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Designing a Security System Based-on Microcontroller Integrated into the Immobilizer System

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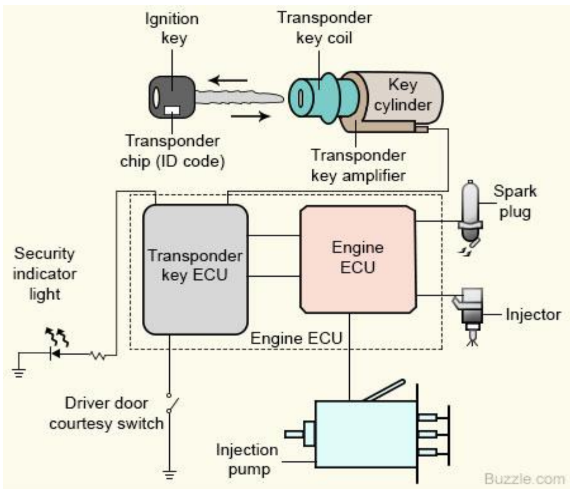
Abstract
The present study indicated that there are two objectives of this paper, namely (a) programming and verification testing and (b) board for a minimum system, integrated wiring, and validation testing. Programming for microcontroller consists is the algorithm and writing of the syntax. Verification tests are three conditions per the existence of the system in detecting (i) but not detected by the PIR sensor because not the original end-user, (ii) but the original end-user has not been present, and (iii) the original end-user has been detected. The minimum system *is original of creation provides five main ports with integrated wiring is a connection to all electronic components on the board, so that it is obtained a minimum acquisition for actuator operation. Validation tests are (i) successful in detection, but the original end-user not detected, so that this is according to the function of the PIR sensor; (ii) per the existence of the system in detecting, but the original end-user has not been present so that this is according to the function of the PIR sensor and the fingerprint sensor is ready to detect; and c) per the existence of the system in detecting and the original end-user has been detected, so that this is according to the function of the PIR and fingerprint sensor have detected. As a whole, a minimum system can be used as a preliminary safety that is integrated into the immobilizer system in a vehicle.*

Keywords — *Security system based-on microcontroller, Immobilizer system, Vehicle, ATmega32 microcontroller, Passive infrared receiver sensor, Fingerprint sensor.*

I. INTRODUCTION

Numerous vulnerabilities were found in the immobilizers designed to protect modern cars from theft [1], so it needs an additional minimum microcontroller-based system that integrated into the immobilizer system, which became an integral part of an automobile is an anti-theft that functioned as an electronic security device [2]. Immobilizer keys disable one of the systems needed to start a car's engine is fitted that prevents an automobile's engine from starting unless the correct ignition key or other device is present [3]. As an anti-theft mechanism, an immobilizer is accomplished by radio frequency identification between a transponder in the ignition key, and a device called a radio frequency reader in the steering column [4],[5]. By disabling the ignition electronically through the computer, an immobilizer prevents the vehicle from being stolen in most cases [4]. A 2016 study in the Economic Journal shown that between 1995 and 2008, the application of uniform immobilizers reduced the rate of car theft by 40% [2]. Typical circuit diagram of an engine immobilizer system [4], as shown in Figure 1.



Source: https://media.buzzle.com/media/images-en/gallery/electricals/450-engine-immobilizer-circuit.jpg

Fig 1: Typical circuit diagram of an engine immobilizer system

A minimum microcontroller-based system is a module integrated and programmable through an embedded mechanism that consists of some important and principal electronic circuits, namely sensors, microcontroller system, actuators, and display that supplied by power from the external supply [6]. The

Microcontroller-based system is several electronic devices with price in cheap, small in structure, and like a computer with large capacity, through program storage in its [6]-[8]. There are three classifications of embedded systems, namely small, medium, and sophisticated scale. A minimum microcontroller-based system is an embedded system. A typical embedded system [9], as shown in Figure 2.

