

# Unique and Low Cost Airport Multi-Application Control System

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## ABSTRACT

*This paper presents the design and implementation of an integrated computer based multi-purpose control system for airports. The system provides three main functions for the airport uthorities. The first function is the Airport Paging System which is an automatic paging system that will automatically announce user specified messages at specified times relating to the departure and arrival times of flights. This function will also allow for manual use of the paging system. The second function is the Airport Gate Monitor which is an automatic system that will monitor the airport gate and take photos of each person entering the gate. These photos are then are archived with date and time tag for security needs. The third function is the Passport Line Control which allows the airport authorities to monitor and activate the passport lines according to their needs. This paper consist of the software part which is developed using MATLAB and the hardware witch is developed using a personal computer, electronic circuits, and USB camera.*

## I. INTRODUCTION

Computer based control systems are very useful in our everyday life. We can use computer to control almost everything around us. It is also possible to use the computer to monitor an area for some critical situation. An example of such a situation is the main gate of an airport where it is important to keep photos of the persons entering the airport for security reasons. Another example is to use the computer based control system to control the sound paging system in the airport where departure and arrival flight information need to be announced at specific times. Computer based control systems are also useful for control of queue lines. The system can be used to activate any line by clicking a button on the computer screen. This paper presents the design and implementation of an integrated computer based multi-purpose control system for airports. The system provides 3 main functions for the airport authorities. The first function is the AIRPORT PAGING SYSTEM which is an automatic paging system that will automatically announce user specified messages at specified times relating to the departure and arrival times of flights.

This function will also allow for manual use of the paging system. The second function is the AIRPORT GATE MONITOR which is an automatic system that will monitor the airport gate and take photos of each person entering the gate. These photos are then archived with date and time tag for security needs. The third function is the PASSPORT LINE CONTROL which allows the airport authorities to monitor and activate the passport lines according to their needs.

The paper consist of the software part which is developed using MATLAB and the hardware witch is developed using a personal computer, electronic circuits, and USB camera. The control programs will provide the users of this system with graphical user interfaces ( GUIs ) that allow the users to operate the different functions of this system easily.

## II. AIRPORT PAGING SYSTEM

The AIRPORT PAGING SYSTEM which is an automatic paging system that will automatically announce user specified messages at specified times relating to the departure and arrival times of flights. In order to implement this function, the system will require both hardware and software parts. Figure 1.1 shows a diagram that illustrates the function of the AIRPORT PAGING SYSTEM.

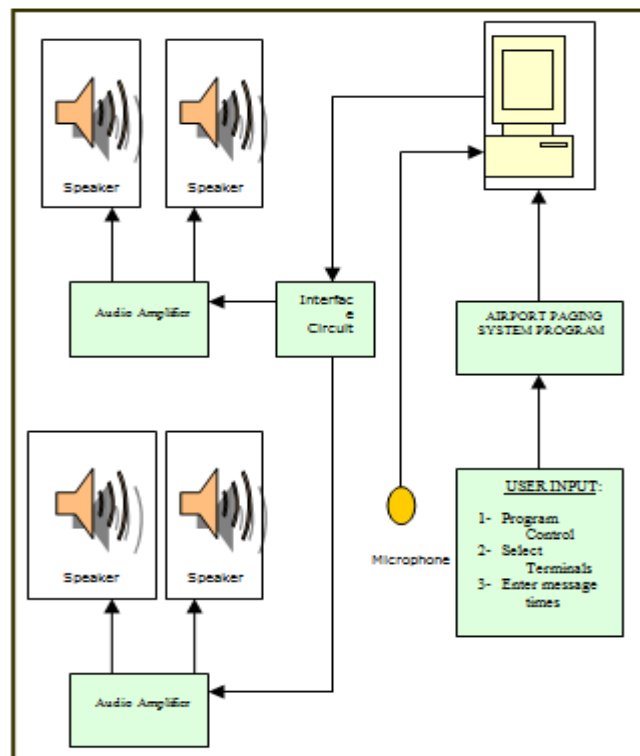


Figure 1.1: Airport Paging System

The AIRPORT PAGING SYSTEM will consist of 2 audio amplifiers each driving two speakers. One pair of speakers is located in the departure terminal and the other pair is located in the arrival terminal. The audio amplifiers are controlled by the computer so that they can be turned ON/OFF at the required times. The audio signals are produced at the sound card of the computer and fed to the inputs of the audio amplifiers. The user can select the terminals to which each message is directed and the time at which the message is played. An alternative solution for the Automatic Airport Paging System is to use manual functions for example the paging system can be operated by a person who will announce the different messages by himself according to the flights schedule. This solution will require an operator.[2]

