Rule Based Aircraft Performance Systems

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RULE BASED AIRCRAFT PERFORMANCE SYSTEMS

ABSTRACT

For aircraft such as BOEING and AIRBUS, there are many rules for takeoff and landing performance calculations. These rules are defined according to aircraft configuration, MEL (Minimum Equipment List) / CDL (Configuration Deviation List) items, Turn Procedures (if available), Airport and Obstacle Database (AODB) and Weather Conditions.

ABSTRACT

In this study, a general database is created to include all kinds of aircraft, airport information and rules effecting aircraft performance. This database system is server based and can be accessed from everywhere. The rules include aircraft configuration such as airframe/engine combination, flap setting, airconditioning, anti-ice, thrust rating, aircraft CG position, climb method etc. , MEL/CDL items and external conditions such as AODB and weather conditions such as runway condition, wind direction, wind speed, outside air temperature, QNH and NOTAMs (if available). Rules can be simple or complex in such a way that composite conditions can be used all together and simple rules can be combined in a complex rule.

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ABSTRACT

This study is different from other studies in that all aircraft types can be combined in a single server based database systems and rule checking process is very dynamic and flexible. These rules can be managed easily on server. This server database can be extented to create national or international aircraft and airport information system in the future.

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ABSTRACT

Besides the advantages of operational safety resulting from making point calculation instead of conventional calculations, with the implementation of this system fuel conservation, emissions of CO2 decrement, aircraft engine health management are acheived.

PREVIOUS RELATED RESEARCHES

A prototype rule-based front end expert system for integrity enforcement in relational data bases: An application to the naval aircraft flight records data base

Expert Systems with Applications, Volume 8, Issue 1, January-March 1995, Pages 47-58
Magdi N. Kamel

The goal of this study is to accomplish the accuracy of the real world data in the databases in accordiance with organisational procedures.

PREVIOUS RELATED RESEARCHES

Lateral Flight Technical Error Estimation Model for Performance Based Navigation

Chinese Journal of Aeronautics, Volume 24, Issue 3, June 2011, Pages 329-336
Hongsheng ZHAO, Xiaohao XU, Jun ZHANG, Yanbo ZHU, Chuansen YANG, Sheng HONG

The goal of this study is to increase environmental turbulence intensity in Performance Based Navigation (PSN) to decrease Flight technical error (FTE) combined with navigation system error (NSE).

PREVIOUS RELATED RESEARCHES

Rule-based optimization approach for airline load planning system

Procedia Computer Science, Volume 1, Issue 1, May 2010, Pages 1455-1463
Feng Li, Chunhua Tian, Hao Zhang, Wade Kelley

The goal of this study is to increase ground operations efficiencies of an American airline by making rule based load planning.

PREVIOUS RELATED RESEARCHES

A rule-based reactive model for the simulation of aircraft on airport gates

Knowledge-Based Systems, Volume 10, Issue 4, January 1998, Pages 225 236

Yu Cheng

The goal of the study is to resolve the conflict of time and apron traffic to increase the apron control activity.

