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An Improved A-Guidance System for Handling Airport Ground Operations

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Abstract

Automatic Advanced Landing System is most essential and required for the most modern airports to reduce down time of activities and to improve quality of air traffic. To increase situation awareness in airports, providing airport stakeholders assistance with surface operations in terms of surveillance, control, routing and guidance tasks. The main goal is to maintain the declared surface movement rate under all visibility conditions, traffic density and airport layout while maintaining the required level of safety. Ground handling traffic movements, including communications between the controller at the control center and vehicle drivers. We would like to integrate the existing system, which is widespread in the airports today and leads to misguiding of aircrafts. We would like to present an economic affordable solution for perfect take off and Landing System for airports with physical ambient conditions of the airport with audiovisual networking. To have a reality demonstration of our idea, we have employed the state of art Embedded Controller Technology along with associated hardware required for input and output.

1. INTRODUCTION

In an airport environment, surface movements are based primarily on the principle "see and be seen" to maintain spacing between aircraft and/or vehicles on the airport movement area. The ability to maintain situational awareness based on visual scans becomes difficult and error prone in particular at rush hours where a higher number of operations take place simultaneously, in some cases within low visibility conditions, forcing workers to perform more efficiently when interfacing with aircrafts. Dependence on voice communication as a sole source of guidance is another contributing factor to increase the likelihood of safety infringements due to the possibility of miscommunication or misunderstanding. In order to operate safely in extreme conditions (e.g., rush hours and bad visibility conditions), airport stakeholders must be provided with accurate information to better manage the movement of aircraft and vehicles while avoiding safety infringements on the airport surface. Ant Colony Optimization (ACO) is an efficient met heuristic proposed by Colorni and Dorigo in 1992 to solve combinatorial optimization problems. The essential trait of ACO algorithms is the combination of a priori information about the structure of a promising solution
With a posteriori information about the structure of previously obtained good solutions.

2. AUTOMATIC ADVANCE LANDING SYSTEM DESCRIPTION

Automatic Advanced Landing system follows a client server approach with two main components. One controllers (e.g., ATC, AOO, Airport Authority and Ground Handler Managers) to manage ongoing surface movements, and another corresponding to onboard systems with Functionalities for airport workers (e.g., vehicles drivers) operating at the airside area. The control center provides a geographical information display of the airport layout, traffic situation and labels identifying the position of aircrafts and vehicles on the airside. The onboard system includes a touch screen display with a graphical viewer that triggers alerts whenever drivers cause a safety incursion or infringement. The A-Guidance also provides automated assistance by reducing off-screen distractions through presentation of all required information on one single screen.

3. AUTOMATIC ADVANCE LANDING SYSTEM ARCHITECTURE

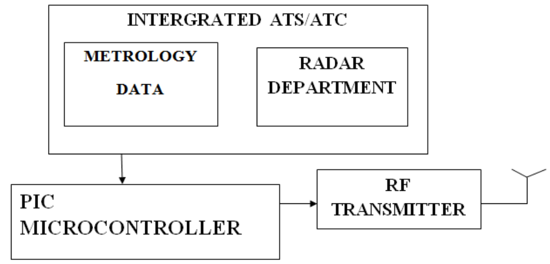
The present level of technological development enabled the development of a solution for the localization of vehicles ground movements using an IP-based wireless communication network to support data communications for location based services. Cooperative vehicles are equipped with a GPS/EGNOS receiver, a Wi-Fi device and an onboard unit that is responsible to compute data and maintain synchronization with the control center.

Information system (GIS) specifically designed to represent the airport layout as a set of overlapped map layers, with seamless. The A-Guidance relies on state-of-the art geographical graphical navigation functionalities for users to dynamically interact with the airport map layout. The A-Guidance system was designed to integrate data collected from existing airport systems, including data from the Surface Monitoring Radar (SMR) for non-cooperative mobiles such as aircrafts and to compute positioning data from cooperative objects such as vehicles equipped with a GPS/EGNOS receiver. However, the current version does not enable communication with aircrafts, therefore in this paper interaction with pilots are not considered. Nevertheless, aircrafts and vehicle movements are clearly identified. As presented in Figure 1, such distinction is obtained through a bidirectional data link established between the A-Guidance and SMR system. The A-Guidance sends vehicles positioning data to the ATC Systems using ASTERIX CAT21. Based on a data fusing process performed at the Application Server, it is possible to correlate aircrafts data with flight plan data and accurately determine assigned stand at arrivals, provide on/off-blocks time, or identify the takeoff runway. The data fusion process coherently integrates data provided by each cooperative vehicle with data collected from external systems. External systems may have multiple sources and provide data as diverse as data on flights, data on vehicles, data on tasks, and data about workers. the ATC system provides data about aircrafts and vehicles positioning collected from the SMR, the Airport Management System provides detailed data about vehicles, and tasks related to airport operators (e.g., surface inspections, bird control, de-icing and snow clearance, follow-me, etc.) and ground handling tasks. The SGO system provides data about flight schedules. Over the last years the architecture has evolved in terms of its hardware infrastructure and on the level of services provided by the Application Server. During 2006 at Porto airport, a middle size airport, tests were performed mainly for the manoeuvring area, with more than 15 cooperative vehicles of different categories. The A-Guidance implements three possible configurations for the onboard system to communicate with the control center:

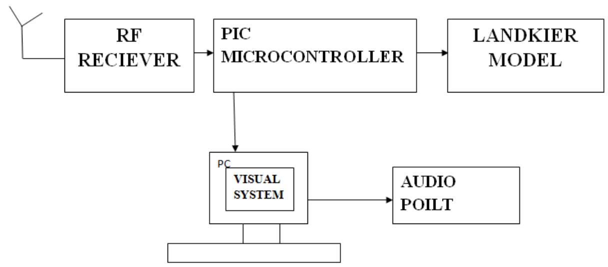
Magnetic device with a flashlight for surveillance of temporary vehicles entering airside areas. The device provides positioning, speed and direction of movement, but with no interaction with the vehicle driver. Device with a numeric keypad and a LCD. This configuration enables the identification of the driver (though a login procedure) and the possibility to report the start and end of a task.

It also enables the reception of alerts in the form of short text messages;

Device with a touch screen display. This is a more costly solution with all the functionalities and data provided by the two previous devices plus a moving map to guide the drivers within the airside. Safety alerts are presented in a graphical form and functionalities to report surface incidences are also provided. Vehicles equipped with a touch screen display, known as the onboard system includes a PC board with a GPS/EGNOS receiver and a transponder with a wireless network interface. The GPS/EGNOS receiver provides a set of data related to positioning accuracy, speed, direction of movement, accurate estimate of the err ors, just to mention a few. The GPS/EGNOS receiver gives a more accurate position (within 2 meters) than the one provided by GPS alone. After validating and correlating the GPS/EGNOS data with the vehicle ID (call sign) and driver ID (obtained from a login procedure), the data are sent to the backend system using the wireless communicates device .The wireless communication network covers the whole airside area, allowing the exchange of data between vehicle drivers and stakeholders at control centers. Distinct high bit rate network technologies are considered (e.g., Wi-Fi, WI-MAX) for transmitting the data. The system can also work, although with a lower quality of service, with lower bit-rate communication technologies like CDMA or TETRA. These last two networks are sometimes found in an airport environment and that is the main reason of their choice as an alternative technology.



a) Automatic integrated data transmitting system



b) Automatic data receiving system

This architecture supports VDL-4 or Mode-S, for communication of the platform with aircrafts. Usually, only one of these technologies is deployed, but if more than one is deployed, a back-up solution for communication becomes feasible. All onboard unit´s derived data are transmitted to the Communication Server, which is responsible to manage the heterogeneity of wireless communication networks, presenting a common interface to accurately provide the received data to the application server. The Communication Server can be connect to the wireless networks, using the airport LAN or equipped with transponders to adapt to the wireless network

Figure: Automatic Advanced Landing System

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In use and manage the communication between vehicles and the control center through the airport local area network. The wireless network integrates the airport network establishing a bidirectional communication between the controller and drivers. This is particularly important to continuously update operational information, like flight data and tasks assigned to each logged driver. In fact all positioning data computed by the Application Server are validated against existing airport safety requirements that apply to each movement area. Positioning data together with driver and vehicle identification are checked against safety business rules to validate for any specific safety-related issues; afterwards the data are displayed as a point feature at the Ground Human-Machine Interface (GHMI) for each connected client application. A colour code is used to call the attention of both users (the controller at the control center and the driver at the vehicle) for any safety alert.

3.1 CONTROL CENTER

The control center component of the A-Guidance system was designed to improve airport operations as one integrated support system. Provide surveillance and guiding functionalities with a detailed event resource-usage description to help the airport to be operated more efficiently as a time-ordered system the graphical display provided by the GHMI is managed by a GIS engine, designed specifically to respond to ASMGCS performance requirements, namely to provide a screen refreshing cycle below one second when updating the position of moving objects (i.e., aircrafts and vehicles).