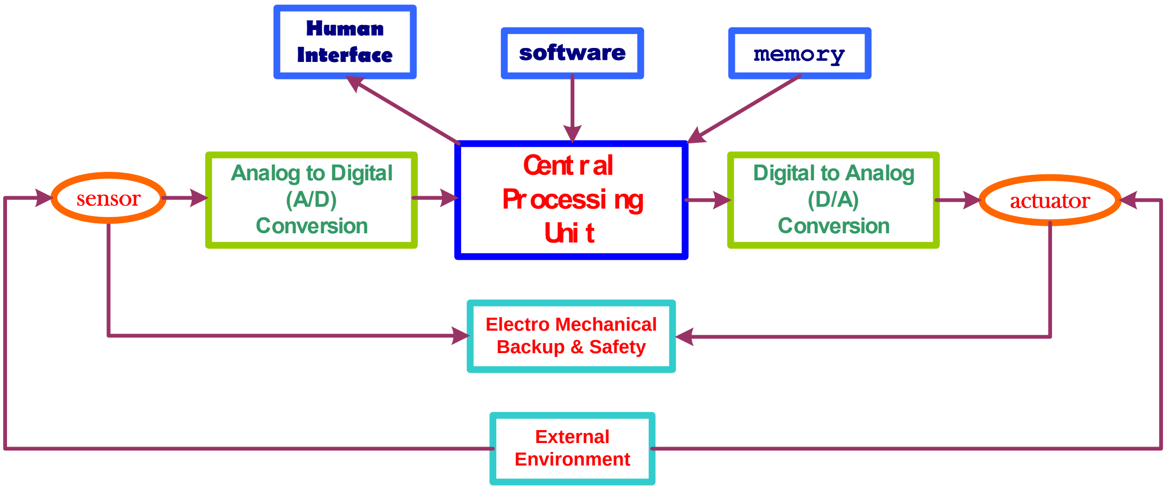


Fig 2: A typical embedded system

Similar research on embedded systems with choice of Basic Compiler (BasCom) programming language in form and for specific used about the segmentation of load groups on a single-phase kWh-meter using the Payload Data Handling (PDH) System [10].

Based on the statement of background can be defined that designing a security system using a minimum microcontroller-based system with a choice of BasCom programming language that functioned as a preliminary security system and integrated into immobilizer system. The formulation of the problem in the form of fabricating, integrated wiring, programming, verification, and validating against the minimum system. The schematic diagram for the formulation of the problem, as shown in Figure 3.

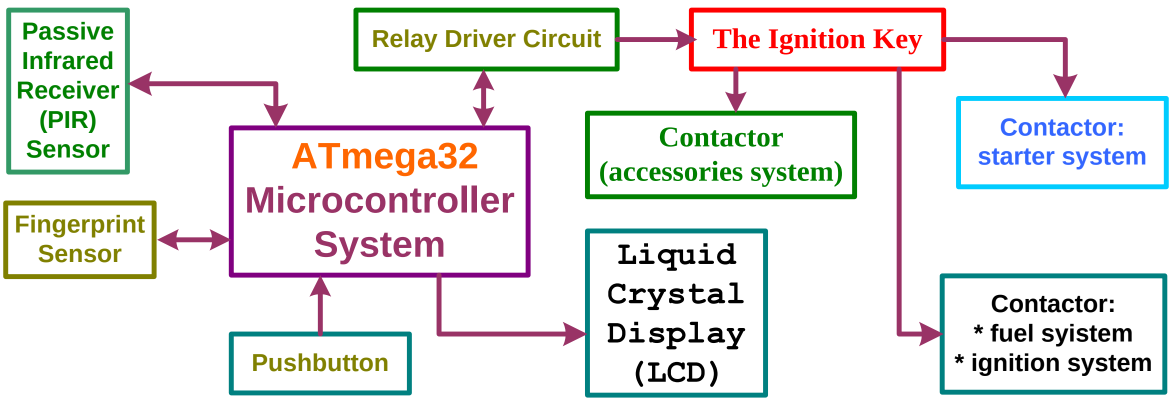
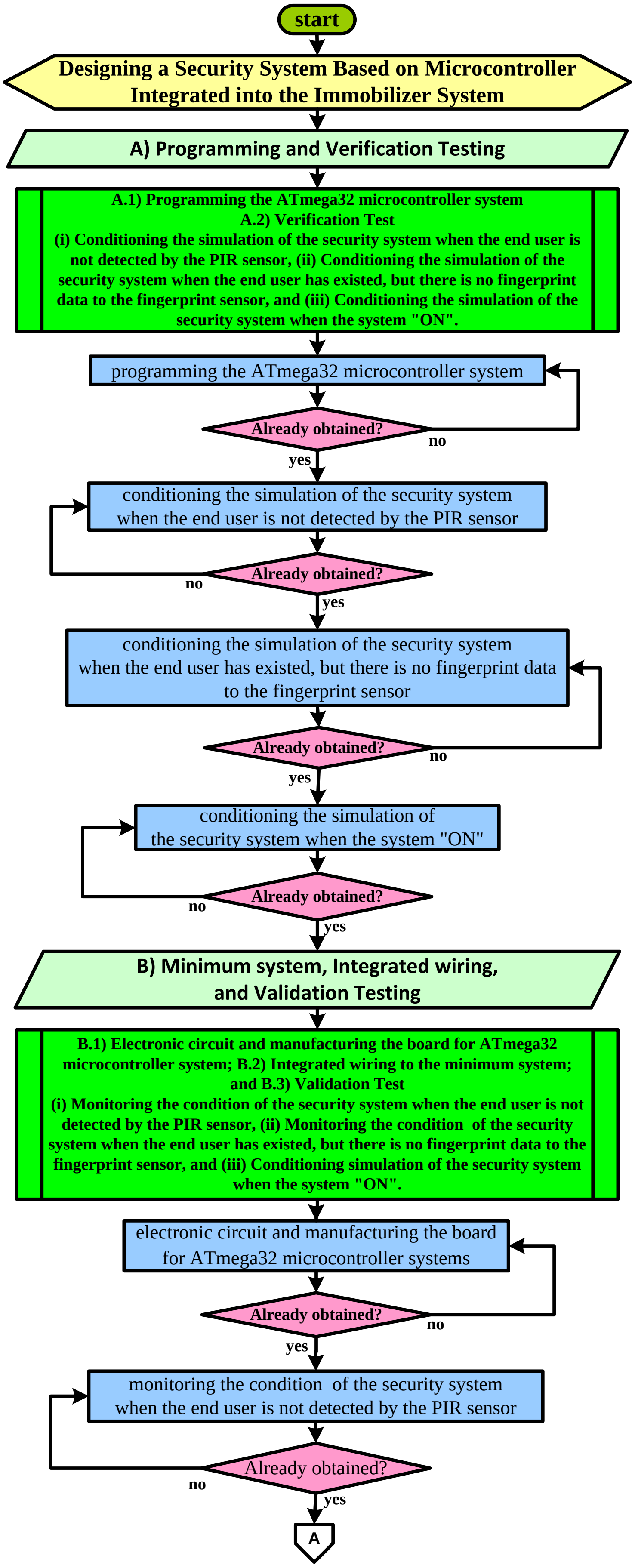