PREVIOUS RELATED RESEARCHES

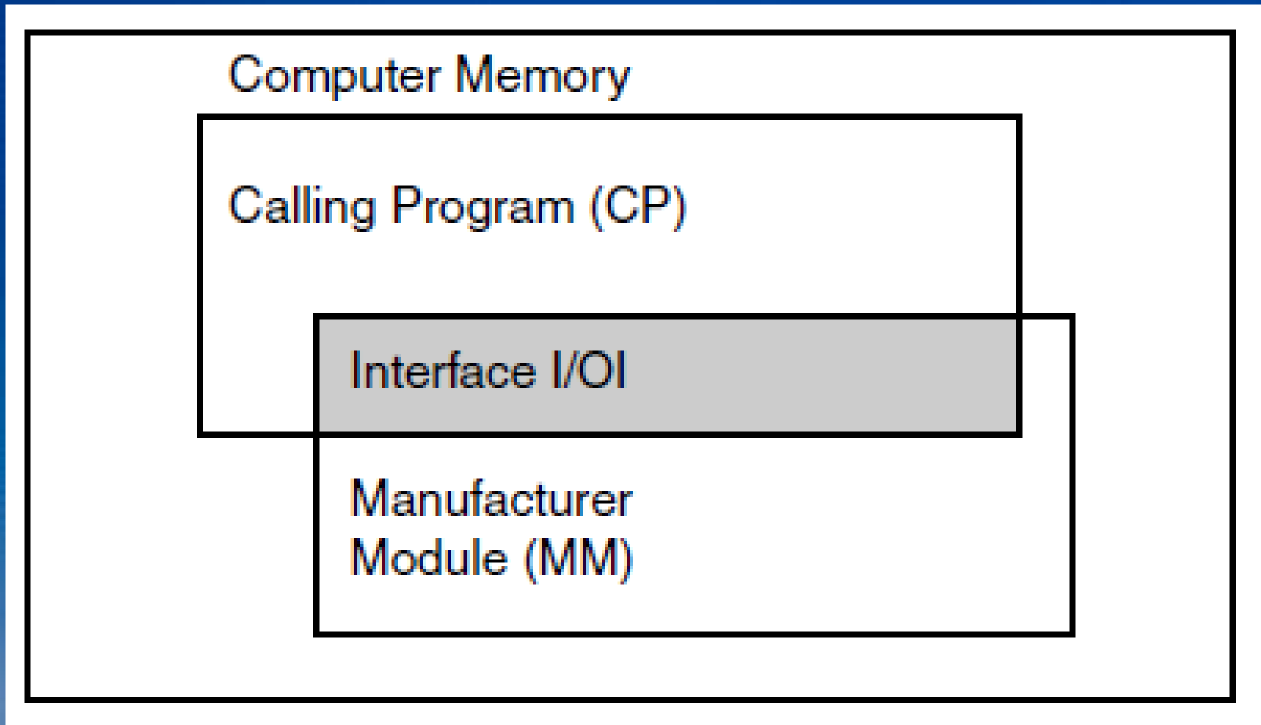
Using decision rules to achieve mass customization of airline services

European Journal of Operational Research, Volume 205, Issue 3, 16 September 2010, Pages 680-686
James J.H. Liou, Leon Yen, Gwo-Hshiung Tzeng

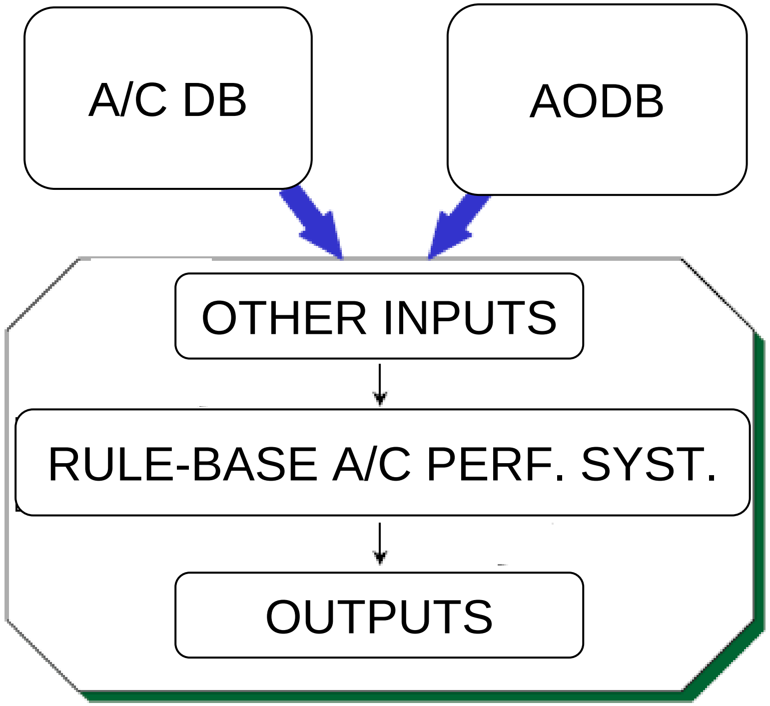
The goal of this study is to increase airlines service quality and gain additional revenue without effecting the passenger perception.

AIRCRAFT PERFORMANCE SYSTEMS

INTERFACE DIAGRAM



AIRCRAFT PERFORMANCE SYSTEMS



OTHER INPUTS : Weather Conditions, MEL/CDL Items, Turn Procs.

OTUPUTS : Limiting Weights, Speeds, Thrust Parameters, Operational Performance Penalties etc.