### III. AIRPORT GATE MONITOR SYSTEM

The AIRPORT GATE MONITOR which is an automatic system that will monitor the airport gate and take photos of each person entering the gate. These photos are then archived with date and time tags for security needs. Figure 1.2 shows a diagram of the AIRPORT GATE MONITOR SYSTEM.[1]

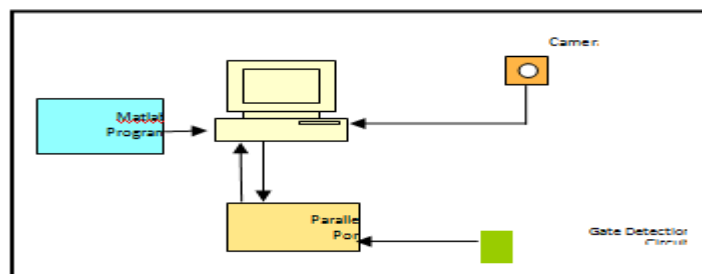


Figure 1.2: Airport Gate Monitor System

An alternative solution to the Gate Monitor System is to use a video camera with recording capabilities to continuously record the movement at the gate and record it for security use. This solution will need expensive video camera and video recording sets with expensive recording tapes.

#### IV. PASSPORT LINE CONTROL SYSTEM

The PASSPORT LINE CONTROL which allows the airport authorities to monitor and activate the passport lines according to their needs. Figure 1.3 shows a diagram of the PASSPORT LINE CONTROL SYSTEM.

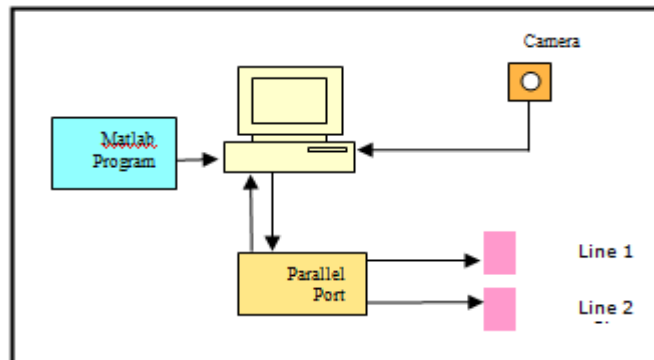


Figure 1.2: Airport Gate Monitor System

An alternative solution to the Passport Line Control System is to operate the lines manually by watching the number of people in the queue and switching the line sign accordingly.

#### V. PAPER ELEMENTS AND STEPS

The following work steps were performed during the course of this paper.

##### 5.1 Hardware Part:

- [1] Test and understand the computer parallel port, its pin out, and the different voltage levels appearing on them
- [2] Test and understand the image acquisition functions required to control the USB camera.
- [3] Design, build and test interface between the computer parallel port and the other parts in the system.
- [4] Design, build and test the interface circuits needed to control the audio amplifiers used in the paper.
- [5] Design and build a gate pass detection circuit using infrared transmitter and receiver and make necessary interfacing for them.
- [6] Build a complete working prototype model for the system for the purpose of testing and demonstration.

##### 5.2 Software Part:

- [1] Review of Matlab programming and control functions using the Digital Input/Output functions from the Data Acquisition tool box. The different functions used to operate the camera and the audio output were tested and verified to work correctly.
- [2] Design, write, and test a complete set of programs that will provide automatic monitoring of the gate and the USB camera. And, provide the control functions of the camera.
- [3] Design and test a graphical user interface program (GUI) that provides an easy interface to the user where the user orders are executed by clicking on pushbuttons on the computer screen.
- [4] Obtain a suitable USB camera with its driver to be used in the paper as the monitoring camera.

##### 5.3 Hardware Part

The hardware requirements for each of the three parts of this paper are listed below.

##### 5.3.1 AIRPORT PAGING SYSTEM

- [1] Two audio power amplifier with 4 speakers and connections
- [2] Interface circuit to control the audio amplifiers by switching them ON / OFF
- [3] Microphone
- [4] Power supply circuit.

##### 5.3.2 AIRPORT GATE MONITOR

- [1] Gate Pass Detection Circuit which is an infrared detection circuit that will be used to detect if the gate is passed by someone along with the circuit interface to the computer parallel port.
- [2] Power supply circuit including a voltage regulator.
- [3] USB camera with driver and connections to be used in image acquisition.

