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PIC Based Model of an Intelligent Gate Controller

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Abstract* — To have an idea is good but to have the idea replicated with a good model is better. This explains the decision to have sensitive places protected, using an intelligent gate controller system, from unwanted individuals or group of individuals that usually take advantages of loose security systems at the point of entry. The microcontroller used for this model is PIC16F84A programmed using "miKroBasic pro for pic". This microcontroller serves as the main controller linking the software components with the hardware components. Features that serve as the input are the face of the driver as well as the plate number of the vehicle. These features are extracted using pattern recognition protocols and processed in Luxand SDK interface and character recognition is done using the OCR tool. In addition, voice control module is embedded in the design using Java programming language to make the process audible via a speech rendering element. This model is built using hardware components, such as; electronic switches in form of relays, the 12V step down transformer, a wooden cabinet, surveillance cameras, dc motor, a monitor, and a host of others.

***Index Terms*— DC motor, microcontroller, mikroBasic, OCR, Surveillance, voice recognition**

I. INTRODUCTION

This model is made up of two separate elements so to speak. The first is a surveillance system and the second is the automatic control of the gate system. In order to have the desired secured area, the use of a computer system and pattern recognition protocols are employed to set up a novel controller which operates the gate depending on the signals received from the processed input parameters such as the face recognition between the software and the hardware components are greatly utilized in this work. Previous works were aimed at the control of the gate using either a remote control or a sensor at the entrance of the gate to detect the presence of any object that is trying to make a passage [1].

Automatic gate control technologies are making use of the power of camera surveillance equipment into the most valuable prevention, safety (security tool) available today for both commercial and residential applications. The use of surveillance camera systems can alert you before threatening situation worsens, as well as to provide you with an important record of events.

The prevention or resolution of just one crime would be enough to pay for camera surveillance system equipment many times over. Considering the alarming rate of crime covering the entry and exit of automobiles, coupled with the need to ameliorate it, it is however imperative that a system that can tackle this by effectively identifying and matching vehicles and its corresponding owners be designed.

The hardware components involved in the physical control of the gate are; relays as electronic switches, dc motor, microcontroller, power supply unit and a sensor. The feature that makes this work differ from the conventional automatic gate control system is the software which utilizes the technology of pattern recognition in order to grant entry access. The face of the driver and the plate numbers of the vehicle being driven are captured using surveillance cameras. These parameters serve as the input data to the designed controller. There are various other projects that utilize surveillance cameras system. These existing systems are usually applied in traffic safety & monitoring, school & workplace security, crime fighting & prevention [2].

The rest of this work is divided into sections such as; automatic face recognition, principal component analysis, PCA algorithms, methodology, design and construction, results and discussion, and conclusion.

II. PATTERN RECOGNITION

Pattern recognition as evident in the face recognition and number plate identification phase of this project is the act of taking in raw data and taking an action based on the category of the pattern.

A pattern is an entity, vaguely defined, that could be given a name for example Fingerprint, speech signal, DNA sequence, Human face, handwritten word. Pattern Recognition is the study of taking in raw data and taking an action based on the category of the pattern [7]. It is the study of how machines can observe the environment, learn to distinguish pattern of interest and make sound and reasonable decisions about the categories of the pattern [3, 4]. Most research in pattern recognition is about methods for supervised learning and unsupervised learning [8].

A. PIC Microcontroller (PIC16F84A)

PIC16F84A belongs to a class of 8-bit microcontrollers of reduced instruction set computing (RISC) architecture. The following terminologies apply to microcontrollers; (i)Program memory (FLASH) is used for storing a written program. Since memory made in FLASH technology can be programmed and cleared more than once, it makes the microcontroller suitable for device development.

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(ii) Electronically erasable programmable read only memory (EEPROM) is a data memory that needs to be saved when there is no supply. It is usually used for storing important data that must not be lost if power supply suddenly stops. For instance, one such data is an assigned temperature in temperature regulators. If during a loss of power supply this data was lost, we would have to make the adjustment once again upon return of supply [5].

B. Application of PIC16F84A

PIC64F84A perfectly fits many uses, from automotive industries and controlling home appliances to industrial instruments, remote sensors, electrical door locks and safety devices. It is also ideal for smart cards as well as for battery supplied devices because of its low consumption.

