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Design & Implementation of a Low Cost Microcontroller Based Automatic Security System

S M Salim Reza, Wahidul Hasan, S M Saleh Reza

***Abstract*—Automatic system is preferred over the manual system especially in the big city where social structure and the infrastructure of the houses are changing rapidly. This paper presents design & implementation of a low cost micro controller based automatic security system to prevent any unwanted entrance inside home. The project is combination of two parts - software and hardware. The software part is basically MATLAB along with mikro Pro C. Software Mikro Pro C is used for microcontroller programming. Matlab code detects the entrance and sends the information to the hardware. Hardware part consists of microcontroller, buzzer, led, LCD, resistor, USB to Serial Converter, keypad, mobile. In this part microcontroller receives signal from USB to Serial Converter via UART and turns on the alarm, display on the LCD and generates a call to the system owner. The proposed design has a various desirable features such as low cost, compact size, simpler control and maintenance, and higher efficiency.**

Keywords— Automation; Security; Webcam; MATLAB; Microcontrolle;

Introduction

One of the most common questions that rise in human mind is this: should security testing be based on automatic or manual methods? The major advantage of automatic security system is that it saves manual labor, hoards energy and also improves quality, accuracy and precision [1-3]. The CCcam security systems [1] available in market always need an observer to monitor the system and it always capture pictures and store videos in PC. As a result it requires large space in hard drive to store the data. To preview any unfair entrance, owner has to go through the whole stored videos. This is a time consuming and lengthy process. So in this paper a cost effective and space Saving security system for apartment, Office and industry is designed and implemented. The project is about building an "Automatic Security System". As technology of world is developing day by day electronic equipments that are required to build security systems are more available in local market. There are lots of automatic security systems. Still researchers are working in this field to make this system more efficient, accurate and cost effective [1-6].

S M Salim Reza
Assistant Professor, Dept of ICT.
Bangladesh University of Professionals (BUP),
Dhaka, Bangladesh

Wahidul Hasan
Independent University, Bangladesh;
Dhaka, Bangladesh

S M Saleh Reza
Adjunct Faculty
Daffodil International University, Dhaka, Bangladesh.
PhD researcher
Bangladesh University of Professionals, Dhaka, Bangladesh.

The main objective of this project is:
a) To save the hard drive space.
b) To eliminate human monitoring.
c) To ensure the security.
d) Building the project with minimum cost.

I. METHODOLOGY

This system stores pictures during any intruder entrance in the vision of the camera. At that time the system generates a call to the owner and turns on security buzzer which helps to prevent any unfair entrance. All the steps of this system are controlled by MATLAB programmer and microcontroller system. The total security system of the design contains three parts: (1) environment, (2) MATLAB detection and (3) microcontroller system. The whole automated system is shown in Fig. 1. At first MATLAB capture pictures by webcam and analyze those images when any intruder entrance is found. After that it sends information to microcontroller which is programmed to turn on the alarm and send a call to its owner. The system is password protected, so no one can turn off the system without knowing the password. The major advantages of this project are to save the hard drive space, eliminate human monitoring, ensure the security, and implementing the project with minimum cost.

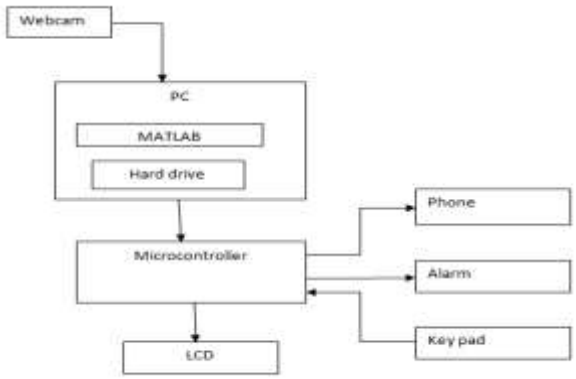

Fig. 1. Block Diagram of Automatic security system

II. DETECTATION THROUGH MATLAB DETAILS

A. Taking Input

At first the security system takes continuous video input by Webcam from the environment. The job is done in particular frame format with RGB color space. In this project the frame is "640×480" and the MATLAB code is shown below:

```
vid = videoinput('winvideo', 1, 'YUY2_640x480');
vid_src = getselectedsource(vid);
vid.ReturnedColorspace = 'rgb';
```

B. Turn on Communication Port

The communication port between MATLAB and microcontroller which turns on code is given below:

```
s1=serial('com5');
fopen(s1);
```