### 5.3.3 PASSPORT LINE CONTROL

- [1] LED indicator for both lines with connections to the parallel port.
- [2] Parallel port connection that gives access to the required lines of the parallel port (Data and Status). This will allow the outside circuits to be interfaced to the parallel port

### 5.3.4 Audio Amplifier Circuit

The audio amplifier circuit is required to take the audio signal from the sound card and produce a higher power at the speakers. The larger the area to be covered by the audio the higher the required power of the audio amplifier needed. There are several audio power amplifier options. One option is to use an integrated circuit to build an audio amplifier. A famous chip for this purpose is the LM386. The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value from 20 to 200. The inputs are ground referenced while the output automatically biases to one-half the supply voltage. The quiescent power drain is only 24 milliwatts when operating from a 6 volt supply, making the LM386 ideal for battery operation. Figure 5.1 shows a block diagram and pin configuration of the LM386 audio amplifier chip and figure 5.2 show the internal circuit diagram of the LM386 chip.

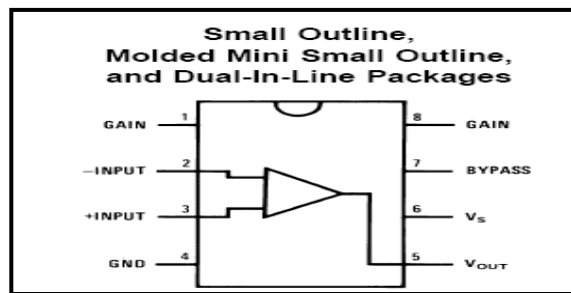


Figure 5.1: LM386 Audio Amplifier Chip

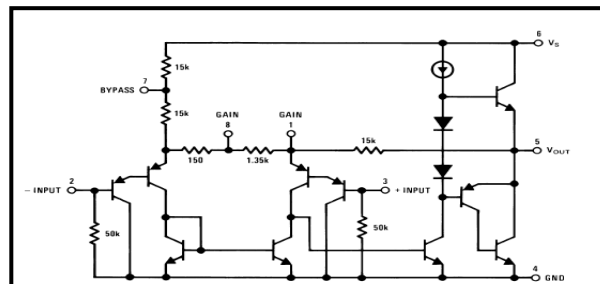


Figure 5.2: LM386 Audio Amplifier Circuit Diagram

Another option is to use a pre built audio amplifier circuits. This option will save time and will represent the actual situations in the airport because there will already be audio amplifier for the announcement of sound messages in the airport. Figure 5.3 shows a photo of the audio amplifier board used in this paper.

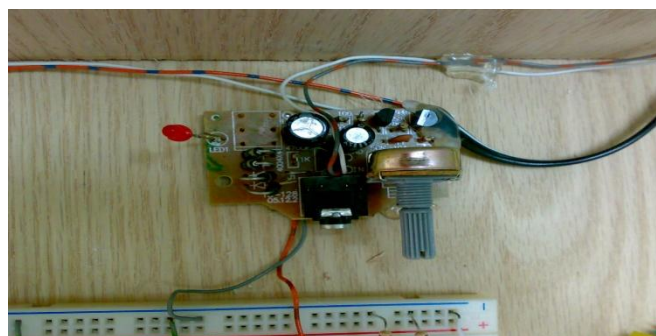


Figure 5.3: Audio Amplifier Board

### 5.3.5 Gate Pass Detection Circuit

An infrared detection circuit was designed and built to detect the presence or passage of a person through the airport gate. The detection signal will be connected to the parallel port of the computer for further processing. The circuit for the infrared detector is depicted in figure 5.4.

