Development of a Computer-Controlled Security Gate System.

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ABSTRACT

In most organizations, security tools are still far below acceptable levels of sophistication since near-primitive tools are still being used to safeguard lives and property. This paper presents a prototyped computer controlled security gate system. The system was interfaced for control purposes to the computer through the digital computer's parallel port. The developed system consist of improvised electromechanically controlled barricades, a digital camera-based remote surveillance system, an interface circuit, and a control software written in Borland Delphi 6 Programming Language®.

The model was configured to depict a typical security gatepost while the control software allows trained security personnel to have a remote view of the automobile's boot, plate number, and to control the automobile's exit and entry through the system interface box. The developed model shows how sophistication can be achieved at a security gatepost with corresponding increases in cost-benefits from a reduced labor force.

(Keywords: security, centronic port, PC, sensors, electromechanical systems, surveillance system)

INTRODUCTION

Computer Process Control (CPC) is the systematic usage of a stored program digital computer to control Industrial and domestic processes [1]. This programmable form of automation involves the integration of a digital computer and associated chips, like programmable logic chips (PLC), and other analog and digital integrated circuits to design the products, plan the production, and control operations needed in manufacturing the products [2]. Merits accruable to this type of implementation include better working conditions for the workers, since there is less direct physical participation in the production process or possible area of application, increased productivity, and flexibility to deal with any changes, including waste reduction and improved quality control [3]. Some possible demerits include an acceleration in the rates of unemployment due to reduction in labor force, high initial costs, and increased dependence on maintenance. The digital programmability, flexibility, and processing power offered by digital computers make them applicable in numerous applications especially as intelligent controllers in different domestic and industrial applications [4].

Security gate automation is a process designed to extend the capacity of machines to perform certain tasks formerly done by humans, and to control sequences of operations with minimal human intervention. Various technologies used in this way range from the more obvious closed circuit television cameras (CCTV), tape recorders, listening (audio) devices, and devices designed to record computer key strokes [5].

This paper practically presents a personal computer (PC) enabled interactive system (PSG2005) that will allow security personnel to monitor, control, and organize the security operations in conjunction with electromechanical devices and a control program based on a set of specified security considerations in public places for reasons of protection, safety, and detection of crime. Security personnel will be able to remotely detect the presence of automobile at the gate and carry out the visual check of the automobile's front or back boot and plate number using appropriately placed moveable digital camera(s). The security personnel can then decide to either open or close improvised electromechanical-based normal and spike barricades on the exit or the entrance path of the organization security gatepost, through the system interface unit directly from the PC.

THE CENTRONIC PORT

The Centronic, or the parallel port, is a simple and inexpensive industrial standard interface designed for connecting printers to computer. The simplicity and ease of programming makes the parallel port popular in the electronics world, particularly for computer based process control applications [6, 7]. Parallel ports were originally developed by IBM as a way to connect a printer to a PC. They consist of a 25-pin connector known as DB-25 [8]. A typical DB-25 connector is shown in Figure 1.

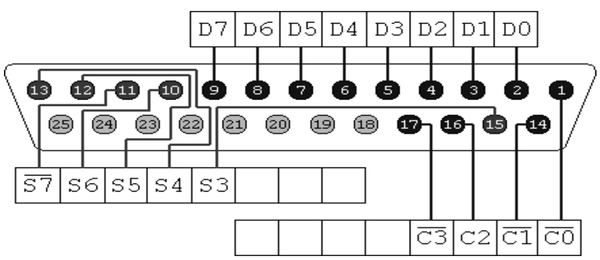

Figure 1: DB25 Connector for Parallel Port.

The PC sends eight (8) bits of data (a byte) at a time to a printer or any designed device connected to a parallel port at a time. These 8 bits are transmitted parallel to each other; as opposed to the same eight bits, being transmitted serially (all in a single row) through a serial port. The standard parallel port is capable of sending 50 to 100 kilobytes of data per second [9, 10].