C. Entrance Detection

This section captures picture from input video in RGB scale and then converts the image in RGB to grayscale. Afterwards, it is adjusted to threshold automatically and converts the grayscale value into binary. It stores the binary value into an integer. Again, it captures another picture by following same procedures. Subsequently, it compares the present binary value with the previous stored integer value by auto-cross correlation. If the compared value is below 75%, it means someone is in-front of the entrance. This section code is given below:

```
a=getsnapshot(vid);
imagen=rgb2gray(a);
threshold = graythresh(imagen);
imagen =im2bw(imagen,threshold);
 if num==0
image2=imagen;
end
end
comp=corr2(image2,imagen);
if comp < 0.75
```

D. Storing Image and Sending Information to MCU Unit

When the above comparison is below 75% at that time the image is stored in Computer hard drive. Moreover the information writes in communication. The code is shown below:

```
imwrite(a,strcat('af',num2str(c),'.','jpg'))
fwrite(s1,word);
```

III. AUTOMATION UNIT

A. Receving Data at Microcontroller

Microcontroller (MCU) reads data from comport via Universal Asynchronous Receiver Transmitter (UART). At present time in most of the PCs comport is not present. Therefore the article is proposed to receive data from Universal serial Bus (USB) through USB to serial converter. The TXD pin of serial converter is connected with RXD pin of MCU. Therefore the written data in serial converter can be read by MCU via UART [5]. A small skeleton of the implemented code is:

```
if(Uart1_data_ready())
id=0;
id = uart1_read();
```

B. Generating Call and Turn on Buzzer

Yes and no button of a mobile are connected with individual transistor's emitter and collector pin. The transistors' base is connected with two other pins of MCU [7].

When UART receives signal, MCU hits in the base of the transistor. The reason to hit the no button is to clear the previous data. Hitting the yes button twice generates a call at the dialed number.

Moreover, by the time UART receives signal from environment, MCU turns on buzzer at given frequency.

C. Protection of the System Through Password

A 3×4 keypad is connected with MCU to give the input as character. This keypad sets a password for the security system. To turn off the system the password has to be applied, otherwise the system will be alive. If anyone waits for more than six seconds to press the password, it generates random number and goes to its previous stage. This technique provides owner protection over the system.

D. Display Unit of the System

If anyone is entered in the system then the display shows comments at LCD unit. Moreover when password is pressed and call is generated at that time LCD shows the cases.

The schematic diagram of total Automation circuit drawn in Proteus real time circuit designer is shown in Fig. 2.

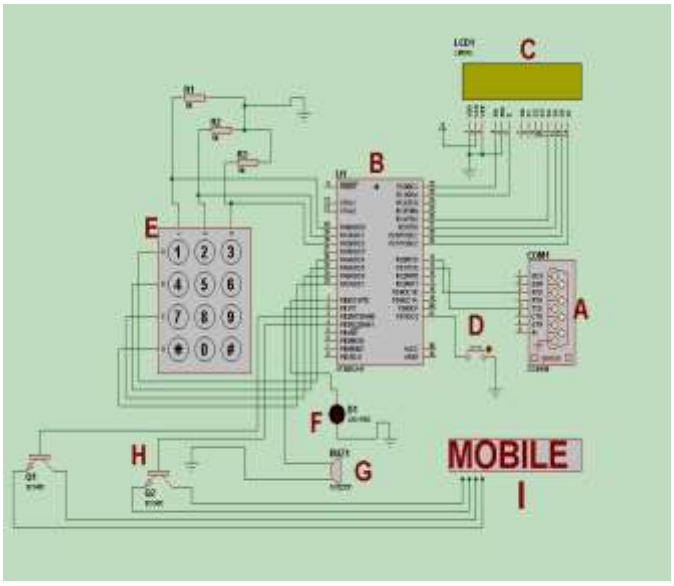

Fig. 2. Proteus layout of the circuit diagram (Automation Unit)

