CHAPTER – 3

SYSTEM DESIGN

3.1 INTRODUCTION

Systems Design here is an important and powerful tool that helps us to overcome the complexity of existing systems i.e. in air traffic services and thus helps us to build a vision of our new work, where we are going to implement LSTM. Our system design describes the model that we are going to design, in a rich and diverse way. Every system emerges from the proper system design. Good plan leads to good design which in turn gives an efficient system. This proposed system includes a development phase to happen in a module by module manner. Software level development includes coding and integrating it as a single entity. For this development phase to become possible, the system design must be framed properly. In this chapter, system design is reflected with the illustration of various diagrams like system architecture, use case, activity, entity relationship and data flow diagrams.

3.2 SYSTEM ARCHITECTURE

Fig 3.1 represents the system architecture. The entities involved in this process are Pilot, Controller bot, Flight plan, Request/response DB and the process involved are Data Collection, Data Preprocessing, text processed audio based output. When the pilot contacts controller for approach/clearance, the actual working begins. Data collection is the first step in this process which is collected from flight plan given from the briefing room, where the actual procedure starts. More specifically the data includes Flight number, name, variant, from Airport, to airport, cruising speed and altitude, type, crew and passenger details and flight history. Then we analyze it according to the pilot needs and outer circumstances as the pilot approaches the system using voice commands. We generate appropriate text in order to generate response as audio

to the pilot. Then LSTM is implemented and text processed audio based output is generated. Our project intends to develop an automated tool with help of Recurrent Neural networks, and data mining and Machine learning techniques and strategies are also used.