Fig 3: Schematic diagram for the formulation of the problem

Based on Figure 3 was defined the objective of this paper, namely to get the minimum system using the boards for electronic circuits and assembled all the parts, to make the programs for microcontroller system, to perform the verification tests as a form of simulation, and to carry out validation tests against the minimum system.

II. METHOD OF RESEARCH

The research method is conducted to obtain research objectives. Flowchart of the method of research, as shown in Figure 4.


start
Designing a Security System Based on Microcontroller Integrated into the Immobilizer System
A) Programming and Verification Testing
A.1) Programming the ATmega32 microcontroller system
A.2) Verification Test
(i) Conditioning the simulation of the security system when the end user is not detected by the PIR sensor, (ii) Conditioning the simulation of the security system when the end user has existed, but there is no fingerprint data to the fingerprint sensor, and (iii) Conditioning the simulation of the security system when the system "ON".
programming the ATmega32 microcontroller system
Already obtained?
no
yes
conditioning the simulation of the security system when the end user is not detected by the PIR sensor
Already obtained?
no
yes
conditioning the simulation of the security system when the end user has existed, but there is no fingerprint data to the fingerprint sensor
Already obtained?
no
yes
conditioning the simulation of the security system when the system "ON"
Already obtained?
no
yes
B) Minimum system, Integrated wiring, and Validation Testing
B.1) Electronic circuit and manufacturing the board for ATmega32 microcontroller system; B.2) Integrated wiring to the minimum system; and B.3) Validation Test
(i) Monitoring the condition of the security system when the end user is not detected by the PIR sensor, (ii) Monitoring the condition of the security system when the end user has existed, but there is no fingerprint data to the fingerprint sensor, and (iii) Conditioning simulation of the security system when the system "ON".
electronic circuit and manufacturing the board for ATmega32 microcontroller systems
Already obtained?
no
yes
monitoring the condition of the security system when the end user is not detected by the PIR sensor
Already obtained?
no
yes
A