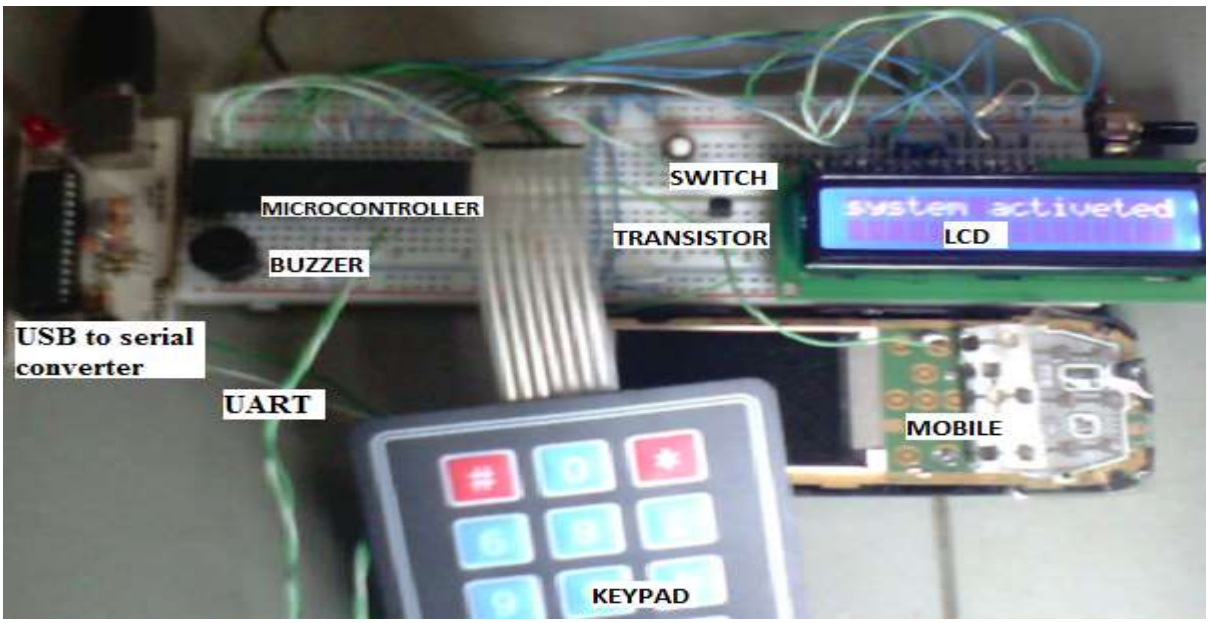

Fig. 3. Hardware Implematation

IV. HARDWARE IMPLEMENTATION

A. Required Equipments

The implemented automatic security system needs the following equipments:

- ATmega16 microcontroller
- USB to Serial Converter
- Adapter (Power Source)
- LCD display
- 12 button keypad

The hardware of the proposed system is shown in above Fig. 3.

B. ATmega 16

Microcontrollers have become common in many areas and can be found in home appliances, computer equipment, instrumentation and etc. Here Atmega16 microcontroller is used. It is used because of its easy accessibility, cheap price and for providing four different ports. ATmega16 is a low-power based CMOS 8-bit microcontroller which depends on the AVR developed RISC architecture. It executes instructions in 35 cycles in a single clock. ATmega16 achieve through puts1 MIPS per MHz allowing the system implemented at optimize power consumption versus processing speed.

Pin description [8]:

VCC: Digital supply voltage. (+5V)

GND: Ground. (0 V) Note there are 2 ground Pins.

Port A (PA7 - PA0) Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated.

The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7 - PB0) Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). Port B also serves the functions of various special features of the ATmega16.

Port C (PC7 - PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). Port C also serves the functions of the JTAG interface and other special features of the ATmega16. If the JTAG interface is enabled, the pull-up resistors on pins PC5 (TDI), PC3 (TMS) and PC2 (TCK) will be activated even if a reset occurs.

Port D (PD7 - PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). Port D also serves the functions of various special features of the ATmega16.

RESET: Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

XTAL1: Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2: Output from the inverting Oscillator amplifier.

AVCC: AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF: AREF is the analog reference pin for the A/D Converter.

C. Adapter

As microcontroller is not access on above 5V DC therefore 220V AC is converted into 5V DC through an adapter available at local market at cheap price.

D. LCD Display

A liquid crystal display is required to view the entered password. LCD display is used to show all the relevant data needed for the proper calibrations and other associate information.

V. RESULT & DISCUSSION

The computer screen when the total program is running is shown in Fig. 4. It shows that there is no human in front of the camera and the arrow sign indicating the there is not any data input. When there is no human in front of the camera no data will transmit to the microcontroller, hence microcontroller doesn't take any action.

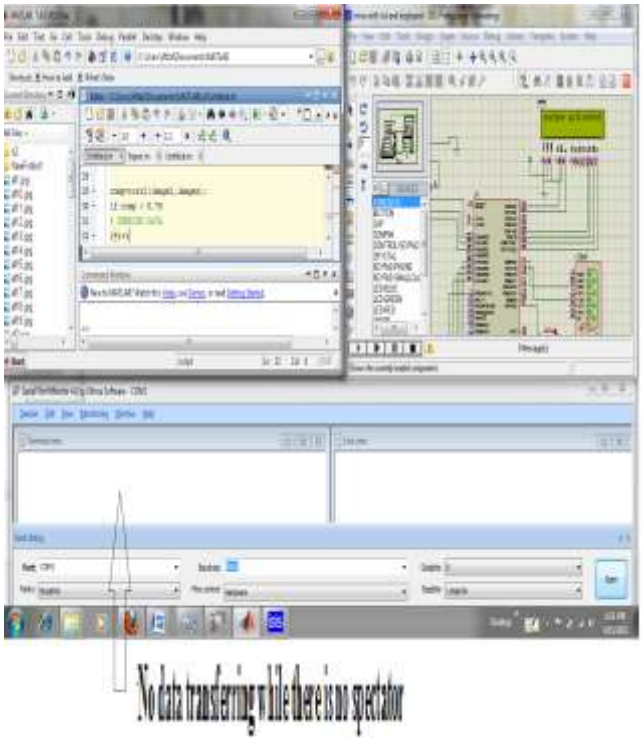

Fig. 4. Total simulation of the system (at no data state)

