

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