Epilots : A System to Predict Hard Landing During the Approach Phase of Commercial Flights

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Abstract

This project aims to develop a system called E-Pilots that uses machine learning algorithms to predict hard landings during the approach phase of commercial flights.The system will analyze flight data to precede hard landings.The goal is to provide pilots with real-time warnings and guidance to prevent accidents and improve safety.The research methodology includes the collection and analysis of flight data, the development and testing of machine learning algorithms, and the integration of the E-Pilots system with existing flight systems.The findings of this project are expected to contribute to the improvement of aviation safety and reduce the occurrence of hard landings. The implications of this research may also extend to other areas of aviation safety and flight automation.
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1. INTRODUCTION:

Between 2008 and 2017, almost 49% of the deadly accidents involving commercial jets happened when they were landing this percentage has stayed the same for many years. Boeing, a company that makes planes, said that only 3% of landings in commercial flights were not done properly Surprisingly, 97% of these bad landings continued instead of trying again. Many of these accidents are caused by planes going off the runway. Not landing properly, hard landing on the runway, and other things can lead to this. However, if pilots decided to try landing again more often, it could reduce the number of accidents in the aviation industry Artificial Intelligence in aviation is considered one of the strategic priorities in the European Plan for Aviation Safety 2020-2024.

1.1 DESCRIPTION

making timely decision to execute a go-around manoeuvre could therefore potentially reduce the overall aviation industry accident rate A go-around occurs when the flight crew makes the decision not to continue an approach or a landing, and follows procedures to conduct another approach or to divert to another airport. Goaround decision can be made by either flight crew members, andcan be executed at any point from the final approach fix point to wheels touching down on therunway (but prior to activation of brakes, spoilers, or thrust reversers). In addition to unstable approaches, traffic, blocked runway, or adverse weather conditions are other reasons for a go- around. Despite a clear policy and training on go-around policies in most airlines, operational data show that flight crew decision-making process in deciding for a go-around could be influenced by many other factors. These include fatigue, flight schedule pressure, time pressure excessive a head-down work, incorrect anticipation of aircraft deceleration, visual illusions, organizational policy/culture, inadequate training or practice, excessive confidence in the ability to stabilize approach, and Crew Resource Management.

1.2 PROBLEM STATEMENT

The objective is to develop an E-PILOTS (Enhanced Predictive Integrated Landing Optimization and Tracking System) that utilizes advanced technology and data analysis techniques to predict the probability of a hard landing during the approach phase of commercial flights.The system should aim to assist pilots in making informed decisions and taking corrective actions to prevent hard landings

1.3 SCOPE AND MOTIVATION

The main motivation is to create a cutting-edge, hard landing prediction that brings convenience and efficiency to Predict Hard landings. With E pilots : A System to predict hard landing during the approach phase of commercial flights , users can interact with the devices using machine learning algorithms and perform various actions . This project aims to enhance user productivity, provide a seamless and intuitive user experience, and showcase the power of hard landing predictions and automation technologies.

1.4 OBJECTIVES

- Develop a system that uses machine learning algorithms to predict hard landings during the Commercial flights.
- Collect and analyze flight data to identify patterns that precede hard landings.
- Integrate the E-Pilots system with existing flight systems to provide pilots with real-time warnings and guidance to prevent hard landings
- Evaluate the performance of the E-Pilots system in detecting and preventing hard landings using a dataset of historical flight data.
- Compare the performance of the E-Pilots system with existing hard

2. LITERATURE REVIEW

Here we will elaborate the aspects like the literature survey of the project and what all projects are existing and been actually used in the market which the makers of this project took the inspiration from and thus decided to go ahead with the project covering with the problem statement.

2.1 Literature Survey

1) European Union Aviation Safety Agency (EASA) : member states as well as US National Transportation Safety Board and USA Federal Aviation Administration.

2) Hybrid model with optimized net architecture. : We propose a hybrid approach that uses features modelling temporal dependencies of aircraft variables as input ta neural network with an optimized architecture.