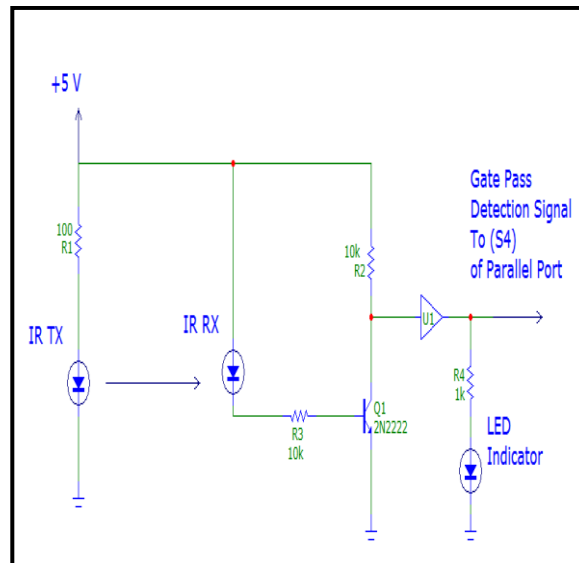


Figure 5.4: Circuit for Gate Pass Detection

The circuit consists of 2 parts, the infrared transmitter and the infrared receiver. The infrared transmitter section consists of a series connection of an infrared transmitter LED (IR transmitter) and a current limiting resistor. When current passes through the circuit, the IR transmitter will be ON and will produce an infrared beam. The infrared receiver section consists of an IR receiver LED that will drive a transistor circuit. The transistor used is the 2N2222A or any of its equivalence like the BCY 58. When power is ON and no IR ray, the IR receiver will not produce any current. This will keep the transistor OFF because no base current will flow and the collector will be at (HIGH) voltage. When IR ray is present at the IR receiver, a current will flow in the base of the transistor which will turn the transistor ON. This will take the collector point of the transistor to approximately 0 volt (LOW). The output of the IR detector will be taken at the collector of the transistor through a buffer gate which will prevent loading to the circuit and provide suitable interface for the digital input of the computer parallel port. A low voltage at the output indicates infrared path is not broken which means no body is detected. The presence of a body between the transmitter and the receiver will break the infrared path and the output will be high. The following table summarizes the output signal indication of the IR detector.

STATUS	IR Detector Output	LED Indicator
Body Present	High	ON
Body not present	Low	OFF

Table 5.1: IR Detector Output

### 5.3.6 Power Supply Circuit

The power supply circuit consists of a 5 volt voltage regulator and a non regulated power supply board. The power supply board provides 12 volts DC unregulated. Figure 5.5 shows a photo of the power supply board.

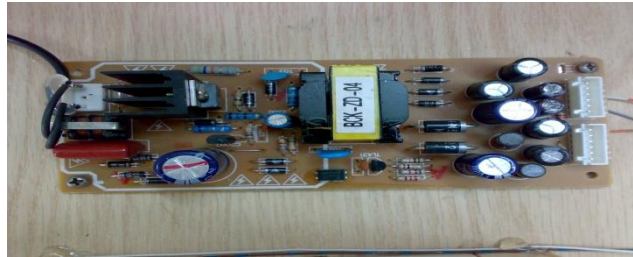


Figure 5.5: Power Supply Board

Since the circuits of this paper require regulated 5 volts DC supply, a voltage regulator is used. The voltage regulator used for this purpose is the AN7805 which is a 5 volt regulator from the 78xx series of regulators. The AN78xx series are 3-pin fixed positive output type monolithic voltage regulators. Stabilized fixed output voltage is obtained from unstable DC input voltage without using any external components. 11 types of fixed output voltage are available; 5V, 6V, 7V, 8V, 9V, 10V, 12V, 15V, 18V, 20V, and 24V. They can be used widely in power circuits with current capacity of up to 1A. Figure 5.6 shows the pi diagram of the 7805 regulator.

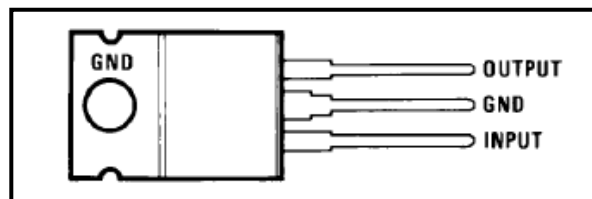


Figure 5.5: 7805 Regulator Pin Diagram

And figure 5.7 and 5.8 show a block diagram of the 7805 and a circuit diagram that shows how the 7805 regulator can be connected in a practical circuit.

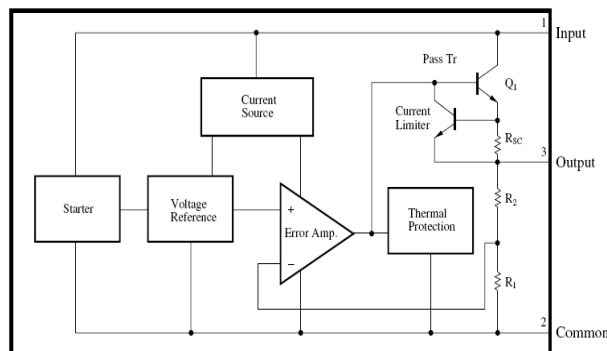


Figure 5.6: Block Diagram for The 7805 Regulator

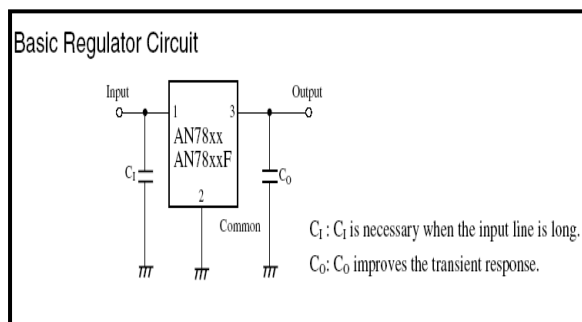


Figure 5.7: Connection Diagram for The 7805 Regulator

The complete power supply circuit is shown in figure 5.8. The capacitors used at the input and output of the regulator are to smooth and improve the DC. An LED indicator circuit is connected at the output of the regulator to provide indication of power ON or OFF.

