IMPROVING THE BORDER CONTROL PROCESS BY QUEUE LENGTH OPTIMIZATION

Gunther Grasemann[1], Mathias Anneken[1] and Elisabeth Peinsipp-Byma[1]

[1] *{gunther.grasemann, mathias.anneken, elisabeth.peinsipp-byma}@iosb.fraunhofer.de*
Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB
Fraunhoferstr. 1, 76131 Karlsruhe (Germany)

Abstract

The increasing amount of travelers crossing the EU borders and illegal border crossing with sophisticated spoofing methods forces the authorities to implement new solutions for the control process. In order to achieve higher control rates and to increase security and objectivity in the process, the borders have been supported by automated border control systems (ABC). One important aspect in the usage of ABC systems is the more complex queuing process.

Therefore, one objective of the EU funded project FastPass is the queue length optimization. By provision of a special distribution model, the optimal constellation of the queues can be calculated. The model describes the processes in their respective implementation. Two operation modes of the system have been realized. The first one is a calculation of probable process scenarios. The second operation mode is the simulation of the process with visualization and interaction components.

1 INTRODUCTION

The automation of passport control processes delivers effectivity, objectivity and an increase in security. However, this works only if the capacity utilization is suitable for the respective application. That means there are different facilities for passport control, automatic and conventional, Schengen and Non-Schengen.

The optimization task is the optimal distribution of the passengers between the available lines. The objectives are maximal speed, security and comfort for the passengers and the control staff.

There are three types of lines (cp. Fig. 1), the conventional line with human controls, an automatic line for passengers from the European Union and one for other passengers. Actually, it is not known before the control process itself, whether a passenger is allowed to use an e-gate and also not if he is willing to do so. Only the probabilities for each person for being allowed to use and wanting to use an e-gate can be estimated. Then a first estimation can be derived about how many lines should be open and how long they will probably be. Thus, there is a first constellation like in Fig. 1: The distribution of the N passengers of a plane can be combined to the vector

$$D = (T_1, T_2, A_1, A_2).$$

If the duration of a single control process is known as D_C for the conventional gate and as D_E for the electronic gate, the complete control time will be given by the following equation:

$$T_{tot} = max\ (D_C \times T_1, D_C \times T_2, D_E \times A_1, D_E \times A_2)$$

This value can be minimized by changing the distribution and thus the number of passengers for the single gates.

Values to be optimized:

Symbol	Specification	Min/Max
T_{tot}	Total time for the control of the plane	Min
T_{max}	Maximum time for a single passenger	Min
N_{BG}	Number of border guards required in total	Min
N_{Gat}	Number of gates required in total	Min

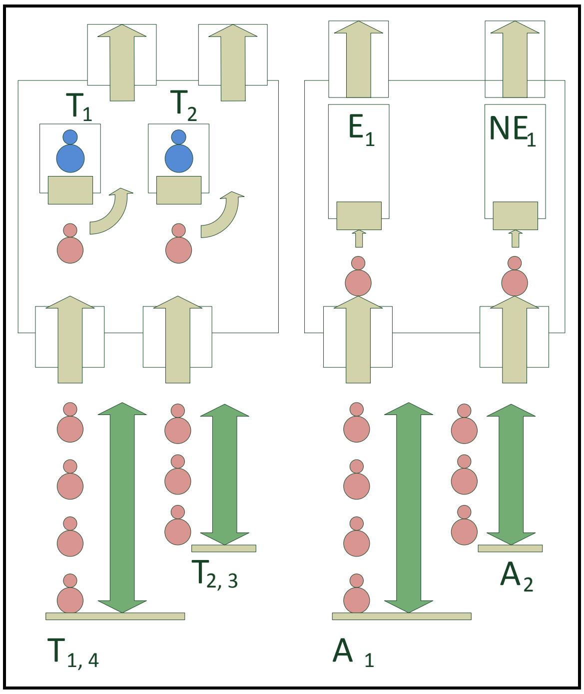

Figure 1: Optimization Scenario

2 METHODICAL APPROACH AND ALGORITHMS

For the modelling and optimization, there are several suitable techniques:

- Markov Chains
- Bayes Optimization
- Linear and non-linear Optimization (Simplex-Algorithm, „Transportation Problem“)
- Operations Research

In addition, a task oriented classification of the travelers is required. Therefore, an assumed set of requirements for the starting constellation of the complete system out of the entire set of information has to be calculated (prediction) and the available measurements have to be taken into consideration for the actual adaptation of the system (indication).

