# AIRPORT MANAGEMENT AND DEVELOPMENT SYSTEM

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## ABSTRACT

**Part I:** Many passengers, either Egyptian or foreigners, are not familiar to the Cairo airport. Egyptians themselves could be using the airport for the very first time. We are introducing a system into the Cairo international airport, offering the visitor a variety of options that reduces his hassle for finding information for places inside or outside the airport.

**Part II:** With the increase in Airport traffic, several approaches have been followed by Airport authorities for improving the efficiency of Airport operations. The Arab world's first system to present to Air Traffic Controllers reliable information on identification and location of aircrafts on the ground. The system provides complete control, guidance, and routing of movements.

Information is displayed on an overlaid airport map providing a clear user interface. Each aircraft on the airport maneuvering area is labeled with target information for presentation to the controllers.

## INTRODUCTION

The authors signed up for a professional IT training program the government was offering in coordination with IBM and Quality Standards for IT, ESRI's distributor in Egypt. The 6-month track aspired ESRI's packages through introductory, programming, and web customizing courses that would help us build a better GIS foundation.

At the end of the six months we were required to present a project that would reflect our new skills and tools. We programmed an application using visual basic in the transportation field. The application was admired by our instructors and colleagues who encouraged us sending a paper to the ESRI user conference so we can have the opportunity sharing the experience with others.

Several meetings were arranged with GIS professors, airport engineers, pilots, and airport authorities to get acquainted with the management system at the airport. It was essential that we had a good understanding of the airplane operations and passenger circulation. Our goal was to developing a useful application using GIS technology and respecting our limited time of the graduation project.

The application consists of two separate modules, directed to separate parties. The first module, we named CTG (Cairo Tourist Guide). Many passengers, either Egyptian or foreigners, are not familiar to the Cairo airport. Egyptians themselves could be using the airport for the very first time. We are introducing a system into the Cairo international airport, offering the visitor a variety of options that reduces his hassle for finding information for places inside or outside the airport. Moreover the applications interface was designed so that any non GIS user can easily cope with it. The systems database stores a complete inventory of the available services inside the airport. When we thought of the problem and how it could be best solved, we reached a conclusion using touch screens! These screens would be located at various places in the airport for easy access by the visitors.

The second module named SMA (Surface Movement Advisor) which is directed to the control towers to help in aircraft operations. We noticed they used traditional methods in their guidance and management. The use of a program that could provide visual guidance was necessary; this of course could be accomplished through GPS devices and GIS software.

## The Development Plans at Cairo International Airport [1]

1963: In March: Cairo International Airport Terminal 1 was inaugurated. It was designed to serve 5 million passengers per year. In that year the number of passengers was 8.18.000

1970: The number of passengers reached 1.268 million passengers.

1977: The Arrival hall no.2 was constructed.

1979: The Departure Hall no.2 was constructed.

1980: Departure and arrival Hall no. 3 was constructed, so the number of the passengers was 5.244 million passengers with an increasing rate of 314% than 1970.

1982: The new Runway 05R/23L was constructed.

1986: The inauguration of Terminal Building no.2 which designed to serve 3 million passengers /year.

1990: The number of passengers reached 7.311 million passengers with an increasing rate of 39% than 1980.

2000: The number of passengers reached 8.943 million passengers with an increasing rate of 22.3% than 1990.

2002: The number of passengers reached 8.393 million passengers with an increasing rate of 0.9% than 2001, and a decreasing rate of 6.2% than 2000 as a result to the 11th of September events.

The following flow diagram demonstrates the zoom to feature function:

**Inside Airport**

| Police | Telecomm | Services | Shopping & Dining | Health Care |

Buffer

Query

Select by location

Select by attribute

Find path

Zoom to feature
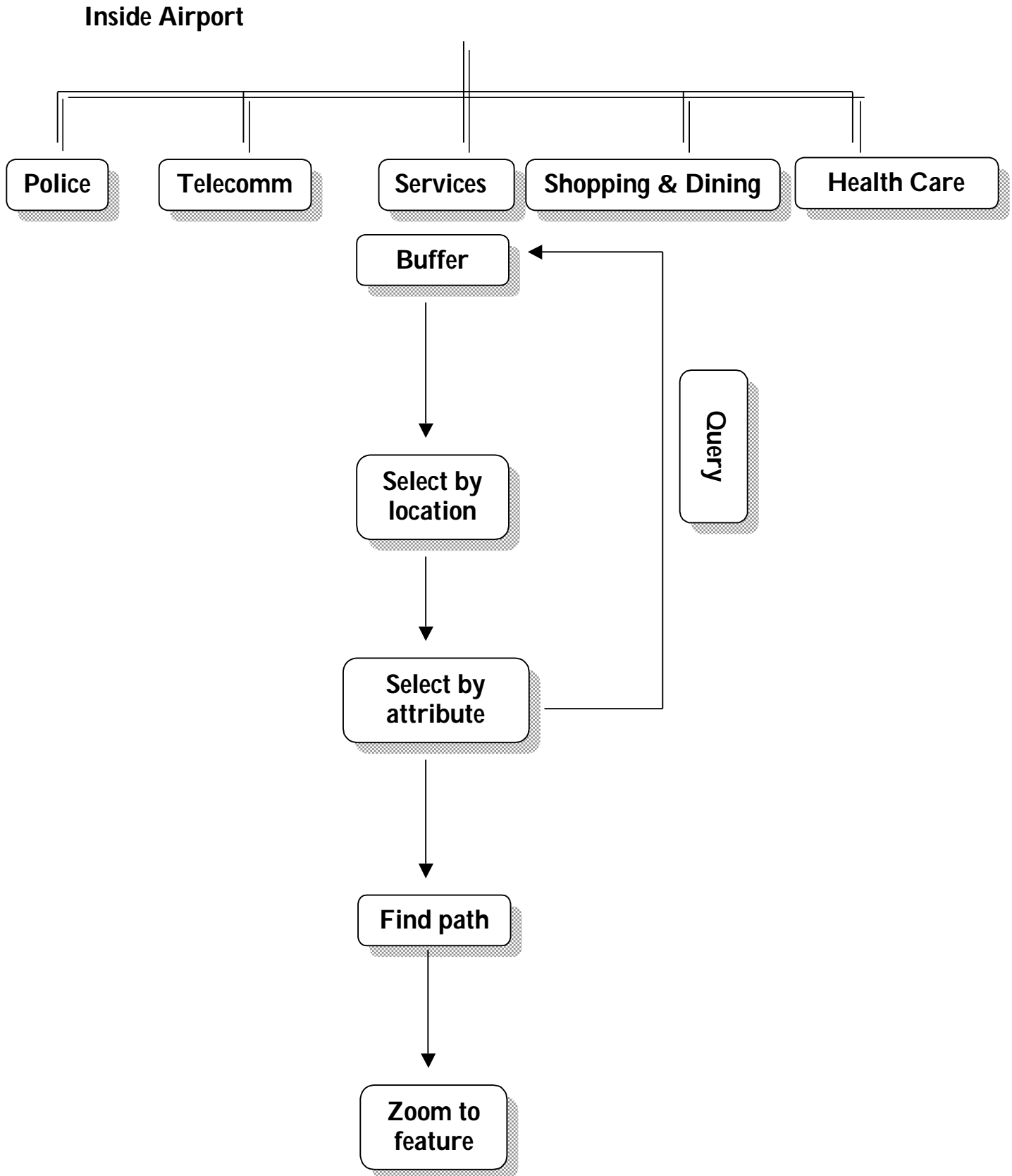
**Description of the flow diagram**

-The position of the each machine defines the origin of the network.

-A buffer is made around the machine with a default predefined initial value.

-All features within the buffer area are selected, whether they belong to the required destination layer or not.

-A selection is made from the previous selection, based on the destination layer.

-If no selected features are returned, the program recalculates the selection with a bigger buffer.

-The shortest distance is then displayed on screen for the user to take.

-The feature is zoomed into.

## Part 1: Cairo Tourist Guide

### The following illustrates an example using the application

The application was prepared with several languages to serve a wider range of passengers and tourists. Users are prompted to select the language (Figure 1). The languages included are: Arabic, English, French German, and Spanish. However, this paper only demonstrates the English language. The visitor then chooses the type of services he would like to access, either 'Inside' or 'Outside' the airport (Figure 2).



*Figure 1: Language Selection*



Figure 2: Selecting Services Inside or Outside the Airport

## Inside Airport

**1-Police Services:** Passport problems-Traffic matters and driver licenses-Customs-Work Permission-Lost & Found (figure 3).