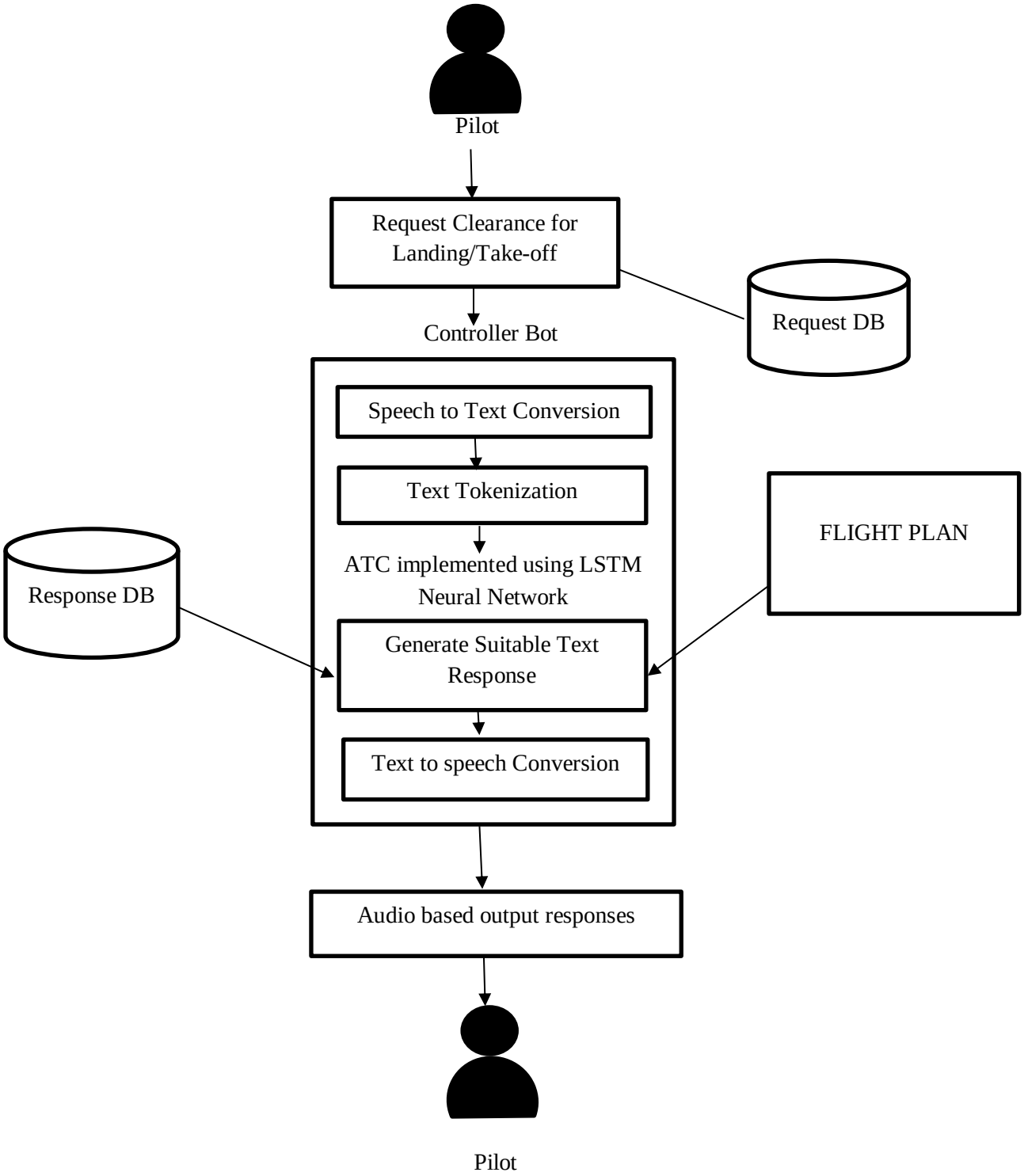

Fig 3.1 Proposed System Architecture

3.3 PROCESS FLOW

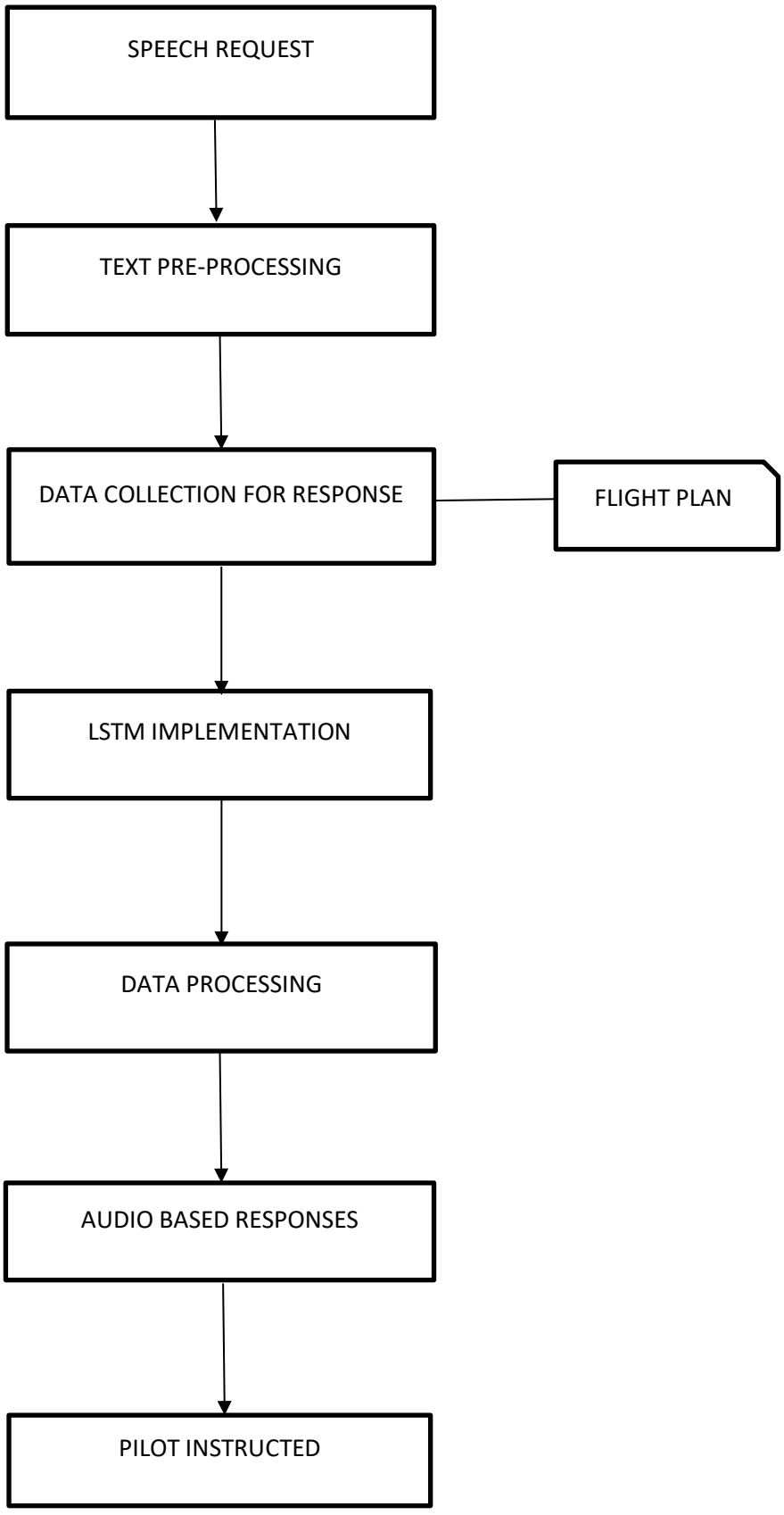

Fig 3.2 process flow

The process explains the systematic flow of predictive analytics process. The fig 3.2 represents the process flow of our project work. The entities involved in this process are Pilot, Controller bot, Flight plan, Request/response DB and the process involved are Data Collection, Data Preprocessing, text processed audio based output. It starts with Speech request from the pilot source. When the pilot contacts controller for approach/clearance, the actual working begins. The data collected is subjected to pre-processing where the data is made ready for analysis on various parameters. Data collection is the first step in this process which is collected from flight plan given from the briefing room, where the actual procedure starts. More specifically the data includes Flight number, name, variant, type, crew and passenger details and flight history. Then we analyze it according to the pilot needs and outer circumstances. Then LSTM is implemented and text processed audio based output is generated. Then data collection is performed from flight plan, which is again a source of response for pilots. Thus LSTM is implemented and data processing takes place. Then audio based output responses are generated as response to the pilot's request.

3.4 ENTITY RELATIONSHIP MODEL

Fig 3.3 represents the ER Diagram of Air Traffic Control System. The entities of Air Traffic Control System are Pilot, Air Traffic Control Tower/Room, briefing Room and aircraft that the pilot flies. The pilot controls an aircraft and consults ATC for approach/clearance. Thus the pilot and ATC possess "has" relationship. The ATC tower "has a" briefing room, where flight plan is obtained. Air traffic Control tower and Controller bot possess "has a" relationship. Each and every entity will have their attribute. Here, Pilot's attributes are Name, Age, and experience. Likewise, the attribute of ATC is ID. The attributes of Aircraft are Name and Registration No. Each and every entity of the system is linked to one another with different kinds of relationship which is one to one, one to many or many to many.