Input parameters at the airport are:

- Information about the scheduled flights, (time of arrival, origin, etc.)
- Estimated information about passengers' properties in the planes (number, classification, distribution)
- Dependencies from time of day, day of the week, actual events

The next block is the set of actual available sensor information:

- Information from the e-gates (as allowed due to data protection)
- Information from the observation from the border guards
- Information from the video sensors (queue length, number of persons, classification properties, images)

Approaches for the modelling of transportation and movement processes are proposed in [4], pp. 41 ff., and in [2]. The modelling and estimation of queue length is described in [5] and [11].

Knowledge has to be generated by use of data mining techniques from observation and experience. The knowledge has to be modelled and stored in a suitable database from which it can be retrieved simply by the front-end modules. The observations and their results have to be visualized by data reduction and aggregation of the most important properties for the prognosis (cp. Fig. 2 and 3).

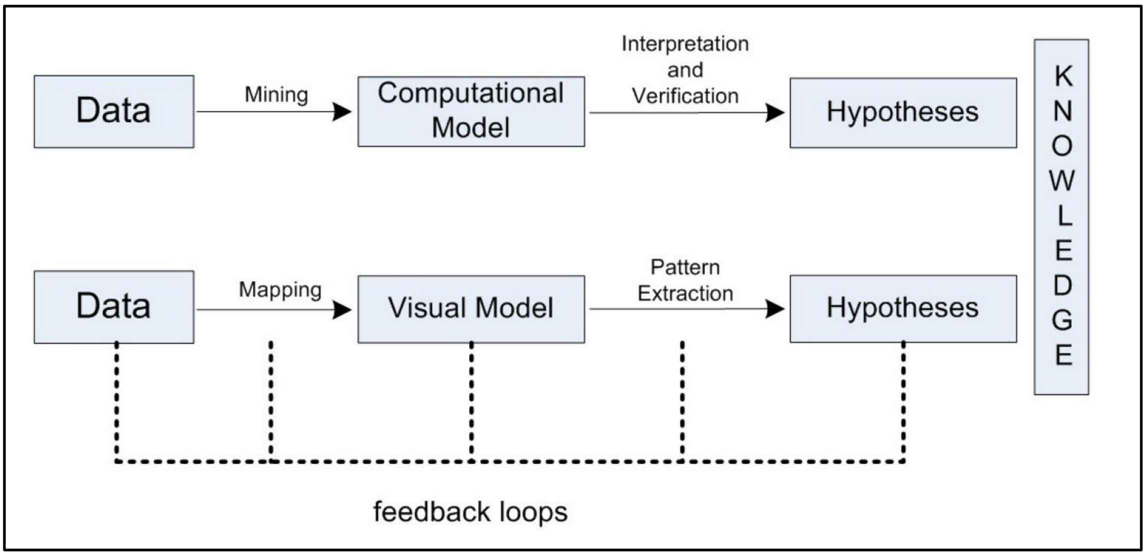

Figure 2: Knowledge generation with traditional data mining and information visualization analytic processes (from [3])

The first step can be realized by a multi-function approach to calculate an initial distribution of passengers' classification properties to be expected by a specific flight.