3) Exahuastive comparison to SOA database of flight : A main contribution compared to existing works is that our model have been tested and compared to SOA methods on a large database of Flight Management System(FMS) recorded data of an aircraft no longer in operation that includes 3 different aircraft models (A319, A320, A321)

4) Analysis of the Performance of Classifiers and Re-gressors : with the final goal of developing a cock-pit deployable recommendation system we have conducted a study of the performance of classification and regression models in terms of Flight height and different aircraft variables.

5) Sources of errors and Capability for go-around recommendations : Unlike previous approaches, we analyse the capability of networks for the detection of Hard Landing(HL) before the decision height, as well as, the influence for the operational context.

2.2 SYSTEM STUDY

2.2.1 FEASIBILITY STUDY

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

- ECONOMICAL FEASIBILITY
- TECHNICAL FEASIBILITY
- SOCIAL FEASIBILITY

2.2.2 ECONOMICAL FEASIBILITY

This study is carried out to check the economic impact that the system will have on the organization. The expenditure must be justified. The amount of fund that the company can pour into the research and development of the system is limited. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

2.2.3 TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. This will lead to high

demands on the available technical resources. Any system developed must not have a high demand on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

2.2.4 SOCIAL FEASIBILITY

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

2.3 EXISTING SYSTEM

2.3.1 Manual Summarization

One existing system for hard landing prediction during the approach phase of commercial flights is the SmartLand system developed by Honeywell Aerospace.The SmartLand system uses multiple sensors on the aircraft to provide pilots with real-time information about the aircraft's position, velocity, and trajectory during the approach phase. The system then uses algorithms to analyze this data and detect any signs of a hard landing, such as excessive descent rate, high vertical acceleration, or touchdown beyond the designated touchdown zone

Drawbacks:

- An existing system not implemented Sources of errors and capability for go-around recommendation.
- An existing system not implemented hybrid approach for hard landing prediction that uses features modeling temporal dependencies of aircraft variables as inputs to a neural network.
- Limited Data Analysis, Insufficient Integration, High Maintenance Costs.

3. METHODOLOGY

Epilots : A system to predict hard landing during the approaches of commercial flights where it does overcome all the drawbacks that mentioned in existing system includes:

Python : Python is a **high-level, interpreted**, **interactive** and **object-oriented scripting language**. Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages.

Decision Tree Classifier : Decision tree classifiers are used successfully in many diverse areas. Their most important feature is the capability of capturing descriptive decision making knowledge from the supplied data. Decision tree can be generated from training sets. The procedure for such generation based on the set of objects (S), each belonging to one of the classes C1, C2, …, Ck is as follows: **Gradient Boosting** : Gradient boosting is a machine learning used in regression and classification tasks, among others. It gives a prediction model in the form of an ensemble of weak prediction models, which are typically decision trees. When a decision tree is the weak learner, the resulting algorithm is called gradient-boosted trees A gradient-boosted trees model is built in a stage-wise fashion as in other boosting methods, but it generalizes the other methods by allowing optimization of an arbitrary differentiable loss function.

K-Nearest Neighbour :

- Simple, but a very powerful classification algorithm
- Classifies based on a similarity measure
- Non-parametric
- Lazy learning
- Does not “learn” until the test example is given.

Logistic Regression Classifier : Logistic regression analysis studies the association between a categorical dependent variable and a set of independent (explanatory) variables. The name logistic regression is used when the dependent variable has only two values, such as 0 and 1 or Yes and No different from that of multiple regression.

Naive Bayes Classifier : The naive bayes classifier is a linear classifier, as well as linear discriminant analysis, logistic regression or linear SVM (support vector machine). The difference lies on the method of estimating the parameters of the classifier (the learning bias).

Random Forest : Random forests or random decision forests are an ensemble learning method for classification, regression and other tasks that operates by constructing a multitude of decision trees at training time. For classification tasks, the output of the random forest is the class selected by most trees. For regression tasks, the mean or average prediction of the individual trees is returned.