It is possible to visualize the graphical layout of the GHMI with all thematic layers selected (see the Map Feature tab at the left side). Vehicles are represented with a colour code outlining for each hazard situation the severity level. A red label denotes a sever incursion and a yellow label a less sever incursion. A vehicle represented with a green colour is operating normally and in blue to outline vehicles that stopped for more than 5 seconds. To clearly understand how safety incursion are triggered, we first need to understand the topological procedures performed by the Application Server which correlates vehicles/aircrafts positioning against the polygon features of the protections layers or against any other polygon defined for restricted access areas. Protection areas are represented as transparent polygons, any unauthorized incursion into one of these features will automatically trigger a safety incursion alert message at the Alert Viewer

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3.2 SURVEILLANCE AND CONTROL CAPABILITIES

The surveillance service provides location-awareness and identification of all aircrafts and vehicles within the movement area, it is the control service that is responsible for safety risk assessment and diagnosis, triggering alert messages whenever a safety hazard is detected. The A-Guidance provides a collaborative decision support environment to manage real-time events, enabling the surveillance of mobiles to be performed in combination with additional management information, namely:

 Situational awareness to distinct airport stakeholders(E.g. flights often get blocked during the taxi-in phase And Aircraft Operators and Ground Handlers can see
Exactly where they are). Operational data such as actual landing, on-block, off block and take-off times. Taxi time prediction.

4. DECISION SUPPORT

All the collected physical parameters must be sent to ATS for decision making on ground conditions for safe landing.

4.1 MECHANICAL:

The responsibilities of mechanical dept are rotating the radar at a constant speed of 12.5 rpm (international standard speed) and collect data's from various aircrafts and their geo position on the air. The collected data's then fed to ATS for decision-making.

4.2 AIR TRAFFIC SERVICES:

This is a decision-making department, but based on the data's collected from the other two departments. The responsibilities of ATS are analyzing the aircraft's perfect position and guiding them for safe landing. The wings position, height of the aircraft with respect to the runway are collected automatically using diagonal antennas and advice the aircraft captain to tale right landing path. The above said three departments are located in different areas and they have their own network and they are exchanging data's manually and automatically. We would like to develop an AD-HOC type system, where the above said three departments will be in one computer. The same computer will guide the aircraft for safe landing.

Using of state of art embedded technology and wireless technology and audio-visual system; we will be demonstrating this project perfect implementation.

4.3 TEMPERATURE AND HUMIDITY:

We are used thermistor to find atmospheric (Room) Temperature and Humidity. They Converts Temperature into Mill volts. With these values, we are converting into ºC (Room Temperature) by manual calculation. For Humidity, one thermistor is inserted into water, & other Thermistor is kept in room so that to sense & display room temperature and water temperature. The formula for Humidity is

$$\text{Humidity} = \frac{T_{water}}{T_{room}} * 100$$

4.5 WIND SPEED AND WIND DIRECTION:

In this project wind direction just like that simulation. Normally the Wind direction can be measured by using switches. Wind speed measured by Fan.

4.6 FOG AND VISIBILITY:

For FOG & Visibility, IR Sensors are used. IR Sensors consists of IR Emitter, and IR Detector. Positive Voltage is given to IR Emitter. Using this voltage, it transmits IR rays continuously & IR Detector collects these rays. If there is any obstacle between emitter & Detector, the amount of rays that is collected by Detector will be reduced depends on the obstacle.

For FOG, IR Emitter & IR Detector is placed face-to-face so that IR Detector collects rays passed by IR Emitter. If there is any obstacle between Emitter & Detector, the amount of rays collected by Detector will be reduced depends on the obstacle like FOG.

For VISIBILITY, IR Emitter & IR Detector is placed parallel so that rays passed by IR Emitter are collected by IR Detector. If there is any obstacle between Emitter & Detector, the amount of rays collected by Detector will be reduced depends on the distance of obstacle from IR Emitter. If distance increased, the amount of rays collected by Detector will be reduced. From this value, we will understand visibility is more (I.e.) visibility increases with decrease in the rays' collection.

5. STEPPER DRIVER LOGIC:

The stepper driver logic consists of buffer, op to-coupler, pre-driver and driver.

5.1 OPTO COUPLER:

It consists of Op to-emitter &Phototransistor. An op to coupler is essential to prevent the computer from hazardous conditions like voltage transients, back emf, and high voltage spikes. We use dc Stepper motors for our robotic applications. Normally when we pass dc current to a coil it will get Electro magnetized, when we with draw the dc source & also it won't get demagnetized. If it is not demagnetized, back

EMF is produced which can create kick back current to the subsequent devices or associated circuitries.

5.1.1 PRE-DRIVER:

We cannot directly couple the TIP122 (NPN) to the op to-coupler since it requires large current for driving. We use the driver SL100 to boost the current level.

5.1.2 DRIVER:

The main principle of the driver is to amplify the current. It amplifies the 50mA current to2A, which is needed to drive the motor.

5.1.3 CONTROL LOGIC:

It consists of an SL100 and relays. Whenever we need to rotate the stepper motor we input high level through PA7 of PPI to SL100 70msec before. So SL100 produce logic low. Now the coil is energized and the 24v is connected to the coil of the driver by the relay.