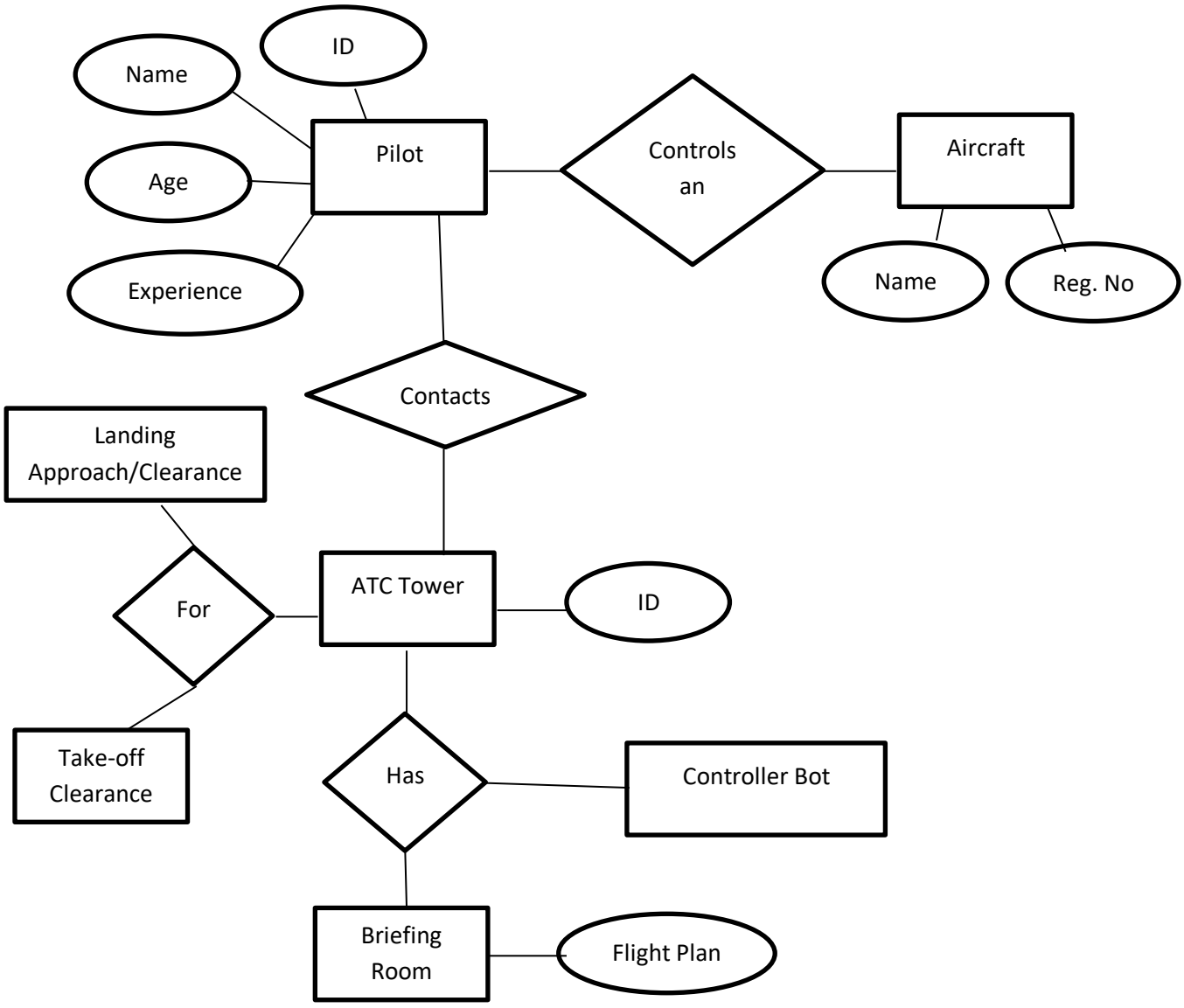

Fig 3.3 ER Diagram

3.5 DATA FLOW DIAGRAM

The Data Flow Diagram of Air Traffic Control System is represented below. The initial data is given as an audible form, which is converted to text in Speech-to-Text Process. The Converted text data is tokenized in the Text Tokenizer process. It then is processed using the data from the flight plans which is already restored with flight details such as name, variant, livery and other flight related and passenger related details, and the language dataset, to understand the intent of the command to produce a reply. The Process then creates a reply and it is converted into audible form and is sent to the pilot.

3.5.1 DFD Level 0

Fig 3.4 represents the data flow level 0. It is designed to be an at-a-glance view, because it explains the very basic flow of our system, that is easily understood by a wide audience, including stakeholders, business analysts, data analysts and developers. In the level 0 of data flow diagram explains the basic flow of the project. The input data contains the audio request and the final result is the audio response. The process between them involves speech/text processing.

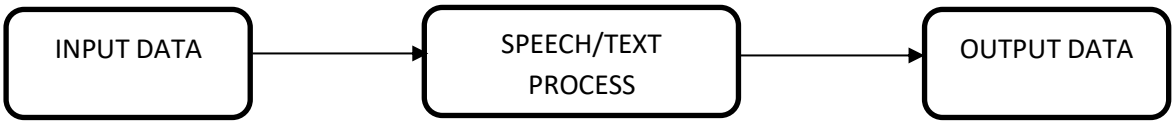

Fig 3.4 DFD level 0

3.5.2 DFD Level 1

DFD Level 1 provides a more detailed breakout of pieces and explains more information of system flow than DFD level 0. In the below figure It highlights the main functions carried out by the system. Speech to text operation is performed over the speech request from the pilot and flight plan is involved here to provide flight data. Fig 3.5 shows DFD level 1.