EEPROM memory makes it easier to apply microcontrollers to devices where permanent storage of various parameters is needed (codes for transmitters, motor speed, receiver frequencies, etc). Low cost, low consumption, easy handling and flexibility make PIC16F84A applicable even in areas where microcontrollers had not previously been considered (example: timer functions, interface replacement in larger systems, coprocessor applications, etc).

In system programmability of this chip (along with using only two pins in data transfer) makes possible the flexibility of a product, after assembling and testing have been completed. This capability can be used to create assembly-line production, to store calibration data available only after final testing, or it can be used to improve programs on finished products [6].

C. Pin Description

PIC16F84A has a total of 18 pins. It is most frequently found in a DIP18 type of case but can also be found in SMD case which is smaller from a DIP. DIP is abbreviation for Dual-In-line Package. SMD is an abbreviation for Surface Mount Devices suggesting that holes for pins to go through when mounting are not necessary in soldering this type of a component.

III. METHODOLOGY

The block and schematic representation of this work is detailed in figure 1 and 2 below. Image capturing at the point of entry is done via the surveillance camera. The necessary feature is extracted and processed/compared with the information stored in the data base, processed by computer and gives out logic instructions for the control of the gate system.

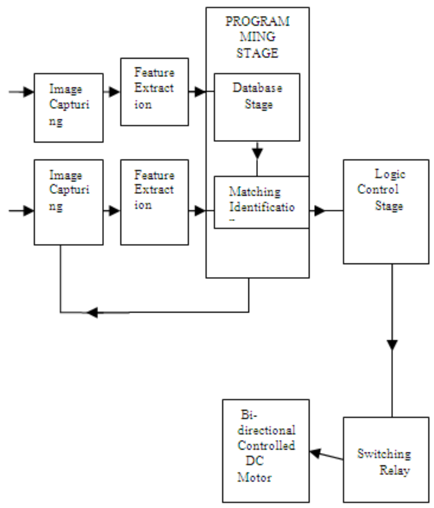

Figure 1: Block diagram of an intelligent gate controller system

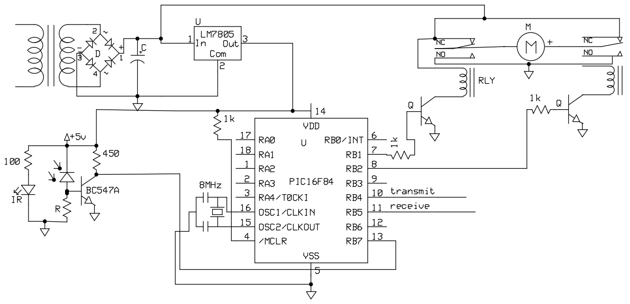

Figure 2: The full schematic of an intelligent gate controller system

Three software tools were used as highlighted hereunder:

1. LUXAND SDK (Face Recognition)
2. OCR Tools (Character Recognition)
3. Visual Studio. Net (2008)

The face and character recognition software were combined in visual studio environment. The Luxand software was used to analyze the face captured from the camera for faces while the OCR tools were used to convert the plate number pictures into characters. Figure 3 below shows the interface of the setup.

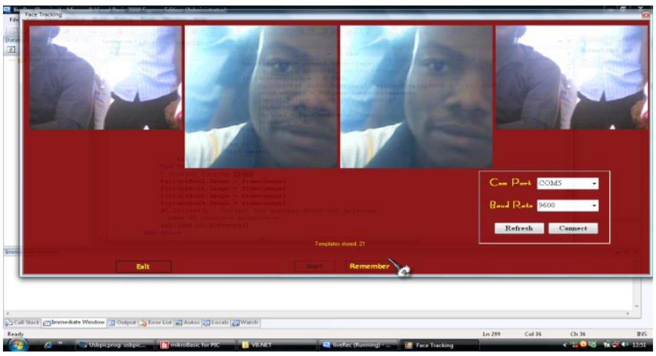

Figure 3: The software interface

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A. Electronic Lock System

The design of an electronic lock system used for the opening and closing of the gate system is shown in figure 4 below:

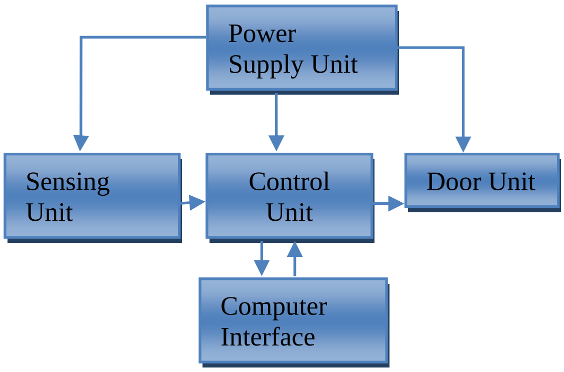

Figure 4: The Block diagram of an electronic lock

The electronic lock system comprise of the power supply unit, the sensing unit, the door unit, the control unit, and the computer interface unit.