4. SYSTEM ANALYSIS

It is a process of collecting and interpreting facts, identifying the problems, and decomposition of a system into its components. System analysis is conducted for the purpose of studying a system or its parts in order to identify its objectives. It is a problem solving technique that improves the system and ensures that all the components of the system work efficiently to accomplish their purpose. Analysis specifies what the system should do.

4.1 REQUIREMENTS ANALYSIS

In requirements analysis encompasses those tasks that go into determining the needs or conditions to meet for a new or altered product or project, taking account of the possibly conflicting requirements of the various stakeholders, analyzing, documenting, validating and managing software or system requirements. In this phase the requirements are gathered and analyzed. User's requirements are gathered in this phase. This phase is the main focus of the users and their interaction with the system.These general questions are answered during a requirement gathering phase. After requirement gathering these requirements are analyzed for their validity and possibility of incorporating the requirements in the system to be development is also studied. Finally, a Requirement Specification document is created which serves the purpose of guideline for the next phase of the model.

4.2 FUNCTIONAL REQUIREMENT

Requirement Analysis will cover the topics like the Functional, Non-Functional and the specific requirements of the project and touching all the software and the hardware requirements as well.

4.2.1 Usability

The system should be easy to use. The user should reach the summarized text with one button press if possible. Because one of the software's features is timesaving. The system also should be user friendly for admins because anyone can be admin instead of programmers. Training the Autoencoders and classifiers are used too many times, so it is better to make it easy.

4.2.2 Reliability

This software will be developed with machine learning, feature engineering and deep learning techniques. So, in this step there is no certain reliable percentage that is measurable. Also, user provided data will be used to compare with result and measure reliability. With recent machine learning techniques, user gained data should be enough for reliability if enough data is obtained. The maintenance period should not be a matter because the reliable version is always run on the server which allow users to access summarization. When admins want to update, it take long as upload and update time of executable on server. The users can be reach and use program at any time, so maintenance should not be a big issue.

4.2.3 Performance

Calculation time and response time should be as little as possible, because one of the software's features is timesaving. Whole cycle of summarizing a page/file should not be more than 30 seconds in order to 3 pages long document. The capacity of servers should be as high as possible. Calculation and response times are very low, and this comes with that there can be so many sessions at the same times. The software only used in Turkey, than do not need to consider global sessions. 1 minute degradation of response time should be acceptable. The certain session limit also acceptable at early stages of development. It can be confirmed to user with "servers are not ready at this time" message.

4.2.4 Supportability

The system should require C, Java, Python and Matlab knowledge to maintenance. If any problem acquire in server side and deep learning methods, it requires code knowledge and deep learning background to solve. Client side problems should be fixed with an update and it also require code knowledge and network knowledge.

5. ARCHITECTURE

The architecture represents a web browser is a software application for retrieving, presenting and traversing information resources on web. The main aim of the project is to create a system that will analyze the flight data it is used to predict the hard landing of the flight with the real time Data by using the machine learning algorithms. By using the python language it makes easier to create browser.