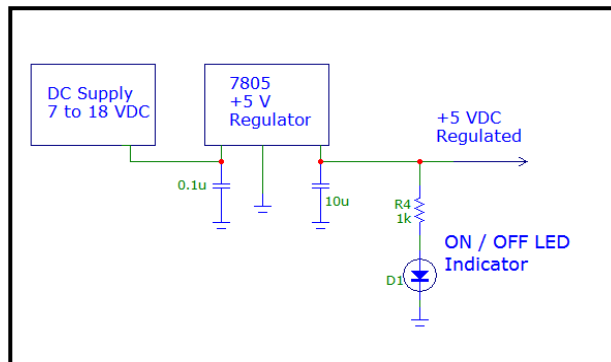


Figure 5.8: Power Supply and Regulator Circuit

### 5.3.7 Switching Circuit

Two switching circuits are used in this paper. The switching circuits are used to turn the Audio Amplifiers ON and OFF using logic signals from Pins D1 and D2 of the parallel port.

Figure 5.9 shows the switching circuit for the two audio amplifiers.

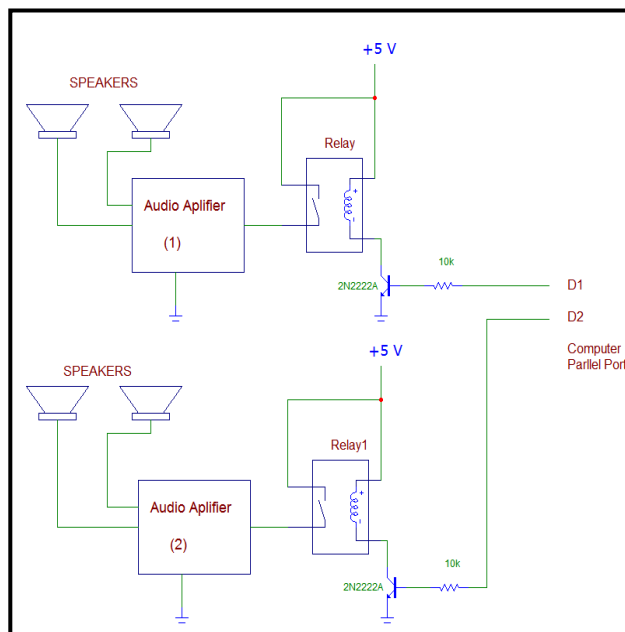


Figure 5.9: Switching Circuit for Audio Amplifiers

It is clear from the circuit diagram that when the input to the circuit from the parallel port is logic HIGH, the transistor will turn ON passing current through the relay magnet which will turn ON the audio amplifier. When the input to the circuit is logic LOW, the transistor is turned OFF which will turn OFF the relay and the relay contacts will be open turning the audio amplifier OFF. The relay used is a 5 V relay with contacts capable of handling the load.

### 5.3.8 Line Control Circuit

The passport line control circuit consists of two LED indicators with current limiting resistors. These two indicators are turned ON or OFF by the logic level coming from D3 and D4 of the parallel port. Figure 5.10 shows the circuit diagram for the Passport Line Control.



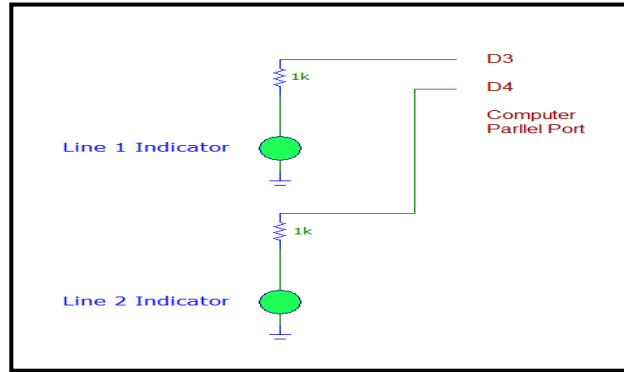


Figure 5.10: Line Control Circuit

The USB camera is also connected to the USB port to be controlled by the computer as needed.

### 5.3.9 Building paper Circuits

The complete paper circuit was built and each part is tested and verified to be working correctly. The circuits were built according to the design in the above sections. All electronic parts were obtained from local market. Figures 5.11 to 5.13 show the built circuits and model.