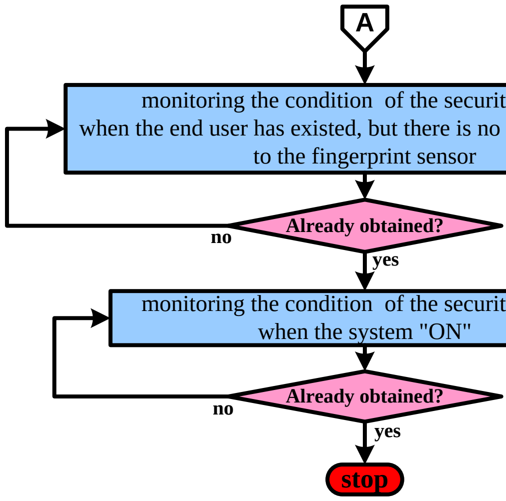


Fig 4: Flowchart of the method of research

Steps in the stages of integrating the minimum system, namely: (i) electronic circuit design and board manufacturing for microcontroller system, (ii) integrated wiring to the minimum system, and (iii) programming the ATmega32 microcontroller system. Verification and validation testing are system performance measurements. Verification test is a simulation that performed on three conditions, namely (a) conditioning the simulation of the security system when the end-user is not detected by the PIR sensor, (b) conditioning the simulation of the security system when the end-user exists, but no fingerprint data has been fingerprinted, and (c) conditioning the simulation of the security system when the system is “ON.” Validation test as measuring the condition that performed on three conditions, namely (a) measuring the condition of the security system when the end-user is not detected by the PIR sensor, (b) measuring the condition of the security system when the end-user exists, but no fingerprint data has been fingerprinted, and (c) measuring the condition of the security system when the system is “ON.”

III. RESULT AND DISCUSSION

A. Programming and Verification Testing

1) Programming

Programming the ATmega32 microcontroller used Basic Compiler (BasCom) language. Programming stages consist of creating algorithms and writing syntax. For the conformity of results, verification assisted by the Proteus application is required. The algorithm is a flow diagram for programming the ATmega32 microcontroller system. The algorithm for programming the ATmega32 microcontroller system, as shown in Figure 5.

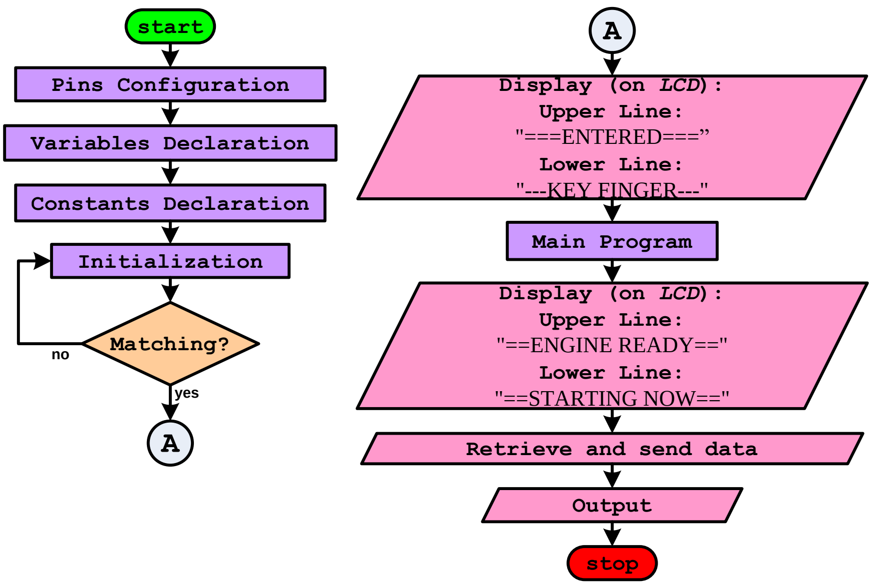


Fig 5: The algorithm for programming the ATmega32 microcontroller system

Based on Figure 5 indicated that an algorithm is a minimal form that meets the criteria for operating a minimum system based on a microcontroller, that the structure of the program consists of several stages. The stages are: (i) pins configuration, (ii) variables declaration, (iii) constant declaration, (iv) initialization, (v) main program, (vi) retrieve and send data, and (vii) output. The seven stages in writing syntax are the minimum limits for operating a minimum system based on a microcontroller. Testing the program is done by applying the simulation using Proteus software. So the circuit is first assembled using Proteus8 software, then the program that has been created using Bascom software in comfile to form hex or machine language and download to the circuit.