**2-Shopping & Dining:** Restaurants-Café Shops-Gift Shops etc. (figure 4)

**3-Services:** Mosques-Car Rental-Airlines-Buses-Banks etc.

**4-Health Care:** Clinic-Ambulance-Pharmacy-Health Check.

**5-Telecommunications:** Telephones-Cyber Cafés-Post & Fax-Telex.
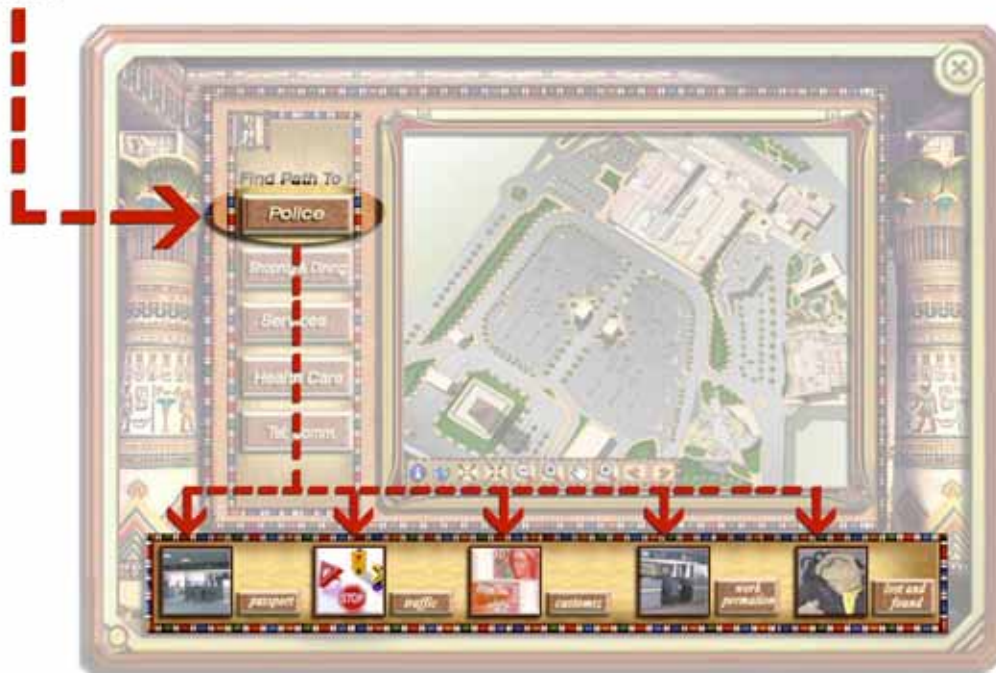


*Figure 3: Police Services*



*Figure 4: Shopping & Dining*

*Figure 5: Path to cyber café*

## **Outside Airport**

1. **Cairo Hotel:** This function would be very useful for tourists arriving at the airport without hotel reservations. The following demonstration illustrates how.

In figure 6; the tourists selects either 'Cairo hotel', or 'Take a tour', or 'Take a taxi' button on the touch screen. Here we're showing the case were the tourist proceeds with 'Cairo hotel'. In figure 7; the tourist can choose a hotel by one of two methods. In the first method he can choose to have a hotel sited away from a certain tourist attraction within a certain distance he specifies. The second method, the tourist gets to try GIS himself by touching on the map display area and choosing a distance. The previous two methods also allow the tourist filtering out the hotel class he desires.