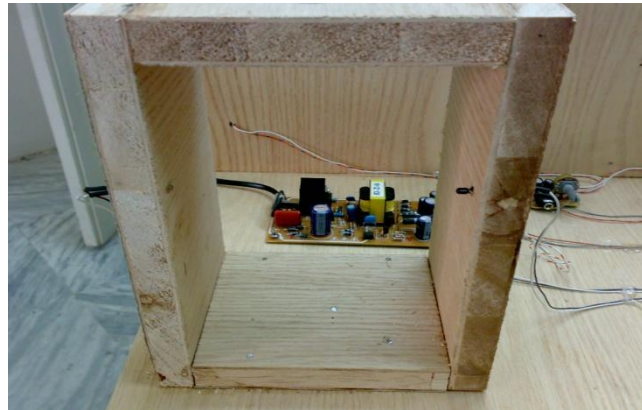


Figure 5.11: Prototype of Gate Pass Detection



Figure 5.13(a):Top view of a Part of Model



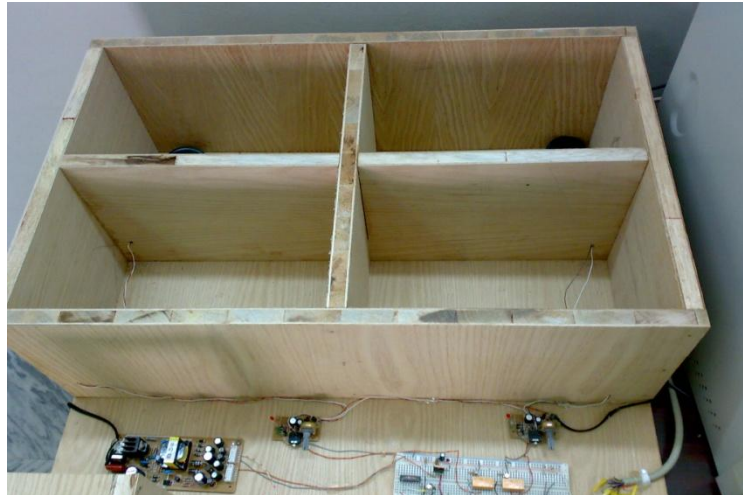


Figure 5.13(b): Top view of other part of Model

## VI. SOFTWARE PART

### 6.1 Airport Control Program Requirement

The Airport Control Program has 4 Graphical User Interface parts that must be designed to provide the user with the following functions:

- [1] The first GUI ( AIRPORT CONTROL SYSTEM ) is the main one and its function is to allow the user to select one of the following functions:  
( AIRPORT PAGING SYSTEM )  
( AIRPORT GATE MONITOR )  
( PASSPORT LINE CONTROL )
- [2] The second GUI ( AIRPORT PAGING SYSTEM ) allows the user to fully control the paging system of the airport.
- [3] The third GUI ( AIRPORT GATE MONITOR ) allows the user to fully control the gate monitoring system of the airport.
- [4] The fourth GUI (PASSPORT LINE CONTROL) allows the user to fully control the passport lines of the airport.

The following sections describe each of the GUIs and shows snapshots of them.

### 6.2 GUI (AIRPORT CONTROL SYSTEM)

The first GUI ( AIRPORT CONTROL SYSTEM ) is the main one and its function is to allow the user to select one of the function provided by this paper model.

Figure 6.1 shows a snapshot of the GUI.



The GUI allows the user to select one of the following functions: (AIRPORT PAGING SYSTEM), (AIRPORT GATE MONITOR), or (PASSPORT LINE CONTROL) by a bush button.

### 6.3 GUI (AIRPORT PAGING SYSTEM)

The (AIRPORT PAGING SYSTEM) GUI provide the user with full control of the airport paging system.

Figure 6.2 shows a snapshot of the GUI in its idle state.

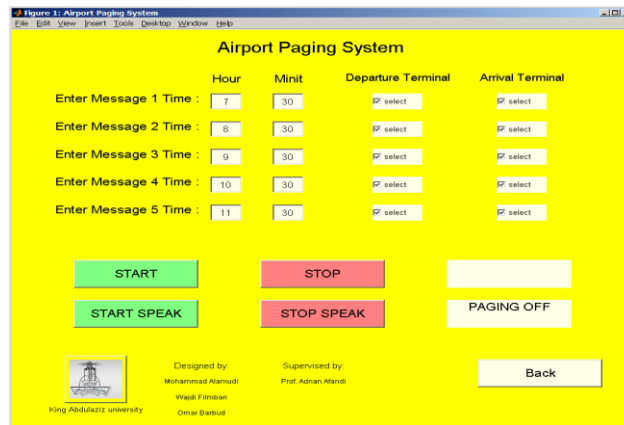


Figure 6.2: (AIRPORT PAGING SYSTEM) GUI – Idle

The (AIRPORT PAGING SYSTEM) GUI allows the user to select the terminals to which each of the five audio messages is directed. The two terminals are the Departure Terminal and the Arrival Terminal. The GUI has input fields to enter the time at which each of the messages is played. The GUI has push button to turn the automatic paging ON and OFF as shown in figure 6.2.



