**ENS 491 – Graduation Project (Design) Proposal**

**Project Title: Prediction of Remaining Life of the Aircraft Engine**

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1. **ABSTRACT**

Aviation sector is getting more and more important today. In addition to building aircraft, their maintenance is quite difficult and costly. Aircraft that are not maintained or whose condition is uncertain cause irreparable casualties. Our starting point in this project: It is to prevent high costs and loss of life by ensuring that the aircraft that are close to the end of their engine life are detected in advance and the engine supply is made as quickly as possible.

Our project aims to create machine learning algorithms to predict the remaining life of the aircraft engine based on approximately 20 sensor data obtained from jet aircraft engines. While doing this, it will be determined which model will work more effectively and with high accuracy by using different RNN models available in the literature. In this process, synthetic data we have obtained from NASA will be used.

1. **INTRODUCTION**

With the development of aircraft technologies, damage to aircraft and maintenance costs cause high costs. In addition, due to the fact that the engine supply is not done on time, the planes may wear out, which causes them to be used ineffectively. Our aim here is to shorten the engine supply period by calculating the estimated engine lifetimes of the aircraft and to reduce the cost by preventing time loss.

It includes data from more than 250 aircraft engines and 26 different sensors. First, we will divide the data into two parts as training and testing. After training our data, we will try our result on test data and try to find the optimum result by iterating it with different RNN models. While doing these, we will encounter various basic data processing problems such as overfitting and underfitting. In solving these, we will try to get the most accurate result by using various methods (adding dropout layers, remove features etc.) to eliminate such problems.

Some Previous Studies

* The main strategy in this link will be to use the dataset to train a regression model to predict RUL. Data visualizations were made, but the method was not specified. (Alhamaly, 2019)
* In this research, prognostics on remaining useful life is a difficult technical challenge in aircraft engine health management. The paper introduces the principle of HSMM, similarity-based, and SVM algorithm, and their detailed structure and method applied to the prognostics. Xinxin, Xiong & Qing, Li & Nong, Cheng. (2016).

(There are many resources, but we couldn't see it because it was paid. Therefore, we do not have detailed information about the methods made.)

* In this study, the data is processed using an RNN model called SAE model. (Ma, Su, Zhao, & Liu, 2018)
* In another study: Remaining Useful Life Prediction of Gas Turbine Engine using Autoregressive Model. (Ahsan & Lemma, 2017)

There were previously patented studies on the calculation of engine life in the literature. There are even patent rights assigned to large companies such as SIEMENS.

Our main aim and motivation for this project preventing unnecessary plane accidents.

1. **PROPOSED SOLUTION AND METHODS**

Our recommendation on this subject is to create a machine learning algorithm by processing sensor data in aircraft engines and make an estimation as a result. Thus, the estimated engine life will be determined. Of course, while doing this, different algorithms available in the market will be tried. In this way, the most effective and highly accurate algorithm will be determined.

This problem both include technical and engineering issues and has no obvious solutions in our hands and has significant consequences on economy and human life. We need to use available data processing methods to solve the problem.

**3.1. Objectives/Task**

First, data should be made the as comprehensible as possible. Second, there will be data processing part in this process. In this section, the conversion of the data to a format suitable for RNN models will be provided. **Then,** data should be trained and then testing it. **Furthermore,** we will divide our data into two parts. Then, we will test the data we trained, in the second part. Also, by processing, overcoming of basic problems such as overfitting and underfitting which are decreasing code efficiency that leads to distort real value, should be implemented. In this process, we will try to overcome problems which stated above. We will then test our data again. Our main purpose to reach the result with high accuracy.By reaching optimal solution, it is provided us high accuracy estimates of motor life.

**3.2. Realistic Constraints**

* **Health and Safety:** TheProject mainly aims to improved public health and enhance the quality of aircraft services.
* **Manufacturability:** Since we are developing a bunch of models, we just need a decent computer to process data.
* **Sustainability:** Since we are developing a softwareAfter the models are determined and performed we can see the best model for the determining life span for a jet engine, we can use the model in the sector till another model discovered and rule out our model.

1. **RISK MANAGEMENT**

Since our project will be software rather than a physical project, there will be no great risks. But in this process, there will be parts where we have difficulties. First of all, we may have problems with information. Because we are in a project that requires software information. At the same time, we may need mathematical (statistics, etc.) support as we will deal with the algorithm. Since our group consists of two people, there may be problems in this regard. Regarding this, our solution may be to consult our teacher. Since our teacher is an expert on this subject, his ideas will be decisive for us.

1. **ETHICAL ISSUES**

In our project, we will be developing a software for aircrafts. Therefore, we will not have any ethical issues.

1. **REFERENCES**

**1-)** Alhamaly, A. (2019, August 28). Jet Engine Remaining Useful Life (RUL) Prediction. Retrieved November 07, 2020, from https://medium.com/@hamalyas\_/jet-engine-remaining-useful-life-rul-prediction-a8989d52f194

**2-) Xinxin, Xiong & Qing, Li & Nong, Cheng. (2016). Remaining useful life prognostics of aircraft engine based on fusion algorithm. 628-633. 10.1109/CGNCC.2016.7828859.**

**3-)** Ma, J., Su, H., Zhao, W., & Liu, B. (2018, July 30). Predicting the Remaining Useful Life of an Aircraft Engine Using a Stacked Sparse Autoencoder with Multilayer Self-Learning. Retrieved November 07, 2020, from https://www.hindawi.com/journals/complexity/2018/3813029/

**4-)** Ahsan, S., & Lemma, T. (2017, October 25). Remaining Useful Life Prediction of Gas Turbine Engine using Autoregressive Model. Retrieved November 07, 2020, from https://www.matec-conferences.org/articles/matecconf/abs/2017/45/matecconf\_ses2017\_04014/matecconf\_ses2017\_04014.html

**5-)** <https://patents.google.com/patent/US20120283963>