Figure 8 illustrates the first method, where the tourist chooses 'The Egyptian Museum'. A 5 km buffer is automatically drawn around the Egyptian Museum, and now by selecting the 'Get Hotel' button on the lower right side of the screen, the window shown in figure 9 appears. All the hotels that lie inside the 5 km. buffer are listed. More over five star hotels are shaded in gold, four stars in yellow and 3 stars in a light purple color. The data shown is aggregated from the table shown in figure 10.
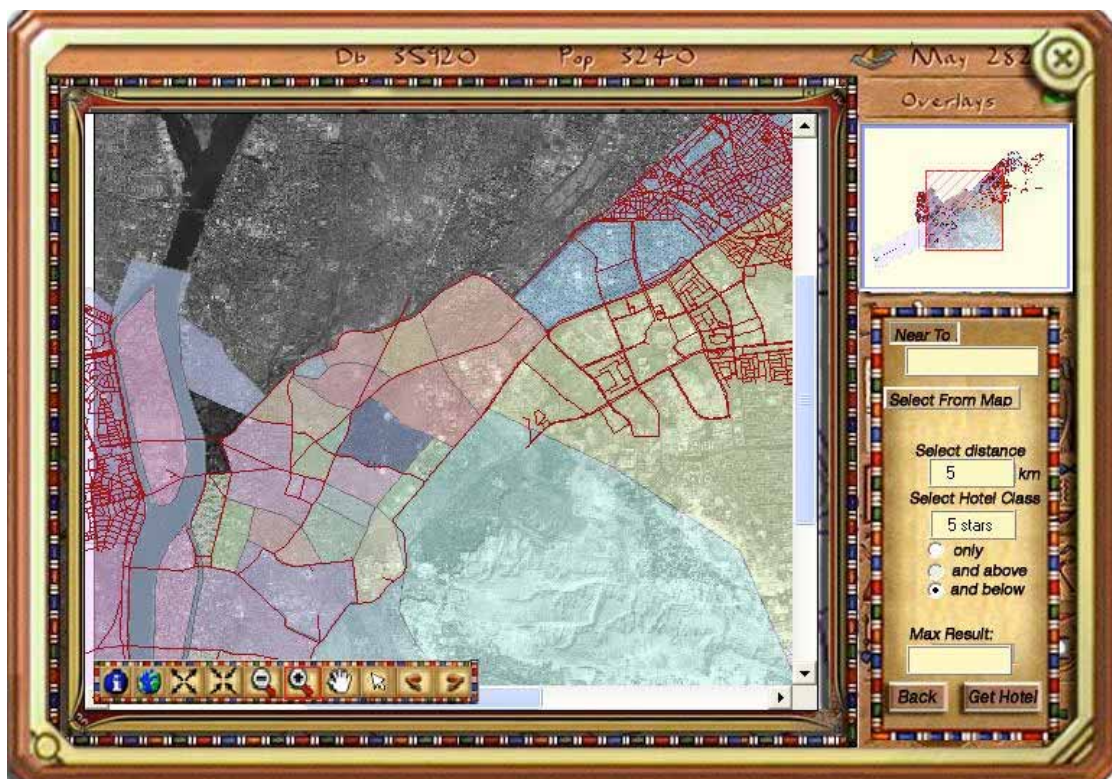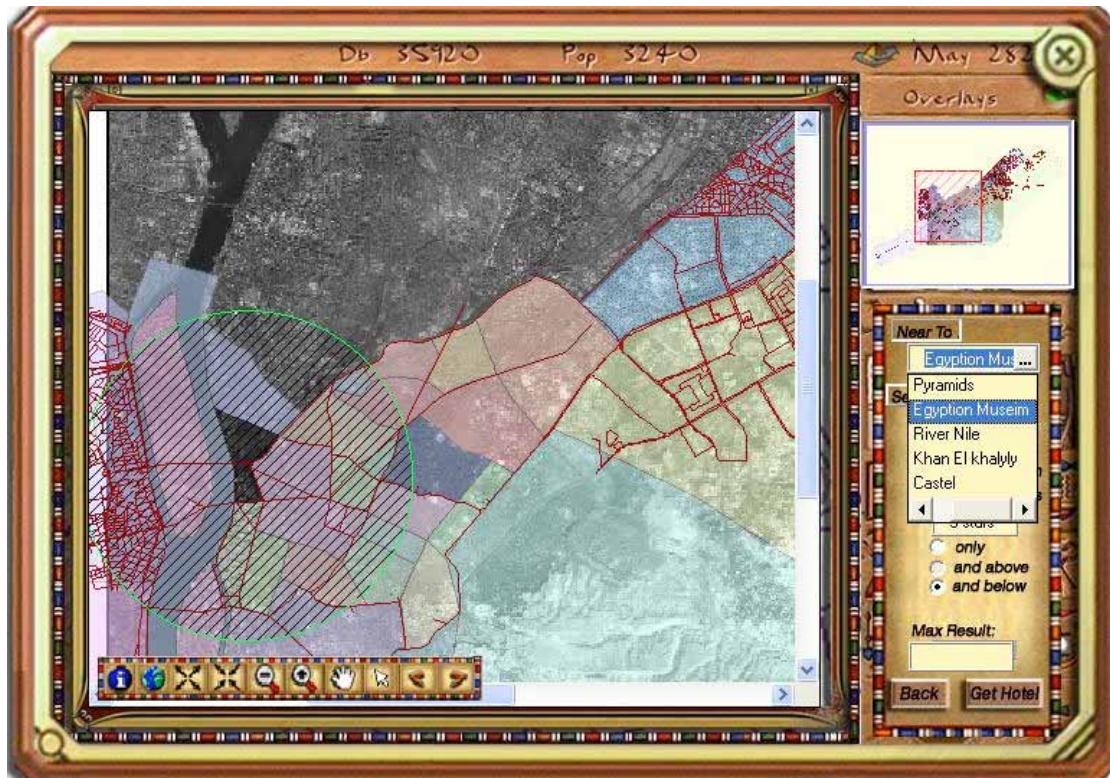
*Figure 6*