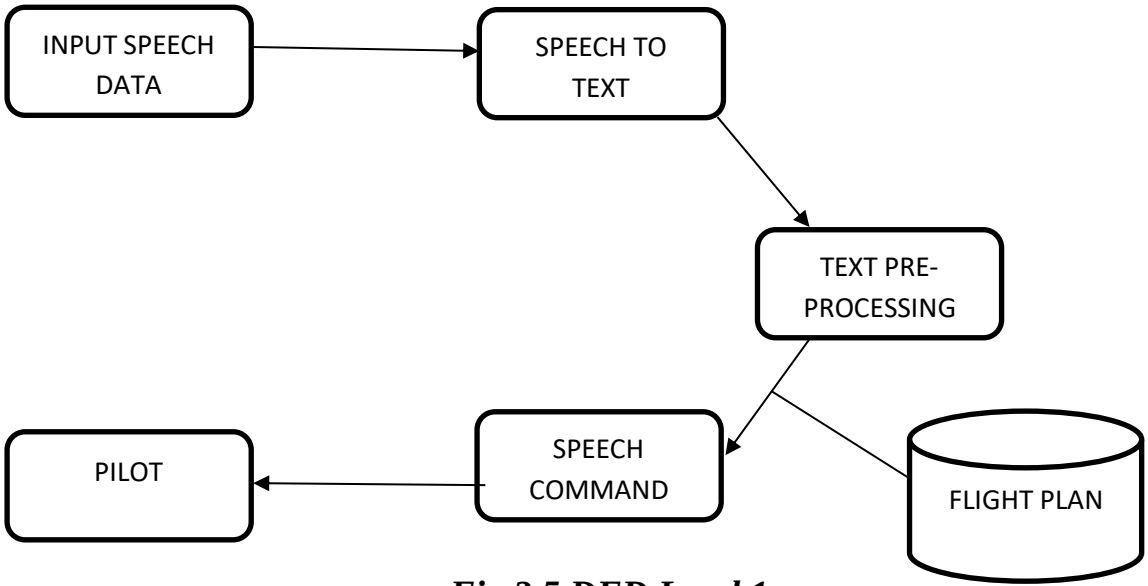

Fig 3.5 DFD Level 1

3.5.3 DFD Level 2

The DFD level 2 then goes one step deeper into parts of Level 1. Initially we process the pilot's request, as text. In Text tokenization process, the converted audio request from pilot that is converted into text is tokenized and stored. The unwanted and unnecessary stop words are removed from pilot's request. Now we create appropriate responses are initially generated as per the keywords that are stored. Then from the flight plan the flight data is fetched and combined with text data which comes as response to the pilot's request text, and combined as single statement with the help of LSTM called text pre-processing stage. Then the text is converted into audio output and supplied as response to the pilot's request. Fig 3.6 shows Level 2 DFD.

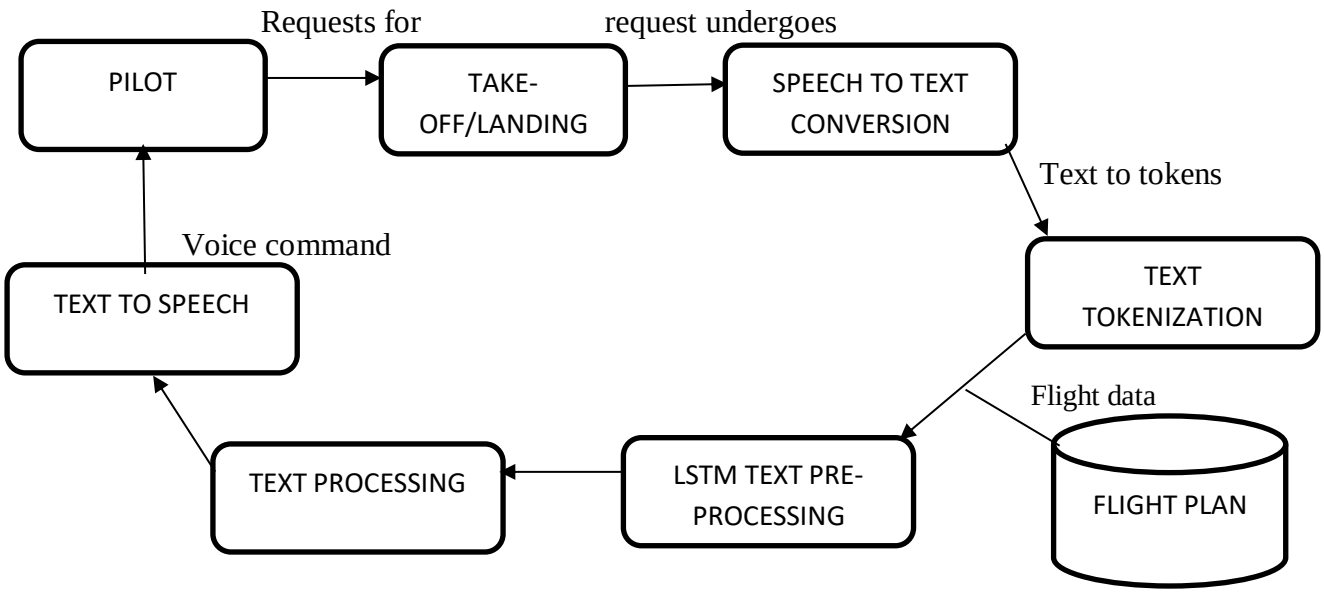

Fig 3.6 DFD Level 2

3.6 UML DIAGRAMS

The following UML diagrams are required for the project. They are

- Use Case Diagram
- Activity Diagram
- Class Diagram

3.6.1 USE CASE DIAGRAM

The Fig 3.7 represents the use case diagram of Air traffic control system. It contains actors (who perform the action) and the use cases (action or task). With the help of this diagram the user and the action performed by them is successfully identified.