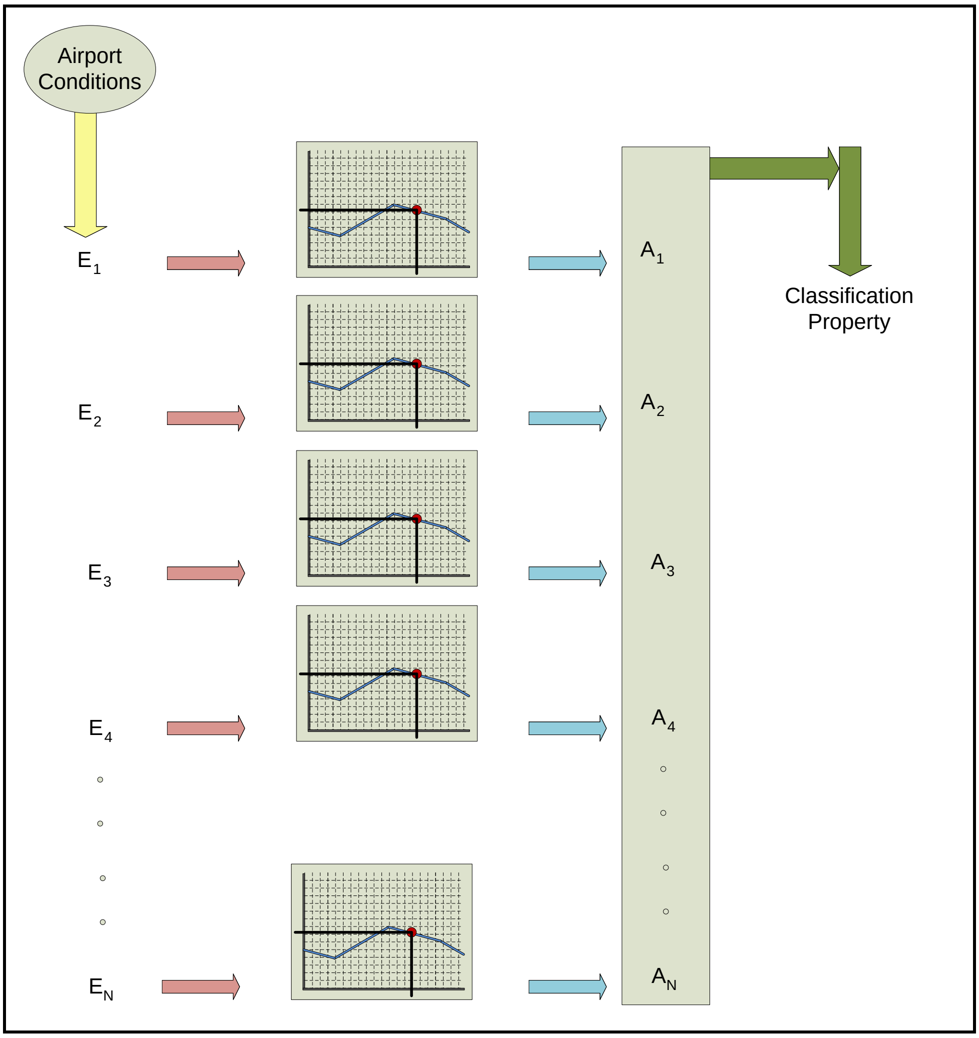

Figure 3: Summarize Classification Property

3 SOFTWARE ARCHITECTURE

For the software architecture, a distributed client server model is provided together with a web service model which is adapted to the standard from the OGC like SOS, WMS or WFS protocol. The techniques are described in [6], [7] and [8]. Some principal ideas are presented in [9].

The center of this approach is the application software in the control room for the border guards; they are responsible for the realization for actual constellations. Several automatic and interactive components serve them to achieve the best actual constellation for the complete control system.

The control room software communicates with the control component of the AIT[1] video subsystem as a client. The AIT systems provide all required and necessary information.

For that, it collects all video streams and calculates the respective values like queue length and number of travelers. In addition, it requests optimizing values from the IOSB subsystem. This system gets prepared values as well as raw images for further analysis steps for the classification.

