Research Statement

# Current Objectives (Summary로 교체하는 방안 or 영역의 중요성/필요성)

내 연구는 기존의 혹은 개량된 Newton’s method를 이용하여 nonlinear matrix equation의 solution을 찾는 것이다. 이 연구는, 여러 queueing model에서 stationary vector를 구하거나, generalized eigenvalue problem (like quadratic eigenvalue problem)을 쉽게 해결하는 데에 활용될 수 있다. 이렇게 지속적으로 application problem에서 활용될 수 있는 general solution에 대해 지속적으로 연구하는 것이 목표

#### 부가설명

첫 문단은 자신의 대략적인 연구 내용(research interest)에 대해 한 문장으로 요약하고 이어지는 문장에서 본인의 궁극적인 연구 목적(research objectives)을 서술합니다.

이후에 연구 주제, 경험에 대해 자세히 서술할 예정이기 때문에 연구 주제들을 자세히 적기보다는 연구 동기나 목적을 부각할 수 있도록 작성합니다.

원래 가지고 있었던 연구 목적도 좋지만 지원하는 기관과 방향이 같도록 연구 목적을 작성해도 좋을 것 같습니다. 또는 과거, 현재, 미래의 연구 주제들에 대해 요약(summary) 하는 문단을 작성해도 좋습니다.

●예시: My research interests are ~. My research is following objectives: Development of ~ for ~.

●예시: I am interested in understanding ~ by ~. In my research, under the guidance of 사람 이름, I have designed and implemented problem solving systems that demonstrate ~. I have built a program that makes ~. I have developed a cognitive theory of how people acquire ~. The next sections describe my work, and then I talk about future research directions.

●예시: My research is guided by questions: What are the sources of ~? What types of pathway ~? How do climate change ~? How can we ~?

●예시: My research interests are in three major areas: sustainable manufacturing, ~manufacturing, ~manufacturing. I have been inspired to explore them further with my background expertise in design, manufacturing and mechanics. Specific topics are summarized below:

●예시: My research goal is to create new knowledge and make a positive impact in the industry and ~. Detailed information for each aforementioned area, including the motivation, is given in the following subsections;

●예시: My research focus in ~. This work encompasses improving ~. I believe that this direction is the key to enabling new levels of performance, efficiency, and ~.

●예시: Early in my research career, I worked on ~. In my future research, I will develop new ~.

●예시: My career goal is to make ~.

●예시: My mission is to become a world leader on systems and control tools for ~.

​추가로 이러한 목적을 이루기 위해 자신이 가진 기술, 노력한 점을 간단히 서술합니다.

​●예시 문장: For these objectives, ~ has been my research principle. With the skilled ~ techniques, I explore both ~ and ~. As an ~ engineer (or scientist), I view the area of ~ that will solve the ~ problems.

●예시: To address these questions, my research utilizes ~ to characterize ~ systems.

●예시: I have carefully prepared myself to achieve the aforementioned goals in the following ways:

●예시: My leadership skills, accomplishments, expertise, and interests provide a strong foundation to achieve this goal.

# Current Research

### Iterative Method solving nonlinear matrix equations

Recently, I have been researching about an acceleration method of Newton’s method with transposition on the given matrix polynomial equation.

Up to this day, I have researched Newton’s method and variations of the method to find special solutions for nonlinear matrix equations like a quadratic matrix equation, a matrix polynomial equation, and an order-convex matrix equation. The variations are for acceleration of Newton’s method in terms of calculation time or number of iterations. On the other hand, applying transposition on the given quadratic matrix equation, the solution can be obtained faster with the fixed-point iteration method.

I have thought that this technique also can be applied for Newton’s method and a matrix polynomial equation, then I have been studying about analysis and numerical experiments with my colleagues.

### Medical Image Processing with Neural Network Models

I have been working on a project to build an algorithm searching normal pulmonary alveolus for trauma patients with lung CT data. In the trauma patient cases, pneumothorax and hemothorax in CT images does not always mean that they have lung diseases. The patients can have blood or air pocket in the thorax with damages from organs not lungs. It is very important to discern the blood or air pocket is from damages from lungs or not with only CT images.

In the institute where I worked, I participated the projects developing medical image processing algorithms with neural network models. One of the projects was developing eye disease distinguishing algorithm with fundus photographs. At that time, my role was to write the annual algorithm validation report. The other one was developing tooth numbering algorithm from mobile dental photos. In the project, I constructed two segmentation neural network models from a modified EfficientNet model and the U-net model.

From these experiences, I applied 3D filtering techniques to the volume calculation algorithm of the pneumothorax and hemothorax from damages from organs not lungs with the lung CT data. My coauthors in the hospital is comparing with the clinical data. This work is almost in the process finishing.

# Future Research

Moving forward, I plan to deal with two subjects. The first subject is to suggest various accelerated iterative method, especially Newton’s method, solving nonlinear matrix equations. A representative method to accelerate Newton’s method is giving appropriate scalar multiplication to the differences of each steps. One of methods finding the appropriate scalar is exact line searches. A disadvantage of exact line searches is that it takes too much calculation resources. On the other hand, in mathematical sense, it gives the most appropriate next step for each iteration. Moreover, for Newton’s method, there is a tendency that each difference of each step converges to a one-dimensional space from many experiments. So, I will give a proof of the tendency and show the efficiency of the method which applies only one time of exact line searches.

It is the second subject to study about deep learning models and apply them to applied problems. In the institute where I worked, almost of my missions were applying deep learning models for processing medical images. So, I have dealt with many medical images like fundus, dental, and lung CT image data. But, I had less chances to deal with other data for example language data. Especially, I want to study about language processing models for SOV(Subject-Object-Verb) or agglutinative language like Korean language. There are many advanced natural language process algorithms for English. However, English and Korean have different language structure and history. So, I hope that I understand the differences of them and construct a model which is fit to Korean.

Through previous two subjects, I will research about efficient neural network models finding solutions of various nonlinear matrix equations. Iterative methods to find solutions of nonlinear matrix equations need a lot of calculation resources. The reason that I research about acceleration techniques for iterative methods also are which save resources like electric power or time. To overcome heavy resource problems with other techniques, I consider applying efficient neural network model to finding solutions. Of course, neural network models also have heavy resource problems. But, most heavy resources are needed when models are been in training process, and there are and will be many researches about increasing efficiency of neural models.