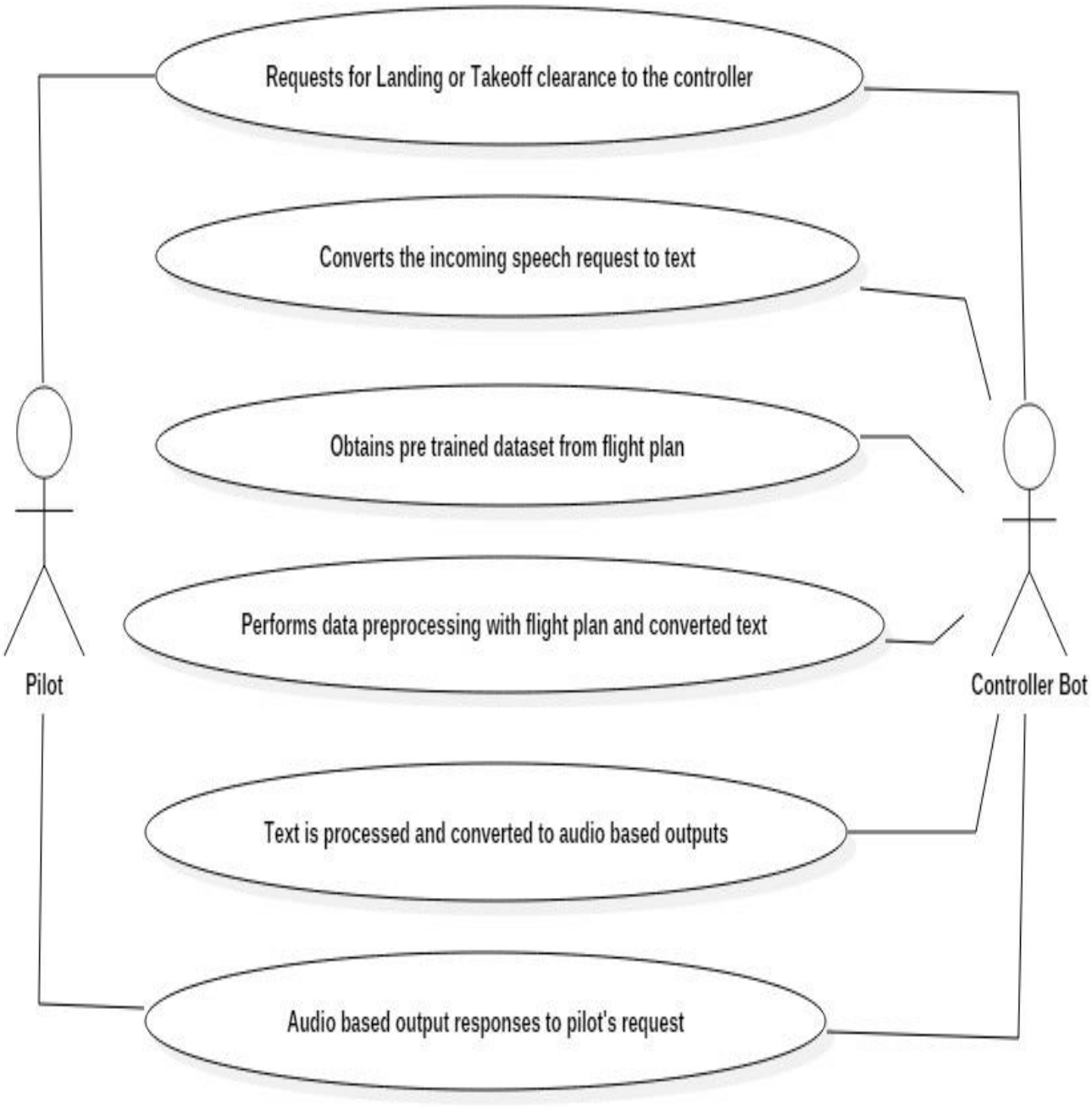

Fig 3.7 Use case Diagram

3.6.2 ACTIVITY DIAGRAM

Fig 3.8 here describes the activity diagram. Each activity has its own sub activities in the flow. Finally when the information is passed the activities comes to an end.

Here the diagram is classified in 4 vertical swim lanes, which are Pilot, AI (Chat bot), and Briefing Room, and Controller. The process flow starts with pilot's request for landing or take off. If normal conditions exist, then his response will be converted to text and text tokenization (data pre-processing) takes place. By doing this, the request will be classified and proper response is generated as text. This is converted to speech and is sent as a response to his/her request.