#a) Pins configuration

The pin configuration is the pin determination used, both as output and/or input. The pins are used as parameters for each addressing program for pin assignment of ATmega32 used for input paths of passive infrared reciever and fingerprint sensors, and output lines for conducting transistors as actuator actuators. Program syntax for pin configuration of ATMega32 microcontroller, namely:

```
$crystal = 8000000
$baud = 9600
'==================================
' Port pushbutton panel
'----------------------------------
Config Pinb.5 = Input
Config Pinb.6 = Input
Config Pinb.7 = Input
====================================
Tombol_next Alias Pinb.5
Tombol_yes Alias Pinb.6
Tombol_back Alias Pinb.7
Set Portb.5
Set Portb.6
Set Portb.7
```

#b) Variables declaration

The variables declaration stage is performed for declarations of the type of data to be performed. Program syntax for variable declaration on ATmega32 microcontroller that is:

```
Dim Id_user As Word
Dim Status As Byte, Status_gf As
      Byte
Dim Temp1 As Byte, Temp2 As Byte
Dim Temp1_w As Word, Temp2_w As
      Word, Temp3_w As Word
Dim Byk_data As Byte, Count As Byte
Dim Buff_ser As Byte
Dim Array_ser(20) As Byte
Dim Cnt_ser As Byte, Cnt_tmout As
      Long
Dim Sta_pra_gf As Byte
```

#c) Constans declaration

Constants declaration represents the value of constants in the program based on the datasheet of the sensor, which is the input of the minimum control system based on the ATmega32 microcontroller. Direct constants declare their value. The constant declaration does not use a colon (:) as in the variable declaration but uses the equals (=). Program syntax for the constant declaration of ATMega32 microcontroller that is:

```
Const Bts_tmout1 = 100000
Const Bts_tmout2 = 20000
```

#d) Initialization

Initialization Stages in the form of initials to the program created to determine each command's status in the program. Initialization can shorten the command in the next program. Program syntax for initialization on ATmega32 microcontroller, that is:

Initialization:

```
   Wait ms 500
   Cursor Off Noblink
Pra_mulai:
   Cls
   Upperline
   Lcd "====ENTERED===="
   Lowerline
   Lcd "---KEY FINGER---"
   Wait 1
```

#e) Main program

The main program is the source of program control since all commands in the program are sorted from the initial view, retrieving the data, displaying the data. Program syntax for the main program on ATmega32 microcontroller, that is:

```
Start:
   If Pir = 0 Then Goto Mulai
Start0:
   Call Get_finger
   If Status_gf = 0 Then
      If Pir = 0 Then
         Lowerline
         Lcd "----------------"
      End If
      Go to Start
   End If
   Lowerline
   Lcd "> capture..    "
```

#f) Retrieve and send data

The command data or conditions corresponding to the sensor's input are sent for and subsequently used for a signal to the actuator. Program syntax for capture and send data on ATmega32 microcontroller, that is:

```
Start1:
   Restore Genfeat1
   Call Send_cmd_finger
   Call Retrieve_resp_finger
```

```
    Temp1 = Array_ser(1)
    If Temp1 <> 12 Then
       Lowerline
       Lcd "> unsucces    "
       ‘Wait 1
       Goto Start1
    End If
    Temp1 = Array_ser(11)
    Select Case Temp1
         Case &H00: Goto Start2
    End Select
    ‘Waitms 500
    Goto Start1
Start2:
    Restore Search_dtbs
    Call Send_cmd_finger
    Call Retrieve_resp_finger
    Temp1 = Array_ser(1)
    If Temp1 <> 16 Then
       Lowerline
       Lcd "> unsucces    "
       ‘Wait 1
       Goto Start2
    End If
    Temp1 = Array_ser(11)
    Select Case Temp1
         Case &H00: Goto Start3
         Case &H09: Goto Nomatch1
    End Select
    ‘Waitms 500
    Goto Start2
Start3:
    Set Relay
    Temp1 = Array_ser(13)
    Call Lowerblank
    Lowerline
    Select Case Temp1
    End Select
    Wait 1
```

#g) Output

The program output is the reaction caused by the sensor input. Program syntax for output on ATMega32 microcontroller, that is:

```
Start3:
    Set Relay
    Temp1 = Array_ser(13)
    Call Lowerblank
    Lowerline
    Lcd "> User "
    Lcd Temp1
    Wait 1
    Temp1_w = Array_ser(14)
    Temp2_w = Array_ser(15)
    Temp3_w = Temp1_w * 256
    Temp1_w = Temp3_w + Temp2_w
    Call Lowerblank
    Lowerline
    Lcd "> Score: "
    Lcd Temp1_w
    Wait 1
    Goto Menu
Nomatch1:
    Lowerline
    Lcd "> No user    "
    Wait 1
    If Pir = 1 Then
       Lowerline
       Lcd “----------------”
    End If
    Go to Start
    ‘Do
    ‘Loop
```

2) *Verification testing*

There are 3 (three) conditioning the simulation using Proteus software, namely (a) when the end-user is not detected by the PIR sensor and (b) when the end-user has existed, but there is no fingerprint data to the fingerprint sensor title and abstract should be in one column while the main text should be in two columns. Simulation of the security system, and (c) when the system “ON.”