The lines in the DB25 connector are divided into three groups, they are:

- Data lines (data bus)
- Control lines
- Status lines

As the name refers, data is transferred over data lines. Control lines are used to control the peripheral, and of course, the peripheral returns status signals back to the computer through status lines. These lines are connected to Data, Control, and Status registers internally. The word connection does not mean that there is some physical connection between data, control and status lines. The registers are virtually connected to the corresponding lines such that whatever is written to these registers will appear in the corresponding lines as voltages. This can be measured with a multi-meter, and whatever is sent to Parallel port as voltages can be read from these registers [3]. For example, if '01' is written to Data register, the line Data0 (D0) will be driven to +5v. The Data lines and Control lines can be programmatically turn on and off in the same way.

In PCs, these registers are input/output mapped and have unique addresses. These addresses must be known in order to work with the parallel port. In Windows 2000® and higher operating systems, the address can be seen by navigating through: Settings > Control Panel > System > Hardware > Device Manager > Ports (COM & LPT) > Printer Port (LPT1) > Properties = in Resources > Resource Setting. It is usually between '0x378-0x37F'. This is hexadecimal number base (mod 16). As an example, 0x378 equals to 888 in decimal form. For a typical PC, the base address of Line Printer 1 (LPT1) is 0x378 and of LPT2 is 0x278. The Data register resides at this base address, Status register at base address + 1 and the control register is at base address + 2. So, if the base address is known, addresses of other registers can be calculated [3].

THE SYSTEM DESIGN

The system design is premised along monitoring, controlling, and organizing the manual based entrance and exit security gates operations to an automatic one using digital computer's hardware and software control mechanisms with improvised electromechanical systems that consists of a movable barricade and spiked barricade. This system aims to control high voltage, high current, electromechanical devices and to acquire video images with a digital camera. The input to the computer consists of sensor signals that signify presence and absence of automobile. The output of the computer will be used to activate and deactivate the electromechanical devices introduced to the entrance and exit security gates. In a bid to achieve these, five questions had to be answered:

a) How will the presence or absence of an automobile be detected by the digital computer?

b) How will the output of a digital computer be made compatible to drive the high voltage/ current of the improvised subsystem?

c) How will the automobile be forced to allow the desired remote security checkup(s)?

d) How will the camera be conveyed to the desired location (vertical and horizontal movements) to give remote visual content of the vehicle's boot?

e) What condition(s) or action(s) constitute the required security checks at the gate?

Figure 2 shows the overall system design for the automated security gate. As shown in Figure 2, presence or absence of automobile was achieved by utilizing entry and exit sensing control circuits. The digital computer was made compatible in the design through electrical isolation with the use of a buffer control circuit to drive the improvised high voltage/current barricade control circuit. The design also makes provision for an acceptable visual capture of video images by digital camera whose movement is controlled by the motorized camera control circuit.

Figure 3 shows the circuit diagram of the interface unit shown in the overall system design for the automated security gate (Figure 2).

For the sensing control circuit, a simple photo-resistor was used to detect the presence and absence of an automobile on the developed entrance and exit security gates prototype model. The 74Ls04 Hex inverter/buffer integrated circuit chip was used to isolate electrically the PC from the high current/voltage of the barricade control circuit. The PC, thus, imparts the desired intelligence onto the barricade control circuit made up of direct current motor control circuits for both reverse (open) and forward (close) movements using the saturation and cut-off operation of C1815 fast-switching NPN transistors. The barricade control circuit controls two DC motors, one for the movable mechanical barricade and the other for the spiked barricade.

The motorized camera control circuit was also achieved with the use direct current motor control circuits for both horizontal and vertical movements (X-Y axis) for ease of capturing the contents of an open automobile boot. The multimedia capabilities of the digital computer in terms of audio was harnessed using appropriate software tools to direct an average driver what to do upon arrival at the security gate via a loudspeaker. The data and status registers of the PC parallel port were used to perform the desired input and output port programming to control the interface unit.