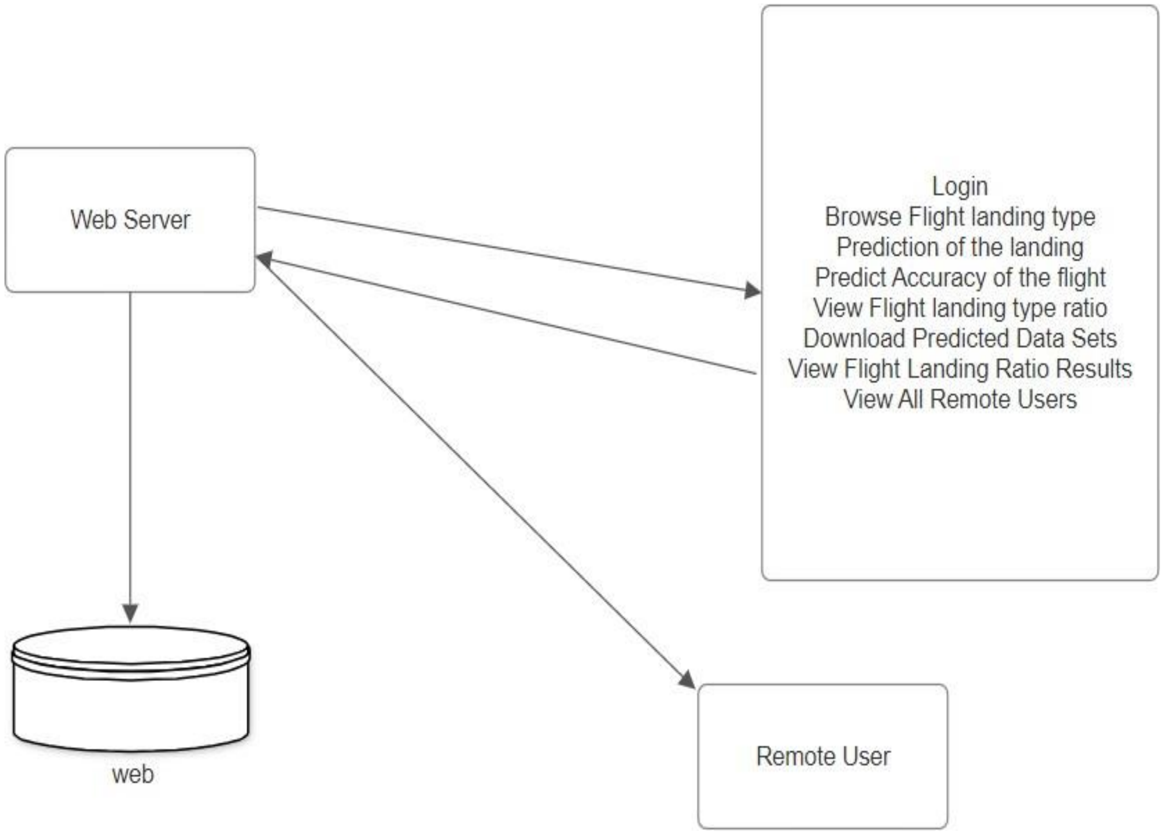


Figure 5 : Architecture

5.1 MODULES:

Service Provider

In this module, the Service Provider has to login by using valid user name and password. After login successful he can do some operations such as

Login, Browse Flight Landing Data Sets and Train & Test, View Flight Landing Trained and Tested Accuracy in Bar Chart, View Flight Landing Trained and Tested Accuracy Results, View Prediction Of Flight Landing Type, View Flight Landing Type Ratio, Download Predicted Data Sets, View Flight Landing Ratio Results, View All Remote Users.

View and Authorize Users

In this module, the admin can view the list of users who all registered. In this, the admin can view the user's details such as, user name, email, address and admin authorizes the users.

Remote User

In this module, there are n numbers of users are present. User should register before doing any operations. Once user registers, their details will be stored to the database. After registration successful, he has to login by using authorized user name and password. Once Login is successful user will do some operations like REGISTER AND LOGIN,PREDICT FLIGHT LANDING TYPE,VIEW YOUR PROFIL

6. SYSTEM REQUIREMENT SPECIFICATION

It deals with defining software resource requirements and prerequisites that need to be installed on a computer to provide optimal functioning of an application. These requirements or prerequisites are generally not included in the software installation package and need to be installed separately before the software is installed. The software are description of features and functionalities of the target system. Requirements convey the expectations of users from the software product. The requirements can be obvious or hidden, known

or unknown, expected or unexpected from client's point of view. We should try to understand what sort of requirements may arise in the requirement elicitation phase and what kinds of requirements are expected from the software system.

6.1 Software Requirements

The functional requirements or the overall description documents include the product perspective and features, operating system and operating environment, graphics requirements, design constraints and user documentation. General overview of the project in regards to what the areas of strength and deficit are and how to tackle them.