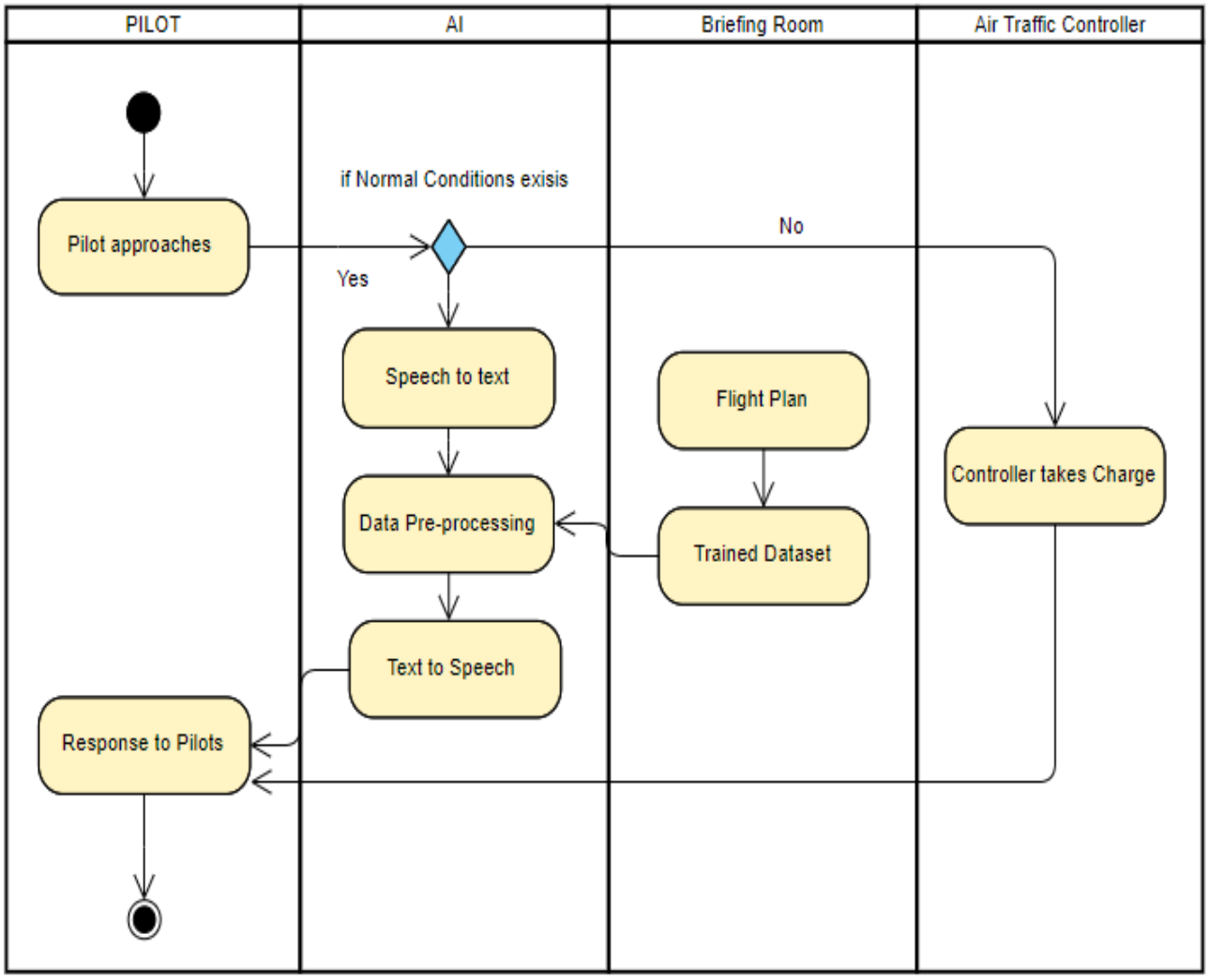

Fig 3.8 Activity Diagram

3.6.3 CLASS DIAGRAM

The classes involved in the class diagram of our system are Aircraft, Flight Plan, Pilot, Airport and Controller Bot. Most of the data is obtained from the flight plan class. The Pilot sends voice commands using the Landing_Request(). The Controller Class receives the command then using the data obtained from the flight plan class, it creates a response for the pilot. The Flight Plan Class has a one-to-one relationship with the Aircraft Class and Pilot Class. The Flight Plan Class has the PIC_ID and Aircraft_ID for accessing those two classes respectively.

Aircraft is a class and the attributes of the aircraft class are ID, name, Model, source, destination, speed and altitude and the operations performed by this class are take-off, En-route and landing. Airport is a class and the attributes are International Air Transport Association (IATA) id, International Civil Aviation Organization (ICAO) id, and airport name and airport location. Its operations include Arrival, departure and surface movement. Flight plan is another important class that holds Plan ID, aircraft ID and its name, model, Source and Destination ICAO, Estimated Time of arrival, estimated time of departure, Pilot in Command ID and Name, First Officer, passenger count and color of aircraft as attributes. Its operations are Input data and Retrieve data.