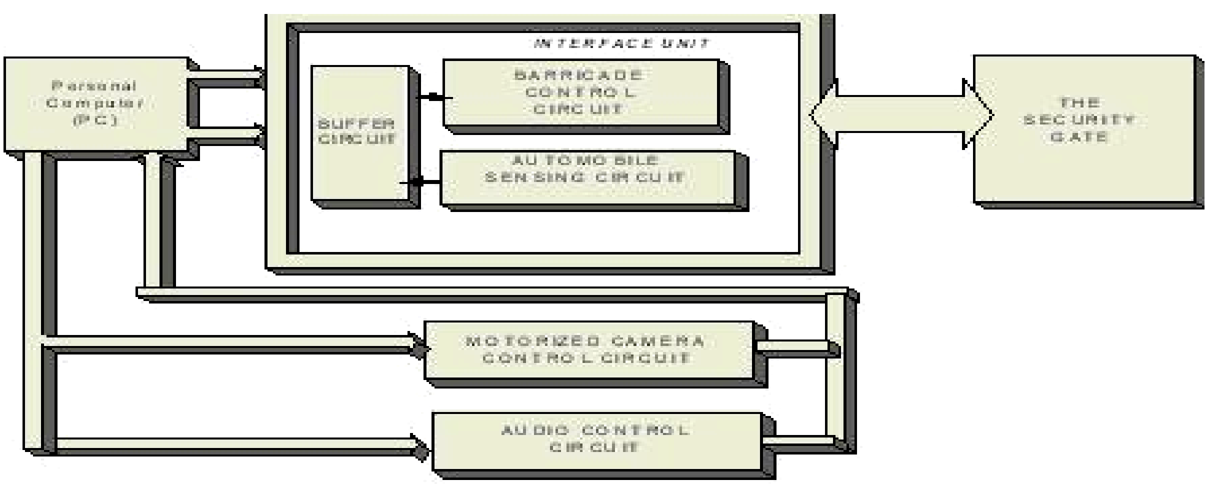

Figure 2: Overall System Block Diagram.