Operating system : Windows 7 Ultimate. Coding Language : Python.
Front-End : Python.
Back-End : Django-ORM s Designing : Html, cs, javascript.
Data Base : MySQL (WAMP Server)

6.2 Hardware Requirements

Minimum hardware requirements are very dependent on the particular software being developed by a given thought Python Code user. Applications that need to store large arrays/objects in memory will require more RAM, whereas applications that need to perform numerous calculations or tasks more quickly will require a faster process.
Processor : Pentium –IV RAM : 4 GB (min)
Hard Disk : 20 GB
Key Board : Standard Windows Keyboard Mouse : Two or Three Button

7. ER Diagram:

- **Purpose**: To describe the structure of the software system, including classes, their attributes, methods, and relationships.
- **Components**: Classes, attributes, methods, associations, and inheritance relationships.
- **Usage**: Class diagrams provide an overview of the system's object-oriented design, representing entities like users, browsing data, analysis components, and more.

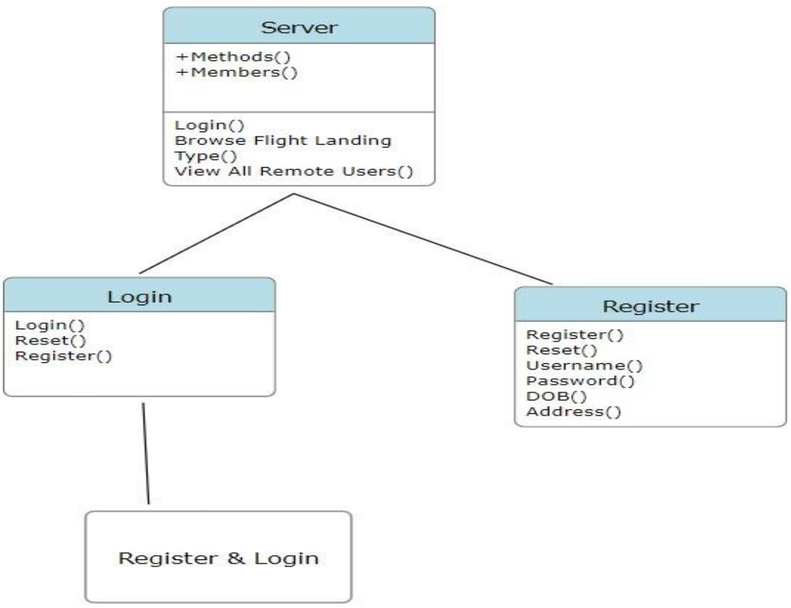


Figure 7 : ER Diagram

8. Flowchart

Flowchart is a visual representation of a process or algorithm, often using symbols and arrows to illustrate the steps, decisions, flow of control within the process.

Purpose: Flowcharts are designed to visualize the step-by-step sequence of actions or operations within the software system. They provide a clear and easy-to-understand way of representing the logic and flow of the application's functionalities.