RULE BASED AIRCRAFT PERFORMANCE SYSTEMS

AIRCRAFT PERFORMANCE SYSTEMS

CALCULATION PARAMETERS (an example model)

Calculation Input Parameters are pre-defined by IATA for the aircraft manifacturers to establish their values for the related aircraft.

POPT	- Program Options Array
CONF	- Aircraft Configuration Array
XMET	- Meteorological Conditions Array
RWYD	- Runway Array
OBSD	- Obstacle Array
FPTD	- Flight Path Turn Data array
UNIT	- Units Array
SPIA	- Supplemental Performance Interface Array

CALCULATION PARAMETERS (an example model)

XMET - Meteorological Conditions Aray (an example array position)

ARRAY POSITION	PARAMETER	VALID VALUES	COMMENT
XMET (1)	TEMPERATURE.		
XMET (2)	WIND COMPONENT		
XMET (3)	CROSSWIND COMPONENT		
XMET (4)	ALTITUDE FLAG	0. = Airport pressurealtitude. 1. = QNH 2. = QFE	
XMET (5)	ALTITUDE VALUE		
XMET (6)	ACTUAL OUTSIDE AIR TEMPERATURE(OAT)		
XMET (7)	TEMPERATURE INVERSION FLAG	0. = No Temperature Inversion 1. = TemperatureInversion	
XMET (8)	TEMPERATURE AT INVERSION ALTITUDE		
XMET (9)	INVERSION ALTITUDE		

RULES (an example model)

XMET - Meteorological Conditions Aray (an example SIMPLE RULE)

ARRAY POSITION	PARAMETER	VALID VALUES	COMMENT
XMET (2)	WIND COMPONENT	VALUE	ALONG THE RUNWAY + HEADWIND - TAILWIND
XMET (5)	AIRPORT ALTITUDE	VALUE	FOR VARIABLE SPECIFIED IN XMET (4)

RULES (an example model)

POPT - Positions Array (an example COMPLEX RULE)
XMET - Meteorological Conditions Aray (an example COMPLEX RULE)

ARRAY POSITION	PARAMETER	VALID VALUES	COMMENT
POPT (14)	SURFACE CONDITION / TYPE OF CONTAMINATION	0 – DRY 1 – WET* 2 – STANDING WATER* 3 – SLUSH* 4 – COMPACTED SNOW * 5 – DRY SNOW* 8 – WET ICE* 11 – ADVISOTY WET	POPT (14) = 2,3,4,5 OR 8 NOT ALLOWED WITH POPT (1) = 4 * WITH DRY CHECK
XMET (6)	ACTUAL OUTSIDE AIR TEMPERATURE (USED FOR MINIMUM CONTROL SPEED AND POWER SETTING CALCULATIIONS)	VALUE OR 9.E20	INPUT IS OPTIONAL FOR POPT (1) SETTINGS OF 0., 1.,OR 2. INPUT IS OPTIONAL FOR POPT (1) SETTINGS OF 4.OR 9.

DATABASE ARCHITECTURE (an example model)

POPT - Positions Array (an example COMPLEX RULE)

Microsoft SQL Server Management Studio

File Edit View Debug Query Designer Tools Window Community Help

New Query

Change Type

SONY-PC\SQLEXP...Y_POSITION_RULE

Object Explorer

REGISTRATION	ARRAY_POSITI...	RULE_NO	RULE_LOGICAL...	APT_LOGICAL_...	APT_VALUE	ARRAY_POSITI...	APE_LOGICAL_...	APE_VALUE
TC-SKB	POPT(05)	1	AND	=	3	POPT(14)	<>	11
TC-SKB	POPT(05)	1	AND	=	3	POPT(14)	<>	2
TC-SKB	POPT(05)	1	AND	=	3	POPT(14)	<>	3
TC-SKB	POPT(05)	2	AND	=	4	POPT(14)	<>	11
TC-SKB	POPT(05)	2	AND	=	4	POPT(14)	<>	2
TC-SKB	POPT(05)	2	AND	=	4	POPT(14)	<>	3

CONCLUSION

We have xonxluded that by making a point calculation and taking all of the parameters into account the accuracy of the results have been increased, operational safety is escelated and a user friendly user interface is prepared to decrease both pilot workload in the daily operations and engineering studies workload .

With the server database a national and international aircraft and airport database can be created in the future.

Besides, with the implementation of this system fuel conservation, emissions of CO_2 decrement, aircraft engine health management are acheived.