*Figure 7*

*Figure 8*



*Figure 9*

*Figure 10: Hotel layers attribute table in ArcMap*



*Figure 11: Pharonic layers attribute table in ArcMap*

2. **Take a tour:** In this function we thought of those tourists who are at the airport for a transit. We wanted them to make the most of their short stay in Cairo. The tourist specifies the duration he desires to tour, then chooses the sites he wants to visit assigning each a rank from 1 to 4. The application automatically calculates the time needed to travel between each site and adds it to a predefined time interval we inputted for each site representing the time spent at the site. Finally the application tells the tourist his tour program and path according to each sites priority. Of course not all sites would be included in the tour if the times short.

The tourist attractions in Cairo are categorized to four groups; Pharonic, Religious, Amusement, and Restaurants. (Figure 12)

*Figure 12*

3.  **Take a taxi:** This function has not been fully completed during the projects period, and therefore will not be demonstrated. Moreover, its idea is based on choosing your destination and any stops you need to make; the program will flash the path and give an approximate cost and time.

# Part 2: Surface Movement Advisor

The program initializes with an animated splash screen created in ArcScene. Once the loading is completed with the flash screen, the start dialog appears prompting the operator with three choices (Figure 13)

- Landing
- Takeoff
- Tracking



*Figure 13*

**Landing operation:**

A database is linked to this dialog with all the trips arriving at the airport. The database shows the last three hours and the next 5 hours, and due to the continuity of movement, the database is automatically refreshed each 25 seconds.

The application provides three unique colors for easy and quick identification of flight status:

*Records (rows) in blue:* represent all aircrafts that have landed in the last three hours.

*Records in red:* represent all aircrafts whose landing time is due in the next 30 minutes, in addition to the aircrafts whose time has passed and have not yet accomplished a landing. It's been put into consideration to that the operator can access an expected landing not due until the next two or three hours. This function is detailed in the next pages.

*Records in green:* represent all aircrafts whose landing time is due after the next 30 minutes, i.e. not scheduled for landing before 30 minutes.(Figure 14)



*Figure 14*

In cases where unknown aircraft models are found in the database, the operator is prompted with its wingspan.

The *Proceed* button: The Program deals with the flight outside the timer, meaning that the operator can access any flight by typing in its information.

The checkbox beside the *Automatic mode* text is checked by default enabling the automatic assignment for flight stands by the application. When unchecked the user has to manually assign each flight its appropriate stand using the proceed *button* this can be used in cases of emergencies or in extremely high traffic situations. The following example illustrates the use of the *Proceed* button.



*Figure 15*

The brainstorming of this idea arose from an actual incident at the airport. Air Traffic controllers were faced with a great number of VIP aircrafts, and that had to stand near a certain gate. In cases like these it's essential that the program not interfere with the locations of airplanes, and would be best for the Air traffic controller locating the airplanes according to his experience.

After selecting the airplane from the table, the airplanes dialog appears (figure 16) showing data aggregated from the table. In this example the airline is a B747 B from Emirate, its flight number is 'EK923' and expected for landing after 382 minutes.

*Figure 16*

After selecting 'OK', another form opens (Figure 17) which prompts the user to select the aircraft stand. There's a check box at the bottom of the page, when selected only the stands that satisfy the airplanes wing span are displayed. Unchecking the check box is quite a critical decision, the Air Traffic controller should be very careful. On the right, the aircrafts wingspan is displayed; this is useful for aircrafts that are rarely used and those unfamiliar to Air traffic controllers. The combo box on the upper left of the screen lists the available stands, moreover the right part of the form suggests the most appropriate stand depending on the nearest to the terminal building. There's also an extra text box on the lower right of the page which shows the stands maximum wingspan incase the suggested stand isn't chosen.