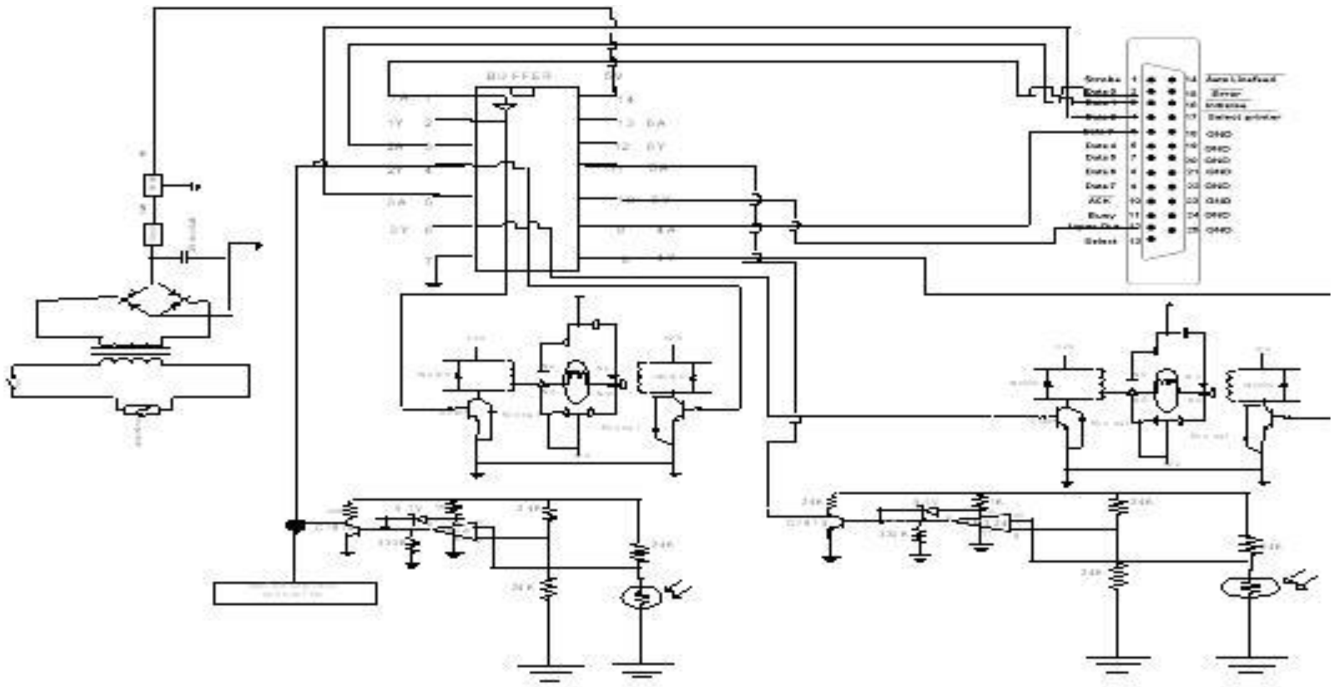

Figure 3: PSG2005 Interface Circuit Diagram.

The control software through parallel port (status register) lines detects the absence or presence of automobile through output voltage of C1815 connected to the output of LM324 op-amp. The direct current motor control circuits are controlled by the parallel port (data register) lines for precise movements determined by the software control.

As shown in Figures 4a and 4b, rectilinear transmission of motion was transferred to the loads (the movable and spike barricades) by the prime mover, the direct current motor. This was achieved mechanically by motion transmission systems made up of gear systems, nut, threaded screws and chain drives. The rotation of the direct current motor is transmitted to the sprocket gear. The rotational motion of the sprocket gear transforms energy into the chain drive, which then transmit energy to another sprocket gear attached to the threaded shaft screw. Along the screw is the nut which moves the load along the chosen direction of the rotation of the prime mover.

In the actual construction of a working model of PSG2005 shown in Figure 5, the system hardware was separated into two, the modelled prototype entrance and exit security gatepost and the overall system interface unit.

Figure 4 a: Snapshot of Motion Transmission System of PSG2005.

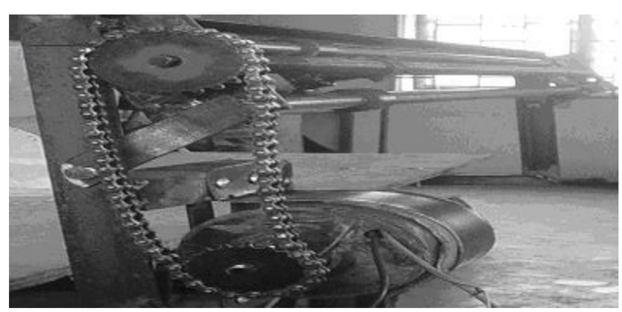

Figure 4b: Expanded View of the Motion Transmission System of PSG2005.

The overall system interface unit consists of the designed and constructed sensing circuits, motor control circuits for the camera and the barricades. Figures 6 and 7 show some of the constructed electronic hardware; sensing circuits and a motor control circuit, respectively.

Figure 5: The Working Prototype of PSG2005.

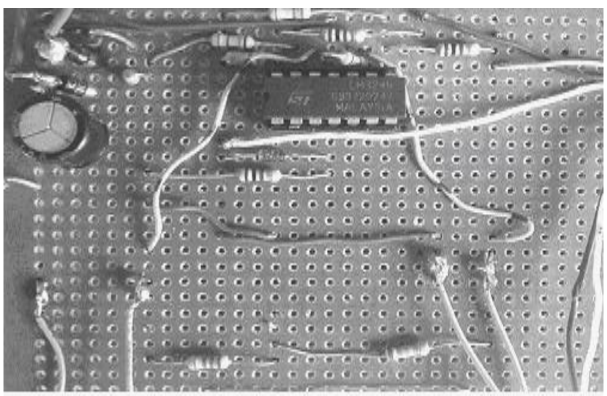

Figure 6: Sensing Control Circuits for Detection of the Presence of Automobiles.