Fig. 5 shows the screen when someone enters in front of the camera. I this case the MATLAB send data to Microcontroller and Microcontroller turn on LED, buzzer, displays "Some one Enter" in LCD, and generates a call to its user. My implemented hardware works exactly in the same way.

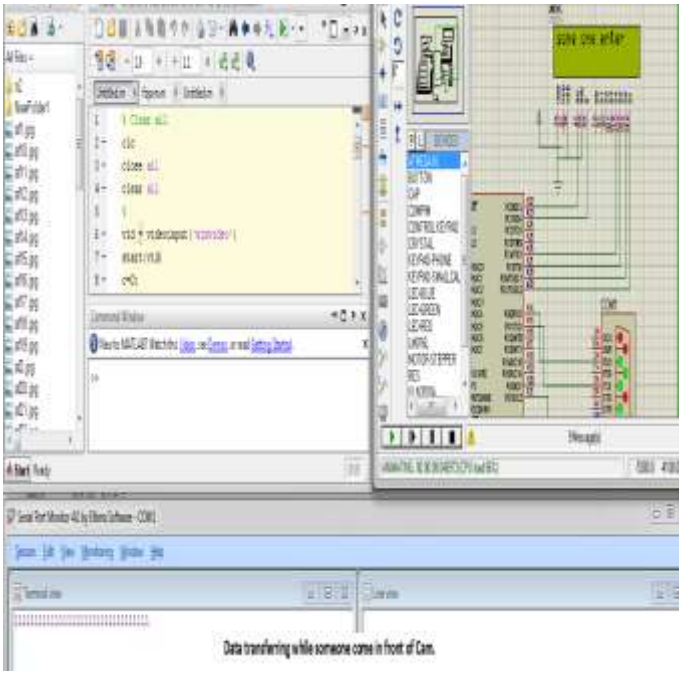

Fig. 5. Total simulation result of the system (at data state)

There are some limitations in the system. The limitations are presented below:

1. The system will not work when the camera vision will blocked.
2. The system will not work properly at dark.
3. The system will work at any motion.

VI. PRICE LIST

The required amount of money to implement the security system is very low which about $40 is. This cost is much lower in comparison with luxurious security systems. Total costing of the security system is listed below:

Component	Price(Tk.)
Atmega 16	220
Lcd	200
Veriable resistor	8
Switch	1
Keypad	80
Bazzar	10
Brad board	150
Usb to serial UART	200
Led	1
Web cam	800
Mobile	1500
Total	3,170 [$40]

VII. CONCLUSION & FUTURE WORK

The designed system is not video surveying throughout 24 hours, it is only capturing pictures when anyone enters in front of the CCcam so that it can save hard drive space dramatically and therefore, it saves a lot of the memory space. When any person comes under the supervision of the system, it remote senses by generating a call to the owner and ensures excellent sorts of security. The system has a unique password and nobody can handle the system without permission of the owner that also ensures security of the system. The most significant features are that it only cost 3170tk ($40). This cost is much lower in contrast with luxurious security systems.
Future hopes of the system are to add face detection, pattern detection, and gate control using GSM modem. Moreover is to add Raspberry Pi by replacement of PC.

When someone comes in front of the camera, the pattern detection of the program detects is it human or not? If a human is detected, then face recognition function is used to match the person's face with the data bank's face. If the face is matched with data bank's face only then the system gives access to that person. If the program does not find a match of the face in the data bank then the system sends a picture of the intruder to the user and user can control the system by his/her mobile via GSM MODEM which will be connected in the system.

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S M Salim Reza has been serving as Assistant Professor of the Department of ICT, Faculty of Science and Technology (FST) in Bangladesh University of Professionals, Mirpur Cantonment, Dhaka, Bangladesh.

Wahidul Hasan has completed his B.Sc Engg in EEE from Independent University, Bangladesh (IUB) and Presently, he has been working as Research Assistant (RA) in the Dept of EEE of Independent University, Bangladesh (IUB), Dhaka, Bangladesh.

S M Saleh Reza has been serving as Adjunct Faculty in Daffodil International University, Dhaka, Bangladesh. At Present, he is also a PhD researcher at Bangladesh University of Professionals, Dhaka, Bangladesh.