Figure 6.3: (AIRPORT PAGING SYSTEM) GUI – Auto Running

When the Start is pressed the system will continuously monitor the computer clock. When any of the message times is due, the system will play the corresponding message. In addition, the system will play the Azan when any of prayer time is due. The prayer times are calculated using a special prayer function. Figure 6.3 shows a snapshot of the (AIRPORT PAGING SYSTEM) GUI while running.

The GUI also allows the user to speak directly into the paging system if he wants. The (START SPEAK) (STOP SPEAK) buttons turn ON and OFF this feature. Figure 6.4 shows a snapshot of the GUI in the (START SPEAK) state.

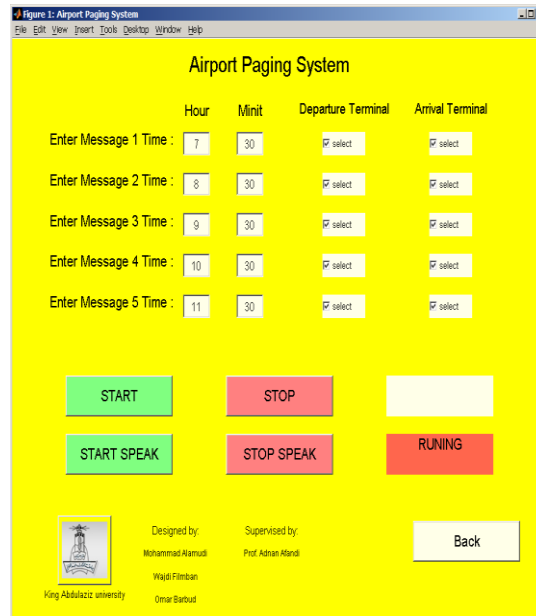


Figure 6.4: (AIRPORT PAGING SYSTEM) GUI – Start Speak

#### 6.4 GUI (AIRPORT GATE MONITOR)

The (AIRPORT GATE MONITOR) GUI provide the user with full control of the airport gate monitor system. Figure 6.5 shows a snapshot of the GUI in its OFF state.

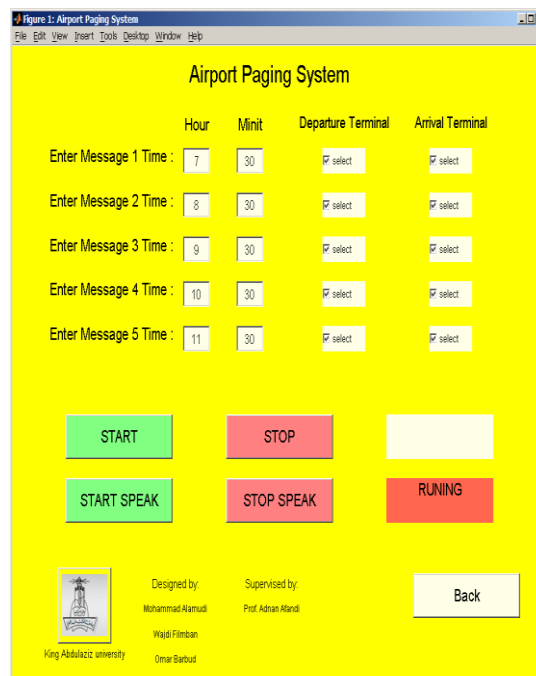
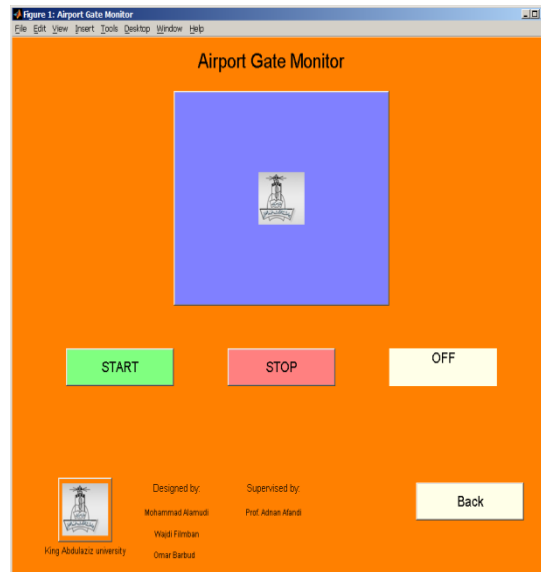


Figure 6.5: (AIRPORT GATE MONITOR) GUI – OFF State

When the (AIRPORT GATE MONITOR) is running, the computer will continuously monitor the gate pass circuit. When a person enters the gate, a digital signal is detected at the parallel port and the USB camera is turned ON.

The program will take a photo of the person entering the gate and post it in the GUI figure as shown I figures 6.6 to 6.8.