6. VISUAL BASIC

The Microsoft VB programming system for windows is an exciting advance for anyone who is involved in writing window base applications. With this event driven programming engine and innovative, easy to use visual design tools, VB lets you take full advantage of the window graphical environment to built powerful application quickly. As more people began to use computers the isotonic and complicated languages used for programming became more of an obstacle. A language called BASIC was developed to counteract this. Its simplicity made it easy for the users to write amazing programs. Over the years this programming language was enhanced and developed. The demand for faster, simpler, smaller and easy to use software led to the development of Microsoft quick Base. This was in line with the programming language technology of the 1980's but an even bigger change was on the horizon namely, graphical user interface (GUI). With the advent of windows, users are able to work in a graphically rich environment. This made application much easier to learn and use. It also facilitated the use of multiple windows on the screen enabling to run more than one program at a time. Although this environment was like a boon to the user, life was suddenly a lot together for programmers. A simple program to display a message on the screen, which could be written in four lines in MSDOS, now, ran to two or three pages.

6.1 PROGRAMMING FOR WINDOW WITH VB:

The VB programming system packages up the complexity of windows in a truly amazing way. It provides simplicity and ease of use without sacrificing performance or the graphical features that make window such a pleasant environment to work in Menus, fonts, dialog, boxes etc are easily designed and these features require no more than a few lines of programming to control. It is one of the first languages to support event driven programming a style of program especially suited to graphical user interface. The aim in modern computer application is to have the user in charge.

Instead of writing a program that plots out every step in precise order, the programmer writes a program that responds the users' action like choosing a command, moving the mouse etc. Instead of writing on large program, the programmer creates an application, which is a collection of co-operating many programs. With VB such an application can be written with unprecedented speed and case. This project has been done with a virtual view of the traction of the train. It represents the animated view of the moving train with boogies with the multimedia effects etc.

6.1.1 FEATURES:

Improved performance. A data base creation tool. Visual data access with the data control so that it is possible to create data browsing application without writing code.

A new OLE (object linking and embedding) control that allows in place editing. A collection of common dialog boxes that streamline common user interface tasks. The ability to create pop-up menus anywhere in the application.

7. AUTOMATIC ADVANCE LANDING SYSTEM REQUIREMENTS

The onboard system offers a good accuracy in locations where there is good visibility of the geo stationary satellites. However, the lack of availability, especially in

Congested areas near or beneath airport terminals, is a

Known problem for most of the market EGNOS/GPS

Receivers. To overcome this situation ongoing research is being addressed for location-awareness transition using the wireless communication network (e.g., Wi-Max or Wi-Fi signal) together with an electronic gyroscope device. Surface guidance includes improvements to visual aids for automated guidance and control along assigned routes. However, for low visibility conditions, airport stakeholders may need additional means, such as a moving map, to monitor progress and compliance with the assigned route. In a future version, the onboard system will include improved

Visual aids for advanced surface movement guidance along assigned routes, such as a moving map to monitor progress and provide additional traffic information.

8. CONCLUSION

Smooth Take-off and Landing of many aircrafts in the airport. With the help of monitoring ambient parameters it can avoid confusion in arrival & departure of the aircrafts. Integration of these monitoring systems reduces time consumption, increases the flow of air traffic and reduced workload for airport stakeholders.

It is recommended to analyze the feasibility of extending the surveillance Voice recognition in noisy environments is also being addressed as part of the ongoing research.

9. FUTURE WORK

ADS-B technology to broadcast their position, speed, and altitude via a digital data link. It is recommended to analyze the feasibility of extending the surveillance Automated to the land kier model now transmission of signals between plane and land is using radio waves. These radio waves can easily be jammed. More over difficulty is allotting a different band of frequencies. If a satellite is involved this problem can be overcome. The current version of the A-Guidance system does not provide capabilities for the validation of surface movements in advance or automating functions. Automation functions for surface guidance are currently being evaluated with approach/departure operations. For flight arrivals, the TMO parameter merge with SMR data can be used to timely identify aircrafts. Correlating this information with flight data, it is possible to accurately determine assigned stands and estimate taxiing times up to blocks-on time. The main goal of such approach is to improve aircraft handling and turn-around times. Routing and control augmentations will be addressed in a future version with respect to current apron control procedures. Keep surveying non-cooperative object where the radar is not present. Aircrafts are usually equipped with ADS-B technology to broadcast their position, speed, and altitude via a digital data link. Ongoing research is being performed to analyze the feasibility of extending the surveillance and Control functionalities to address video monitoring Capabilities as well as solutions to keep the system functioning for indoor operational scenarios. Voice Recognition in noisy environments is also being addressed as part of the ongoing research.

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