Pilot is a class and its attributes are Pilot ID, Pilot name, and his experience in hours of flight operation. His primary operations are aircraft control operations such as landing request, takeoff and runway request, and receive response. The next comes the controller Bot which has ID and command as the attributes and inspection and traffic monitoring, Receive request and send response as its operations. The aircraft has many to one relationship with airport. The pilot has one to one relationship with aircraft. The flight plan is associated with aircraft, airport, controller bot which has one to one, many to one, many to one, one to one relationships respectively. Fig 3.9 shows our system class diagram

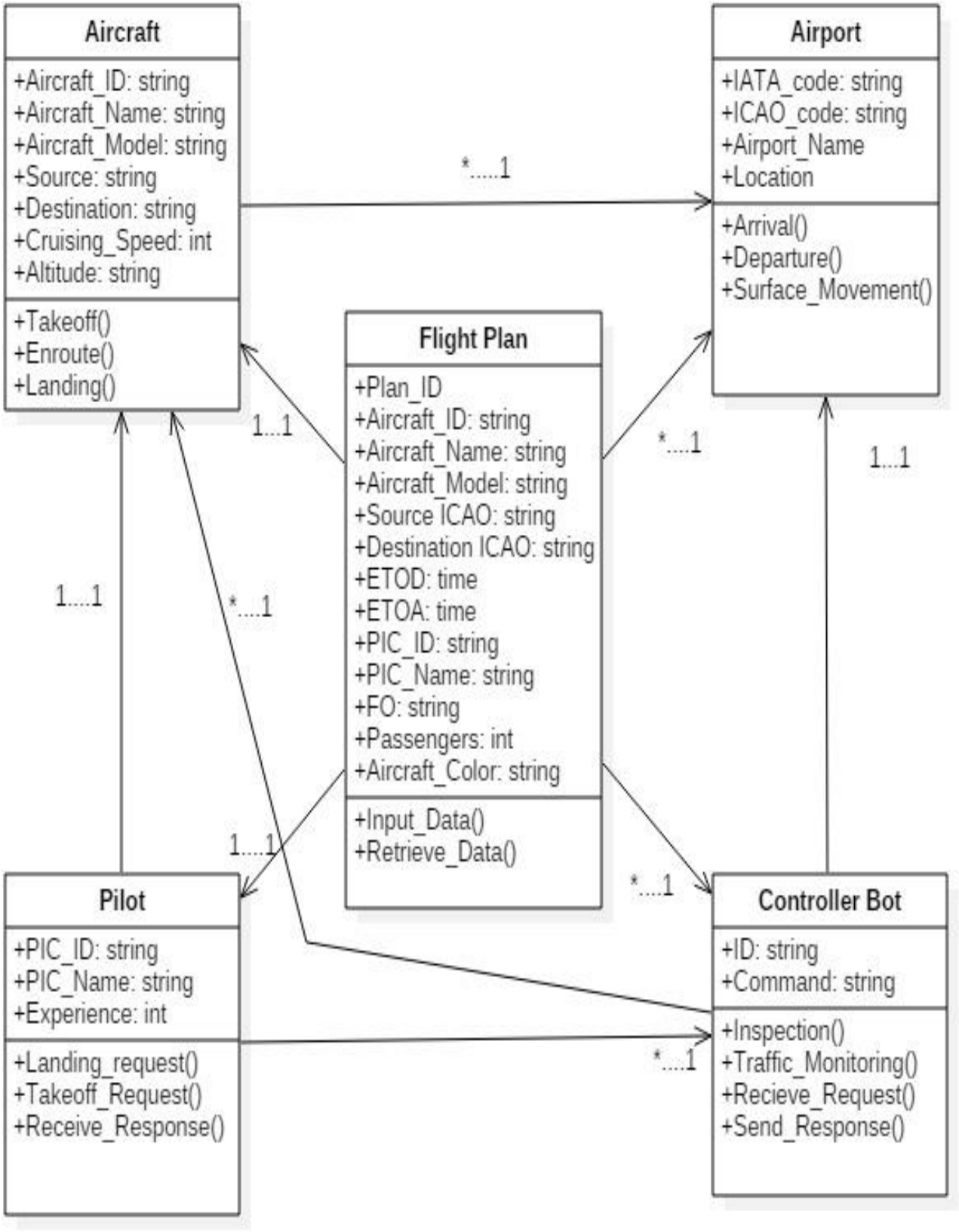

Fig 3.9 Class Diagram

3.7 SUMMARY

This chapter helps in making the system design efficient for the working of our system i.e. approach and clearance control which are the integral part of air traffic system and thus also helps in understanding and analyzing the nature of the system. Every UML diagrams owns its nature, usage, meaning and its role in the system. Also it briefs about the system in various perspectives like, as an actor's role, as sequence of activities, as the flow of data and their activities and the relationships between the entities, thus helps us to understand the basic architecture of the system. With this system design and the proposed system structure and the process flow, the diagrams explains us the data collection and segregation and the several stages of pre-processing, analysis, detection, prediction of our specialized air traffic system.