### 6.5 GUI (PASSPORT LINE CONTROL)

The (PASSPORT LINE CONTROL) GUI provide the user with full control of the passport lines. In this paper, 2 passport lines are assumed to exist. Each line has a light sign to indicate if it is active. The two signs are controlled by the user through the GUI. The GUI has 3 pushbuttons. 2 of them the (connect and disconnect) are used to activate the program or deactivate it. The third pushbutton is to turn ON the camera and see a live view of the passport lines so that the user can decide which line to activate. The GUI also provides 2 activation boxes, one for each line. Figure 6.10 shows a snapshot of the GUI at disconnect state and figure 6.11 shows a snapshot of the GUI at connect state with both lines activated.

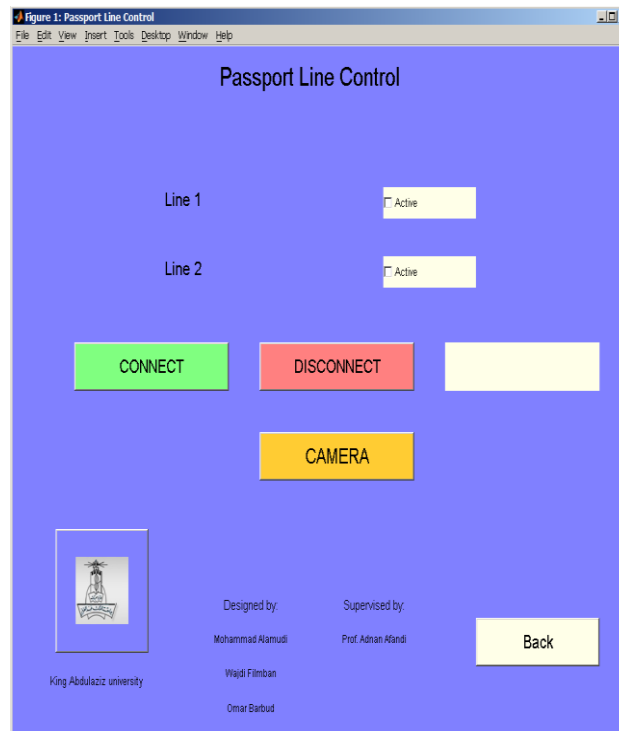


Figure 6.10: (PASSPORT LINE CONTROL) GUI – Disconnected State

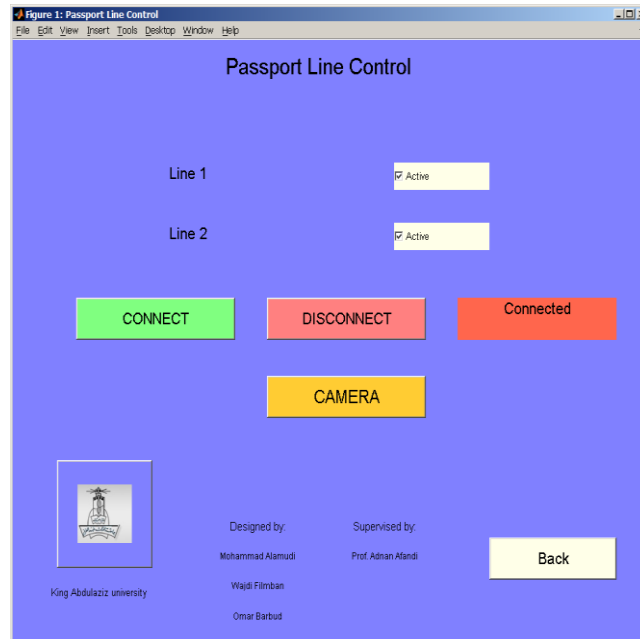


Figure 6.11: (PASSPORT LINE CONTROL) GUI – Connected

## VII. CONCLUSION AND FUTURE DEVELOPMENT

This paper presents the design and implementation of an integrated computer based multi-purpose control system for airports. The system provides 3 main functions for the airport authorities. The first function is the AIRPORT PAGING SYSTEM which is an automatic paging system that will automatically announce user specified messages at specified times relating to the departure and arrival times of flights. This function will also allow for manual use of the paging system. The second function is the AIRPORT GATE MONITOR which is an automatic system that will monitor the airport gate and take photos of each person entering the gate. These photos are then archived with date and time tag for security needs. The third function is the PASSPORT LINE CONTROL which allows the airport authorities to monitor and activate the passport lines according to their needs. The paper consist of the software part which is developed using MATLAB and the hardware witch is developed using a personal computer, electronic circuits, and USB camera. A final demonstration model is built to test and verify the functionality of the system. As a future development, the system can be expanded to cover more passport lines. Other functions can be added to control airport systems.

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