Once the stand is selected from the combo box it flashes and then the display zooms to it (Figure 18). As shown in Figures 17, 18 the stands are labeled by their exclusive numbers. Further more, occupied stands are given different symbols than those vacant.

*Figure 17*



*Figure 18*

Now its time for the Air traffic Controller choosing the best runway for landing, (Figure 19) this is usually made upon weather conditions and of course the vacant one. Selecting the 'Auto' button opens the form shown in figure 20.



*Figure 19*

Figure 20 shows the network solved from the data the Air Traffic Controller chose in the previous steps. The origin is the runway on which the aircraft is intended to land on, while the destination is the stand. A blue path in the display screen shows the solved network. Two neat tools are available, the first is the 'Full screen' button which opens a full screen of the display only. The second tool 'To text' opens a new window documenting various information on the aircraft in a printable form (Figure 21). A written format of the taxiway paths that the aircraft should follow are also recorded on the lower part of the window.

*Figure 20*

*Figure 21*

**Tracking:**

A conflicting situation is shown in figure 22; Aircraft MS 140 is on runway 05L/23R on its way to Moscow. At the same time Aircraft KL 553 is taxing for takeoff on the same runway to Frankfurt. The program automatically assigns a red color for runway 05L/23R reserving it. Further more, taxiways Delta, Echo, and Fox are assigned a yellow color on the display screen. This informs the Air Traffic Controller that these taxiways lead to a restricted zone which is the runway. While a green color is assigned to taxiway Alpha indicating that it's free for taxing.



*Figure 22*

**Modifying Flights**

The *Modify flight* button enables the operator to adjust the landing flights by adding, removing, and modifying them.
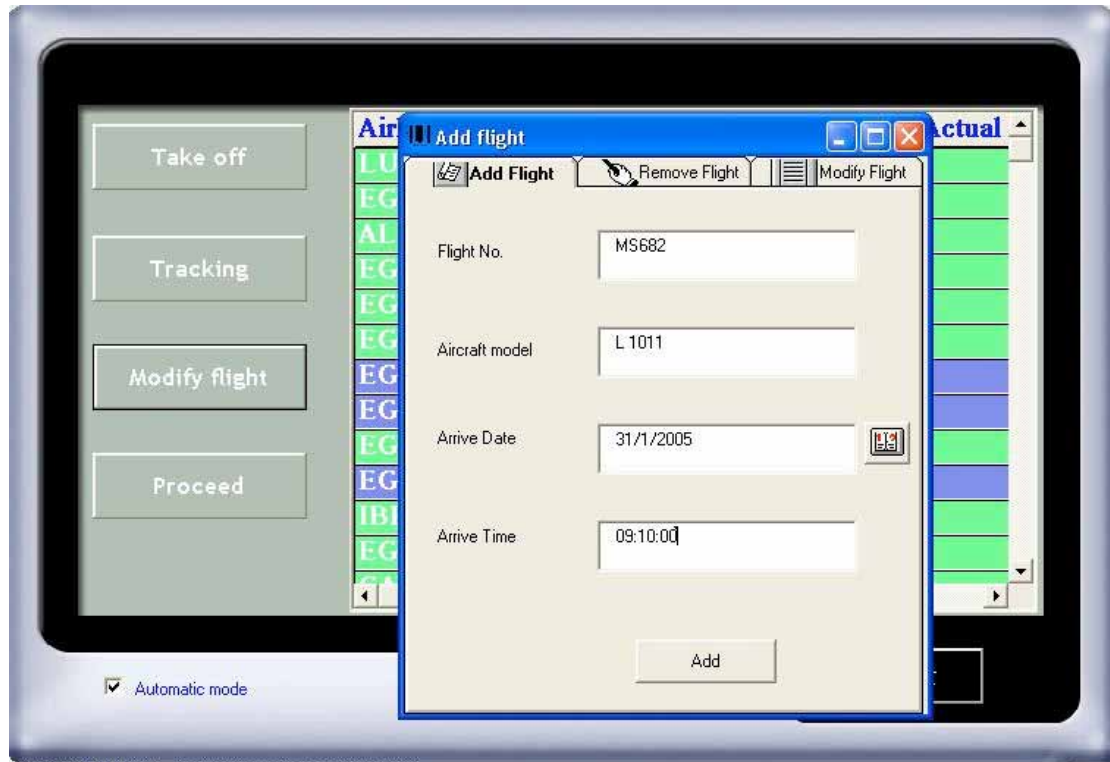