B. Power Supply Unit

The power supply unit comprises of the transformer TR1, full-wave bridge rectifier DR1, a filter capacitor C1, a regulator U1 and a smoothing capacitor C2.

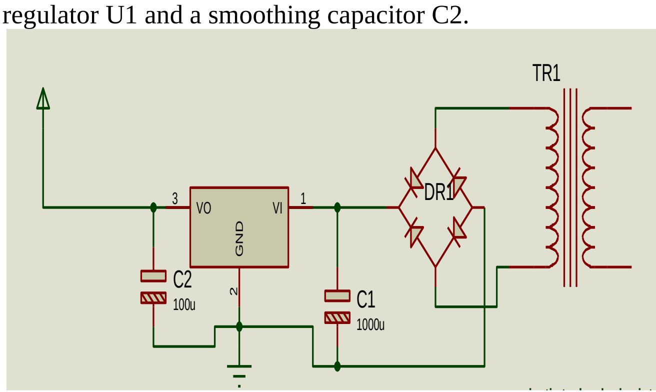

Figure 5: Power supply unit schematic

The transformer is a 500mA/12V step down transformer. This 12V AC supply is converted to 12V DC supply and is regulated by a 3-terminal regulating power transistor. Smoothing of the resulting voltage is carried out by the capacitor C1. The output of the regulator is connected to a smoothing capacitor C2 to prevent the effect of voltage spike from having effect on the functionality of the circuit.

C. Sensing Unit

The sensing unit for the system is incorporated into the software which means that the sensing operation is automatically controlled.

D. The Control Unit

The major active component in the control unit is the PIC16F84A, which is a programmable interface controller shown in figure 6 below:

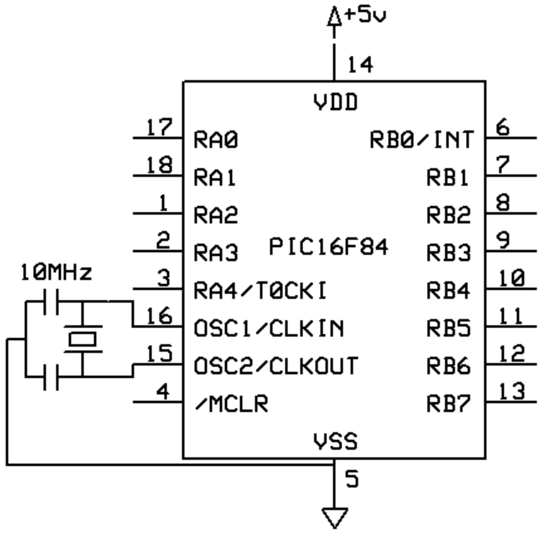

Figure 6: The Control Unit Schematic

The IC is programmed using the MicroBasic Integrated Development Environment (IDE) and the ICprog IDE software. This software is used to program the IC in the basic language and then transferred into the memory of the PIC. The control unit gets the input from the entry unit, decodes them and then takes the following steps:

- Generate the timing signal for the system
- Decodes the input
- On receiving signal from the sensing unit will activate the computer
- Receive Signal from the signal
- Control the gate opening and closing

The rate at which the IC executes the instruction in its memory will depend on the value of the crystal oscillator connected to the PIC.

The number of instructions executed by the microcontroller per second is calculated as given below:

Value of the crystal oscillator (XT) used = 8MHz

Number of instructions/second = $\frac{\text{Value of XT oscillator}}{4}$

E. The Gate Unit

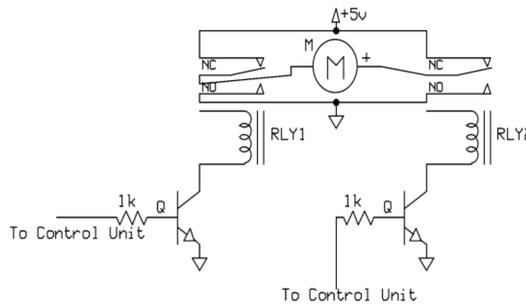

Figure 7: The Gate Unit Schematic

The gate unit consists of the electromechanical switch and the dc motor as shown in figure 7. The door unit is made up of the rack and the pinion which helps in moving the door mechanism. The electromechanical switch (relay) is responsible for control of the motor to the desired direction.

