Chapter 6  Conclusions and suggestions for future work

6.1 Conclusions of the work carried out
To understand the pilot’s mental model in making crucial decisions in air combat situations, four types of SA models using TIFL with and without uncertainties in system have been completely studied and simulation results are presented in the thesis. Airline monitoring system and flight formation are critical avionics problems. To address them, T2FL method has been considered in the thesis. A complete new IT2FLS system has been developed, and is validated using simulated data with uncertainties, also the importance of new sensor data i.e flight level is illustrated in decision making result. The decision result of both the avionics scenarios are compared with results of TIFLS. Presence of uncertainties in input sensor data renders the existing T1 FLDS somewhat ineffective due to decision errors it exhibits. To overcome this, IT2FLDS has been proposed in the thesis. Lyapunov energy function method is used to study the combined FLC closed loop controller, and stability analysis and some new inferences are derived from it.

Thus, the specific contributions made in the thesis are:

1. Literature survey on data fusion, decision fusion, SA models and different techniques used in decision fusion is carried out. Various aviation scenarios for SA models are analyzed. A novel type 2 trapezoidal membership function (MF) is also, utilized.

2. Attack and threat assessment scenarios are implemented using T1FL and performance evaluated.

3. Airline monitoring system is developed based on IT2FL and performance evaluated. New rule and input sensor data (altitude or flight level) is incorporated in to the airline system, it is found that decision output accuracy has enhanced.

4. Formation of flight recognition system is developed using dual layer of IT2FL and evaluated.

5. Lyapunov asymptotic stability results are derived for DMF controller as a combined closed loop control system along with IT2FL controller, and some novel inferences are made. The simulation presented establishes this theoretical result.

On the whole, the schemes proposed, and validated in the present thesis, make a definite advancement in the area of pilot’s situation assessment where for interval type 2 fuzzy logic
(IT2FL) has been used, perhaps for the first time for the purpose. All the presented results validate the schemes, and also establish that for the scenarios considered in the thesis, the IT2FL has been found to give better results and decisions compared to type 1 fuzzy logic (T1FL). So, this novel study should be very useful for building automated situation alert systems and thus aid pilot in reducing his/her work load, thereby achieving improved performance and efficiency of the entire situation decision system.

6.2 Suggestions for the Future work
Real time algorithm implementation in aviation or any complex systems, and the hardware development and implementation could be future work. While the results obtained from IT2FL-decision system (DS) system are very promising, some more studies can be made to build and evaluate different and new fuzzy inference functions (FIFs) and their applicability in general control systems as well as in aerospace data fusion and decision fusion systems. Such novel possibilities would widen the horizon in various other domains like medical image fusion, automobile, robotics, and power systems.