*Figure 23*

When pressing on the *Add flight* tab the operator is prompted to enter four categories involving the flight: The flight number is used to reserve the stand which the aircraft should occupy. Each aircraft has a wing span which is dependant on the model, and not all stands allow for all aircrafts. Small aircrafts are obviously allowed on any stand while as larger type aircrafts, like the B747, are allowed on specific stands. Most of the popular Aircraft models are predefined in the application with their wingspan; this is used for specifying the stand. For simplicity in entering the date, a calendar has been provided on the right side. A date format has also been programmed which prevents the operator from entering a false date and/or time.
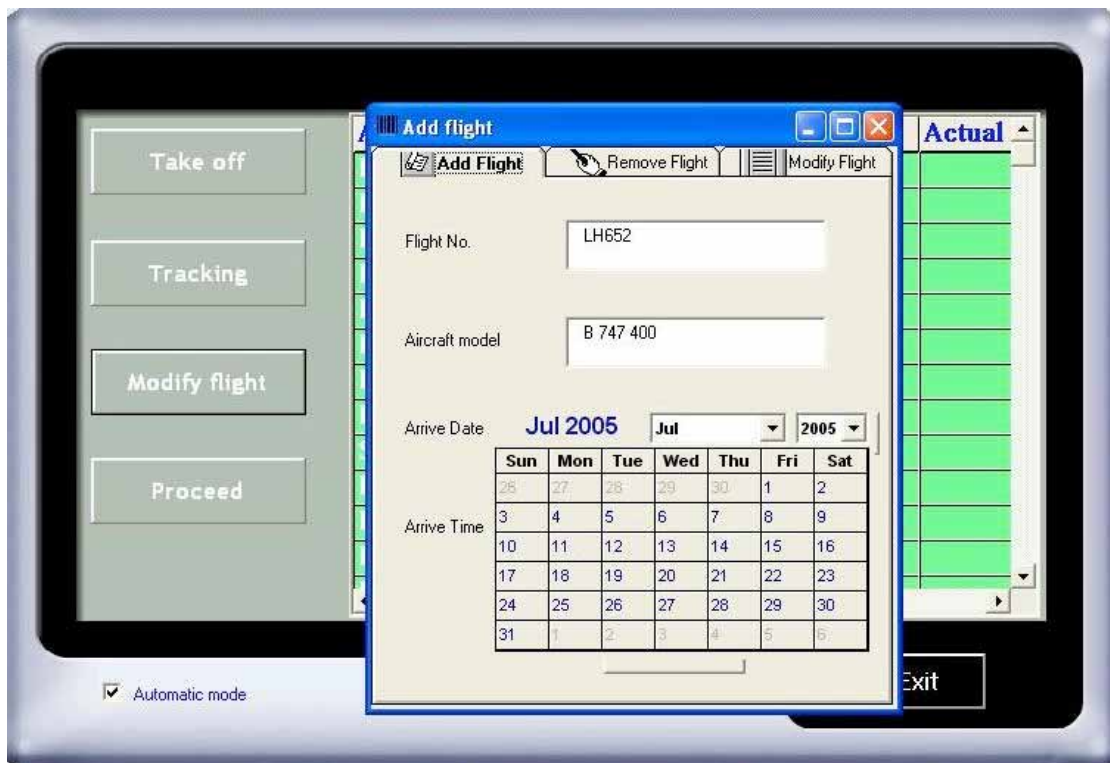
*Figure 24*

## Conclusions

This paper is a review of our graduation project from a 6-month IT professional training program offered by the Egyptian government with the coordination of IBM in the GIS track. The application reflects our new skills in the rapidly developing technology. We used visual basic 6.0, ArcEngine 9.0, and ArcInfo 9.0 to develop a user friendly interface providing a one-button click for various functions. The application consists of two modules.

The first was developed to help manage passenger and visitor circulation through the terminal. Further more, we prepared spatial data with most of Cairo's tourist attractions and their attributes, so any tourist can easily take a quick tour through the city. This surely would promote the tourism industry, more over; tourism agencies could have good benefit implementing the new technology.

The second was directed to the control tower to supply Air Traffic Controllers reliable information on identification and location of aircrafts on the ground. With visual information of aircraft movements and destination on an overlaid map, Air Traffic Controllers can easily update, delete, or add any flight. The application also prevents conflicts among aircraft movements.

# ACKNOWLEDGEMENTS

References
1- www.cairoairport.net

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