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[1] AIT = Austrian Institute of Technology, FastPass Coordinator

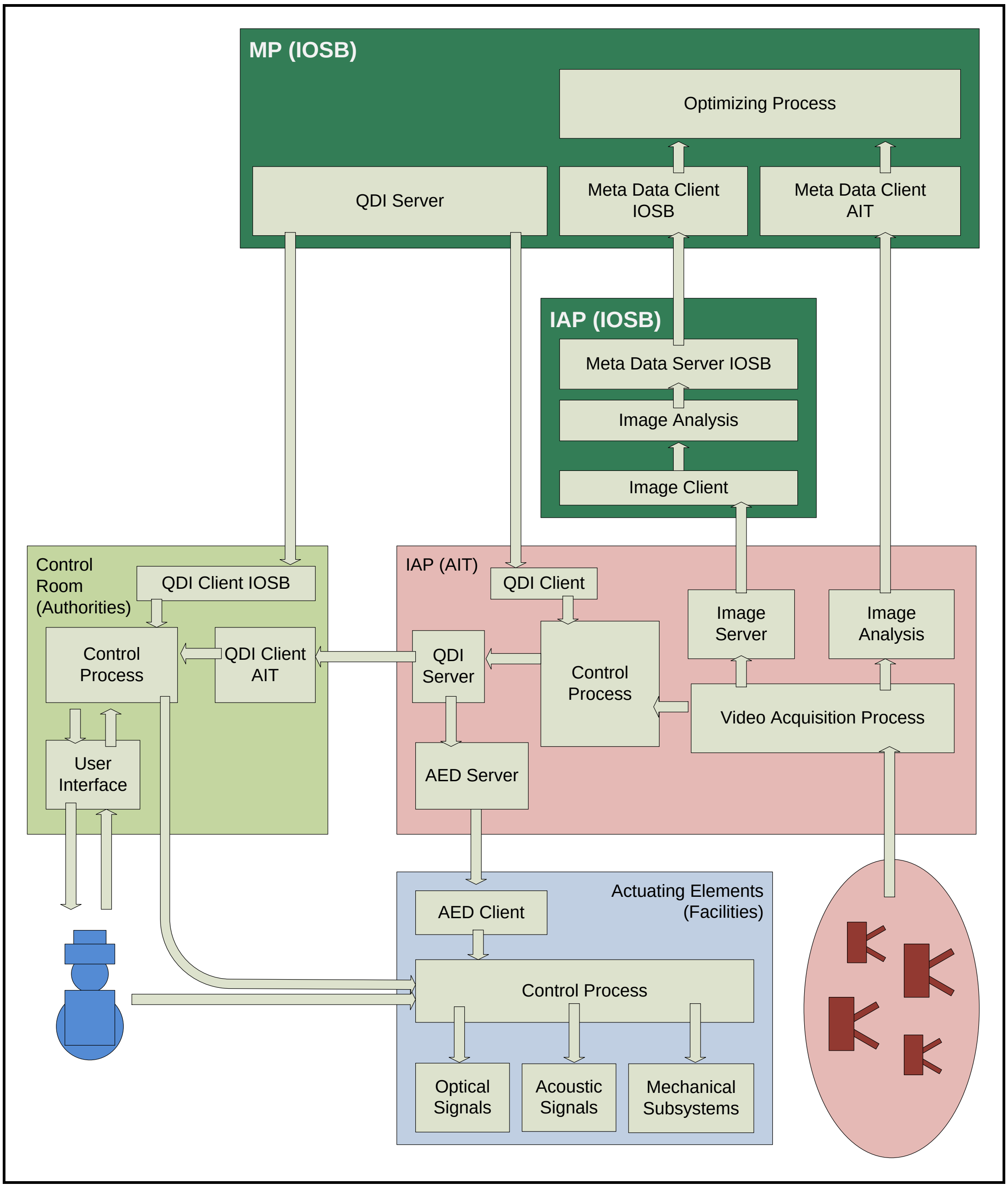

Figure 4: Block Diagram Software Architecture

The core of the system is the control block in the AIT application (cp. Fig. 4). Normally, it will be asked by the control room software to generate an actual constellation of the gate system that should be optimal in the meaning of all regarded parameters. In this case, the AIT system is a server for the control room. As a client, the AIT software requests the modeling process (MP) to send the optimal configuration. MP has to collect information from the AIT subsystem and the IOSB subsystem to collect all information for the optimizing process. The results are sent to the AIT system, which sends them to the actuating devices and to the control room.

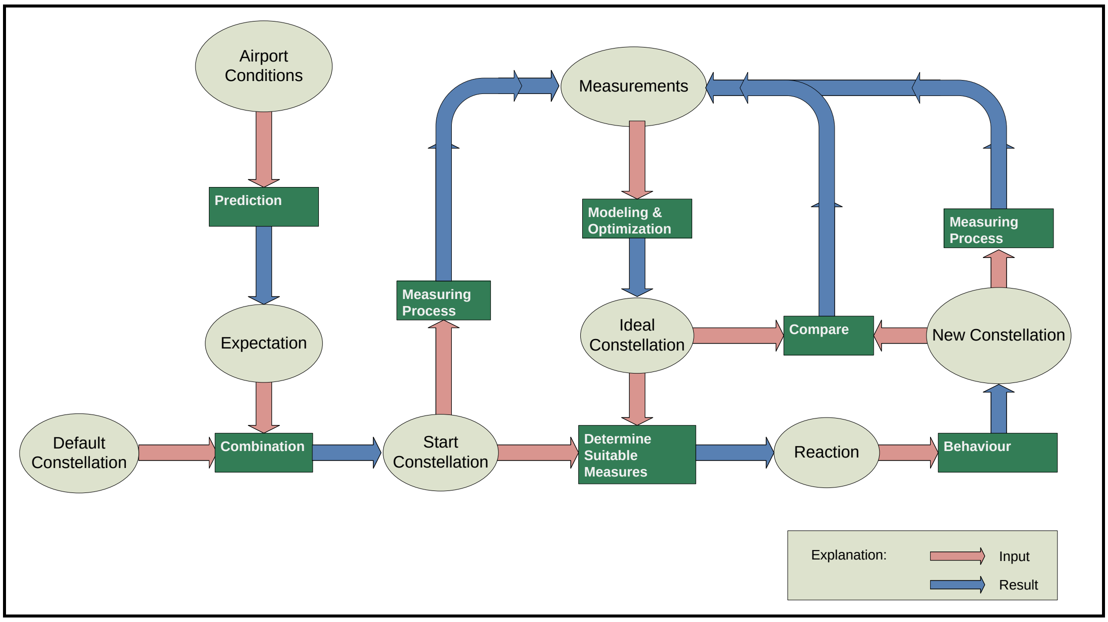

Figure 5: Process Flow Diagram

The process flow diagram (Fig. 5) shows the dependencies in the single steps: based on the airport information, a prediction is calculated to have an expected set of passengers in each group which delivers the start constellation of the system. In the process, all observed and measured values are calculated by the modelling process to achieve an optimal configuration which might be realized or approximated by means of signature or advices. This can be measured again and the control loop can be closed keeping the new constellation as close to the ideal one as possible.

The communication and interoperability between the flow optimization modules and the surrounding software components is implemented with a web service architecture concept based on the respective standards ([1], [10]). This enables a structured and task oriented approach, comprehensive modularity and thus the possibility to think and work in modules, independent implementations and different tool and working environments like languages, operating systems, development systems a. f. m. (cp. [9]).

4 CONCLUSION

For the control process, automated systems lead to higher effectiveness and more security. The more complex constellation of the gates needs an optimized control of the queues. That is realized by video surveillance, automatic length estimation and the optimization of the queuing process.

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