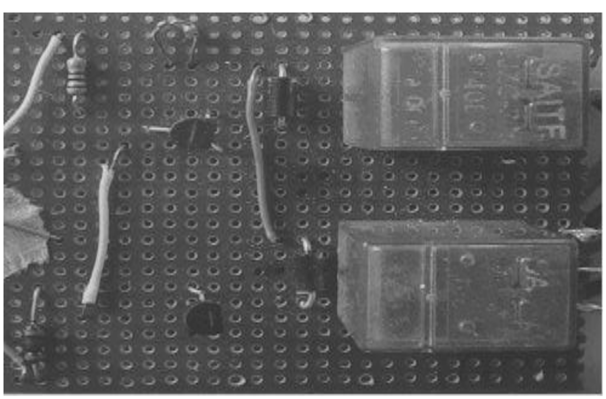

Figure 7: Control Circuit for a DC Motor.

THE SYSTEM CONTROL PROGRAM

The system control program directs the constructed electromechanical devices in the modeled entrance and exit security gates via the overall system interface unit. The software was developed with Borland Delphi 6.0®.The software could perform the following functional objectives:

- Sensing the presence or absence of an automobile.

- Directing the motorized camera subsystem to move in X-Y plane as the case may be to locate the contents of an automobile boot based on the command from the supervisor at the security centre.

- Scan the content of an automobile boot and display the video image on a visual display unit.

- Open and Closes the motorized barricade on the road based on the result of scanned automobile boot content based on the command from the supervisor at the security centre.

- Take a log of automobiles passing for any desired period.

THE SYSTEM OPERATION

PSG2005 was developed as a closed loop (feedback) control system. The overview of the system operation is shown in Figure 8. The digital signal flowing into the computer will enable the authorized security personnel at the security center to know the presence of an automobile, control the motorized camera subsystem to move in X-Y directions (as the case may be) in order to have a remote surveillance of the automobile's boot, plate number, and driver's face. Control of the motorized barricade subsystem for opening during a precise period for an automobile to move out of the gate so that the exit sensor retriggers the barricades back to their previous states. By such closed loop control, the desired flexible and cost effective remote surveillance security system was achieved.

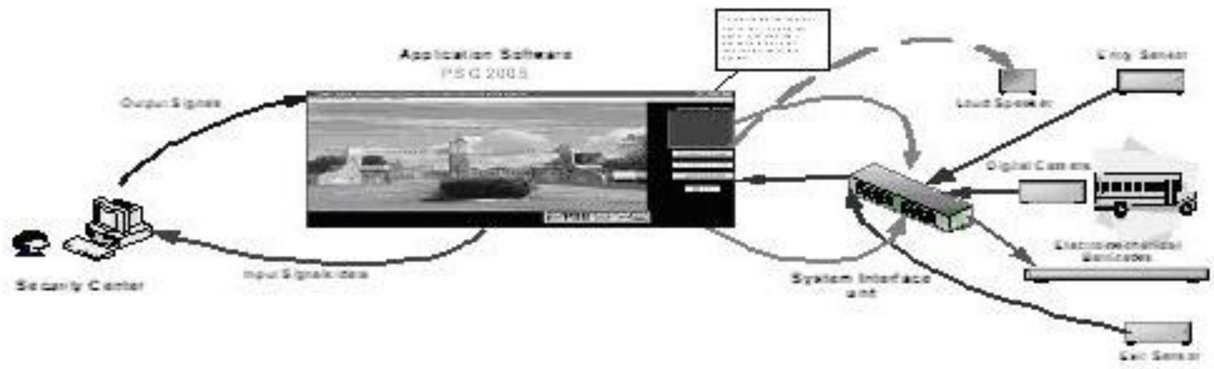

Figure 8: Overview of the System Operation.

CONCLUSION

This paper has successfully presented a functional, low cost computer controlled security system that controls and monitors some of the operations at typical security gateposts. Implementation of the surveillance system through the camera mounted on the DC motorized-camera system helps to incorporate the intelligence of the human eye within the system. In addition, the inclusion of a spike barricade system, in addition to a normal barricade, prevents non-cooperative drivers from escaping without being checked. A real-life equivalent of the prototype can be developed with minimal development costs and with relatively low operational costs as compared to the present manual operations for such check-points.

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SUGGESTED CITATION

Arulogun, O.T., O.M. Olaniyi, and A.A. Ipadeola. 2008. “Development of a Computer-Controlled Security Gate System”. *Pacific Journal of Science and Technology*. 9(2):371-376.

Pacific Journal of Science and Technology