Display results conditioning simulation of the security system when the end-user is not detected by the PIR sensor, as shown in Figure 6.

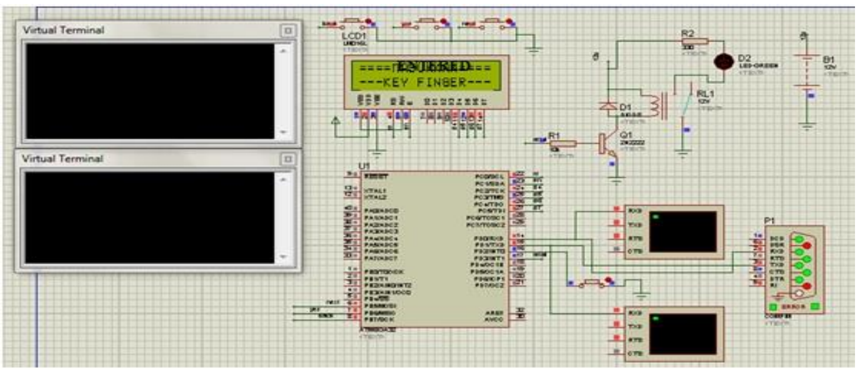


Fig 6: Display results conditioning simulation of the security system when the PIR sensor does not detect the end-user

Based on Figure 6 shows that the syntax is per the existence of the system is detecting but not detected by the PIR sensor because of not the original end-user. The simulation for conditioning the safety system is done by giving data input to passive infrared receiver sensor in the form of human presence signal (user) and fingerprint to the fingerprint sensor, then forwarded to a microcontroller system with RS232 cable. RXD input is connected to the 14 pin of the microcontroller, and for TXD input is connected to the microcontroller's pin, it shows "ENTERED KEY FINGER" on the LCD as shown above.

Display of conditioning simulation results of the security system when the end-user has been present, but there is no fingerprint data to the fingerprint sensor, as shown in Figure 7.

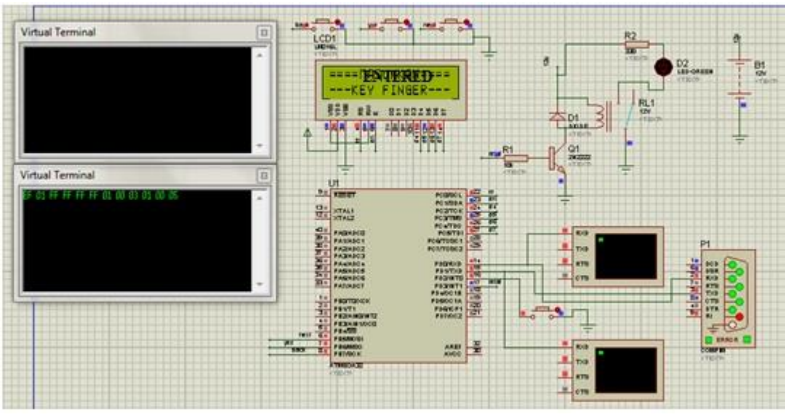


Fig 7: Display of conditioning simulation results of the security system when the end-user has been present, but there is no fingerprint data to the fingerprint sensor

Based on Figure 7 shows that the syntax is per the existence of the system in detecting, but the original end-user has not been present. The simulation for conditioning of the security system is done by giving input signal of human existence (user) to a passive infrared receiver and fingerprint sensor by the user to fingerprint sensor to a microcontroller system with RS232 cable. The RXD input is connected to the 14 microcontroller's foot, and for TXD input is connected to the microcontroller's foot, it displays "ENTERED KEY FINGER" on the LCD the Virtual Terminal Fingerprint will display the users' stored data retrieval on the fingerprint sensor module with repetitive cycles.

Display of simulated conditioning results on the system security when the system is ON, as shown in Figure 8.