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IV. RESULTS AND DISCUSSION

Having programmed the microcontroller using the mikroBasic IDE interface, the hexadecimal representation of the code is transferred into the memory of the PIC through a linker as displayed below in figure 8 and 9.

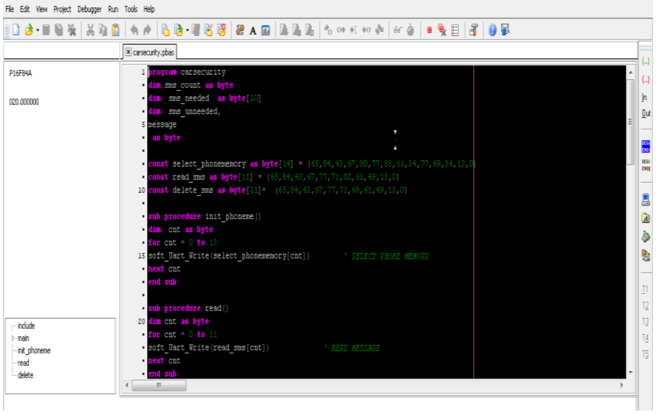

Figure 8: The MicroBasic IDE interface

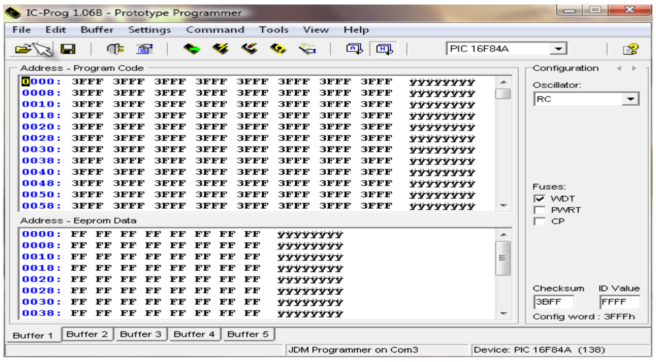

Figure 9: The PIC Program IDE interface

The voice processing of the system is carried out in the Java environment and highlighted as shown in figure 10 below:

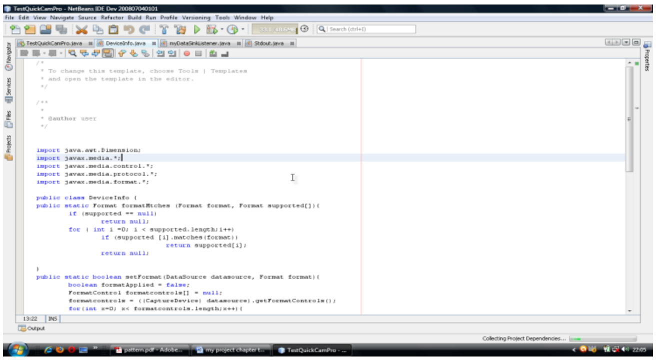

Figure 10: The voice control interface (Java interface)

A. *The Model Construction*

The construction of the system was in stages, the stages involved in the project construction are:

1. Circuit Assemblage/construction
2. Model Design
3. Software design

The model structure was designed using a wooden television cabinet, modified into a stand for the surveillance cameras and the computer. Pyrex plastic was attached to the stand to form an enclosed unit. The gate was attached to the Pyrex plastic. The plastic was screwed to the stand with bolts and nuts. The enclosed space was shown in figure 13. The floor level of the stand accommodates the computer as well as other peripherals.