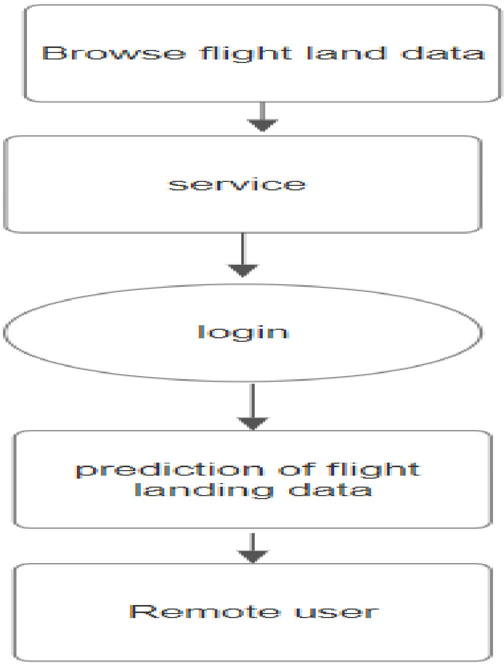


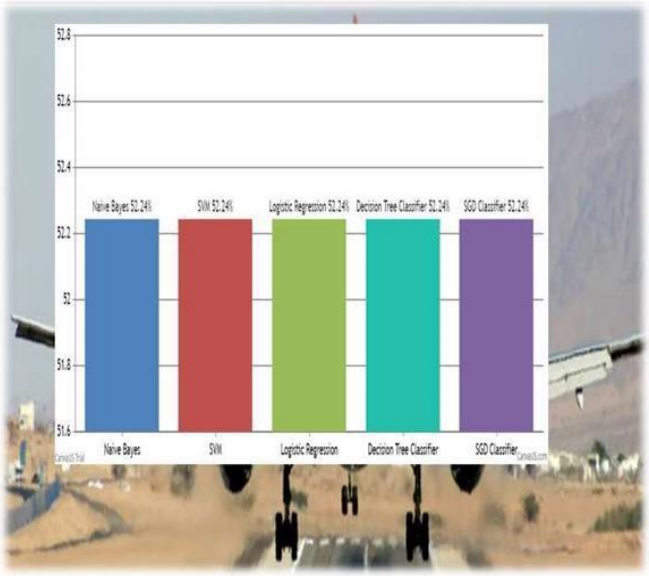
Figure 8 : Flowchart

9. RESULT :

figure 1 : Remote User

figure 2 : Service Provider

ACCURACY BAR GRAPH :: **ACCURACY RESULT**



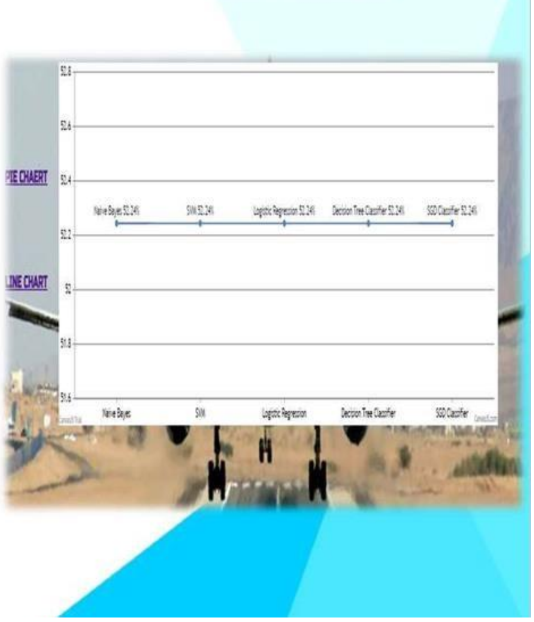


Figure 3 : Accuracy Prediction

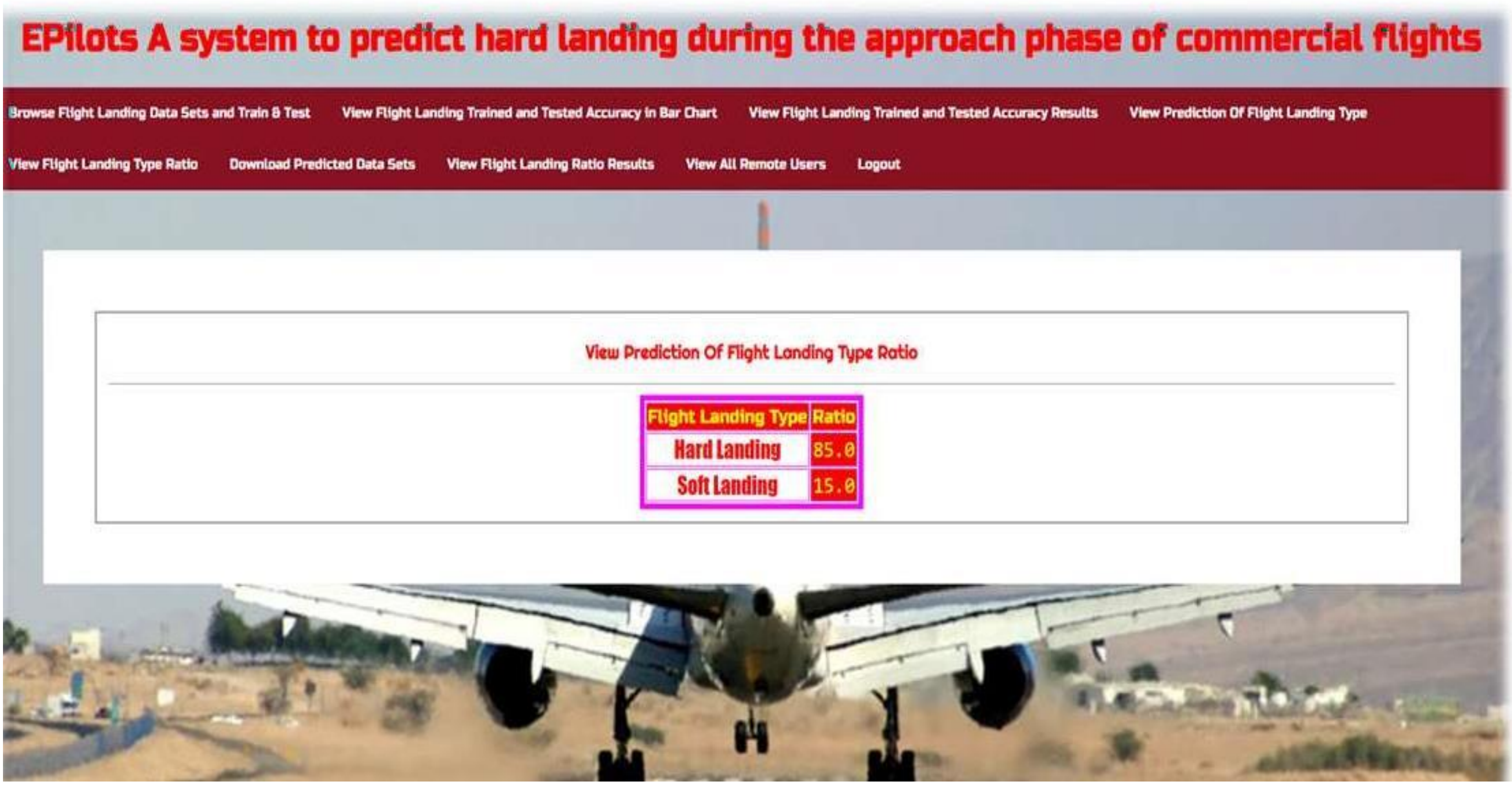


Figure 4 : Landing Ratio

CONCLUSION:

The following conclusions can be extracted from the analysis carried out in this paper.

The analysis of automation factors (autopilot, flight director and auto-thrust) suggests that these factors do not have any influence on the probability of a HL event and, thus, it might not be necessary to incorporate them into models. Experiments for the optimization of architectures show that the configurations that achieve higher sensitivity are the ones with the lowest number of neurons. As reported in the literature [24] increasing the number of layers and neurons does not improve the performance of neither classifiers nor regressorsModels using only Physical variables achieve an average recall of 94% with a specificity of 86% and outperform state of- the- art LSTM methods. This brings confidence into the model for early prediction of HL in a cockpit deployablsystem. Regarding capability for go-around recommendation before DH, even if we perform better than existing methods, there is a significant drop in recall and specificity due to the dynamic nature of a landing approach and factors influencing HL close to TD.Comparing classifiers and regression approaches, experiments show that a low MSE error in estimation of max G does not guarantee accurate HL predictions. Experiments for assessing the capability of models for early detection of HL show that classifiers are able to accurately predict HL before DH. This is not the case of regressors, which predict max G more accurately if data close to TD is considered into the model. The study suggests that classifiers are a better approach for early prediction of hard landing.

Finally, there are some issues that have not been covered in this work, that remain as future work, and should be further developed. Among such cases, stand out the robustness of the classifier (regressor) to unseen cases and its behavior under a drifting data environment. In a safety demanding environment as aviation, it surely be needed to investigate such issues and we expect to do in further works. In the future, such a system could be expanded to also include AiR Traffic Management in which the information is shared with the Air Traffic Controller in order to anticipate the likely scenario and optimize runway use.

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