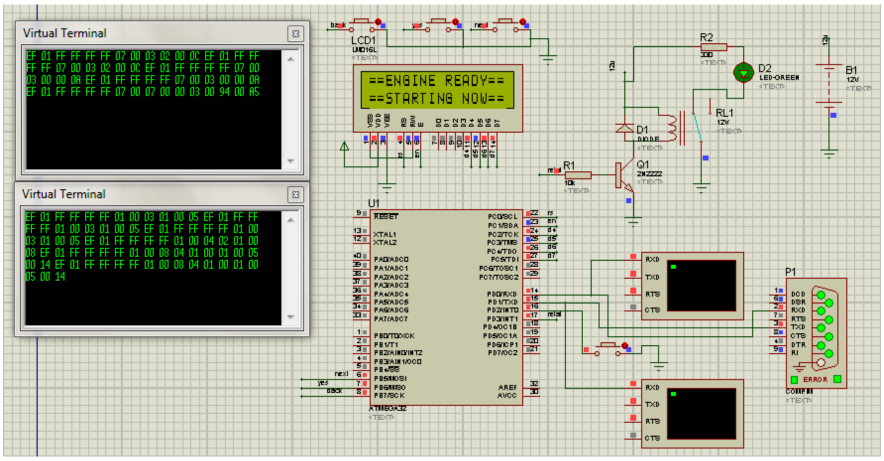


Fig 8: Display of simulated conditioning results on the system security when the system is ON

Based on Figure 8 shows that the syntax is per the existence of the system in detecting, and the original end-user has been detected. The simulation for conditioning the safety system is done by giving input data in the fingerprint sensor by the user from the fingerprint sensor to the microcontroller system with RS232 cable. The RXD input is connected to the pin of the microcontroller, and for the TXD input is connected to the pin of the microcontroller, then the fingerprint sensor module sends the data command to the microcontroller to verify the user data, then displays "ENGINE READY STARTING NOW" on LCD and Virtual Terminal Microcontroller as shown above.

B Minimum System, Integrated Wiring, and Validation Testing

1) Minimum System

For experimental studies of actuator operation (in the form of electromagnetic switches) for connection/disconnection of electric current electrical loads (in the form of contactor switches on motor vehicles). Obtaining the electronic circuits as the basis for the manufacture of microcontroller system boards obtained through ironing, solvent, and drilling holes for the legs of electronics components. The bottom view of the board for the ATmega32 microcontroller system, as shown in Figure 9.

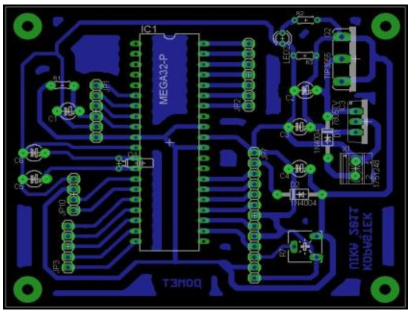


Fig 9: The bottom view of the board for the ATmega32 microcontroller system

Board for ATmega32 microcontroller system is original of creation provides five main ports used for (i) 12-volt dc power supply connector, (ii) passive infrared receiver and fingerprint sensor, (iii) 2x16 LCD, (iv) downloader, and (v) output. The five ports are inputs and outputs from ATmega32 pins. The serial data pin is connected to the microcontroller for addressing assignment on the sensor data pin of a passive infrared receiver and fingerprint for monitoring incoming data. The pins used in passive infrared receiver and fingerprint sensor modules are GND, VCC, RXD, and TXD. The pins are then connected to the corresponding pins on the microcontroller.

2) Integrated Wiring to the Minimum System

The minimum integrated system cross-section, as shown in Figure 10.

Fig 10: The minimum integrated system cross-section

Figure 10 indicated that the integrated wiring is a connection to all electronic components on the board. Minimum acquisition of ATmega32 microcontroller-based integrated system for actuator operation. The electromechanical relay as an actuator is controlled by a BD139 transistor as actuator drive by obtaining an output signal from an ATmega32 microcontroller. BD139 transistor as a switch for the supply of power to the electromechanical relay coil. For conditions where there are commands from an ATMega32 microcontroller in the form of a signal that has been selected or set, giving a voltage of 5 volts dc, which is then connected to the base leg of the transistor. The supply voltage on the base leg of the transistor, resulting in the ground on the contact relay coil connected.

In contrast, when the base foot of the transistor can not supply a voltage, the relay coil is not energized. The auxiliary contact of the electromechanical relay is used to connect and disconnect the 12-volt electric current power supply to electrical loads in the form of electrical in motor vehicles. Excess use of relays, it is possible to provide the desired voltage and current and is used to operate controlled electrical loads.

3) Validation Testing

Block diagram of the minimum system for validation testing, as shown in Figure 11.