B.Circuit Assemblage /construction

For best engineering practice, the materials used for constructing this model were locally sourced. The construction started from the assemblage of the circuit components on a Vero board, this was done according to the specification given in the circuit diagram. The components were soldered after the assembly. Each stages of the coupling of the various components were tested to prevent error in the entire system which if accumulated may cause major problem. The circuit assembly is shown figure 11 below:

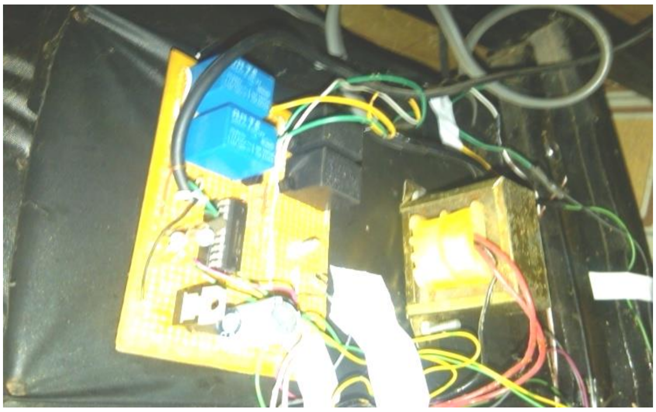

Figure 11: Components on Vero board

C. *Gate Unit*

This unit was attached to the side of the model. This section was made from a DVD drive system to give a scenario of a sliding gate. The gates were placed on both sides of the model so as to depict entry and exit points. The gate unit is connected to the relay on the circuit so that whenever the circuit decides on which of the gates to control, the corresponding relay operates. The picture of the gate unit is shown figure 12.

Figure 12: The gate unit model

D. *Hardware input source (Camera)*

This system, being a system that will monitor both entry and exit, uses four surveillance cameras, two of which will handle the face of the driver on entry and exit and the two others will handle the plate number on entry and exit.

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The two cameras that will capture the face of the driver are placed at the top end of the model to perfectly capture the facial images. The two other cameras are placed on the sides of the model which is a little lower than the level of the first two surveillance cameras to perfectly capture the vehicle's plate numbers as well. Figure 13 shows the locations of the cameras.

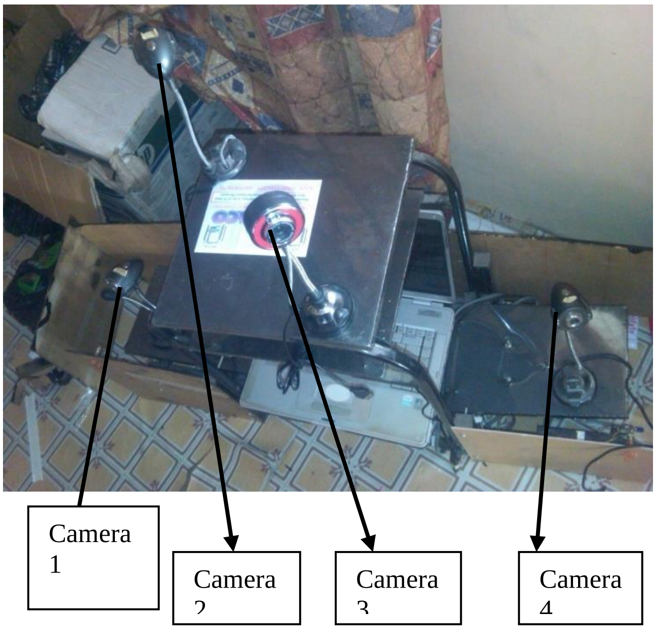

Figure 13: Camera locations

Due to the fact that there are finite numbers of USB ports on all computers, the system requires a USB hub for the connection, the USB Hub that was used has four ports that is needed. Figure 14 shows the USB Hub used.

Figure 14: USB Hub

E. Discussion

Once the system is powered on, the PIC will resume continuous checking through the surveillance camera used as sensors. Immediately the system identifies a vehicle, the control unit sends a signal to capture the face and the plate number of the incoming or outgoing vehicles. If the vehicle is coming in, the system only captures the face of the driver and plate number and does comparison with what is stored in the data bank. The gate opens or remains closed as to the authenticity of the input data. For areas where visitor's vehicle are allowed, at the entry point, the system only captures the face of the driver and the plate number then opens the gate. At the exit point, the system does the capturing again and compares the data with what it captured at the entry point. If the images or patterns match the exit gate opens. Otherwise, it remains closed.

V. CONCLUSIONS

This model could be utilized to provide the needed safe haven for all. Final products could be turned out from this model to lower the production costs. The power of soft computing in combination with hardware systems could be further explored to churn out novel products that would be useful for all. More intelligent gate system controllers of this nature should find their ways to all important and sensitive outlets to reduce cases of attacks. The "trustworthiness" in terms of response and performance of this model is highly commendable.

The use of mobile monitoring device(s) could be considered in future research.

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