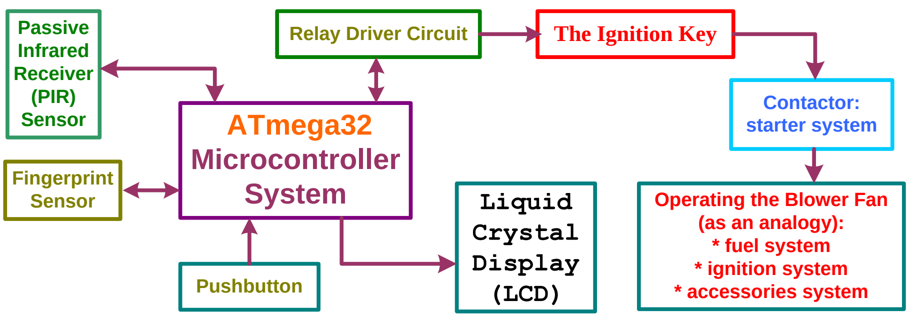


Fig 11: Block diagram of the minimum system for validation testing

Based on Figure 11 shows, that the minimum performance measurement of microcontroller-based ATMega32 system with passive infrared receiver and fingerprint sensor for motorized vehicle security system consists of three monitoring of the condition, namely (i) the security system when the end-user is not detected by the PIR sensor, (ii) the security system when the end-user already exists, but there is no fingerprint data to the fingerprint sensor, and (iii) the security system when the system "ON."

Display system and LCD results when the end-user is not detected by the PIR sensor, as shown in Figure 12.

Fig 12: Display system and LCD results when the PIR sensor does not detect the end-user

Figure 12 shows that the system is successful in detection, but not the original end-user detected. This is according to the function of the PIR sensor. As the result of the detection of the user's absence on the sensor, the microcontroller gives the actuator command to display "ENTERED KEY FINGER" on the LCD while the fingerprint sensor is off. Voltage conditions and values on LCD and passive infrared receiver sensors when ON and OFF switch. Condition and value of stress on the conditioning of the security system when the end-user is not detected by the PIR sensor, as shown in TABLE I.

TABLE I
Condition and value of stress on the conditioning of the security system when the PIR sensor does not detect the end-user

Switch	Display on LCD	Sensor PIR		Fingerprint Sensor Condition	Condition of Ignatian Key on Ready to Start (ST)
		Logic	Voltage (volt)		
"OFF"	OFF	"0"	0	OFF	Analogous with Blower Fan Condition "OFF" (not operated)
"ON"	"ENTERED KEY FINGER"	"0"	0	OFF	Analogous with Blower Fan Condition "OFF" (not operated)

Display of system and LCD results when end-user already exists, but there is no fingerprint data to a fingerprint sensor, as shown in Figure 13.

Fig 13: Display of system and LCD results when end-user already exists, but there is no fingerprint data to a fingerprint sensor

Based on Figure 13 shows that the system is per the existence of the system in detecting, but the original end-user has not been present. This is according to the PIR sensor's function, and the fingerprint sensor is ready to detect the original end-user. The result of the detection of the user against the passive infrared receiver sensor but has not yet entered the fingerprint data of the fingerprint sensor; the microcontroller gives the actuator operating command to display "ENTERED KEY FINGER" on the LCD while the fingerprint sensor is on (blinking). Voltage conditions and values on LCD and passive infrared receiver sensors when ON and OFF switch. Condition and value of stress on the conditioning of the security system when the end-user already exists, but there is no fingerprint data to the fingerprint sensor, as shown in TABLE II.

TABLE II
Condition and value of stress on the conditioning of the security system when the end-user already exists, but there is no fingerprint data to the fingerprint sensor

Switch	Display on LCD	Sensor PIR		Fingerprint Sensor Condition	Condition of Ignatian Key on Ready to Start (ST)
		Logic	Voltage (volt)		
"OFF"	OFF	"0"	0	OFF	Analogous with Blower Fan Condition "OFF" (not operated)
"ON"	"ENTERED KEY FINGER"	"1"	3,4	FLASHING ONLY (no fingerprints)	Analogous with Blower Fan Condition "OFF" (not operated)

Display the results of the security system when the system is ON, as shown in Figure 14.

Fig 14: Display the results of the security system when the system is ON

Based on Figure 13 shows that the system is per the existence of the system in detecting, and the original end-user has been detected. This is according to the PIR sensor's function, and the fingerprint sensor has detected the original end-user. The result of the detection of the user against the passive infrared receiver sensor and by entering the fingerprint data on the fingerprint sensor, the system will be active. The passive infrared receiver and fingerprint sensors will be inactive as long as the system is on, so the microcontroller gives the actuator operating commands to display "ENGINE READY, STARTING NOW" on the LCD. Condition and value of the voltage on conditioning to security system when the system "ON," as shown in TABLE III.

TABLE III
Condition and value of the voltage on conditioning to security system when the system "ON."

Switch	Display on LCD	Sensor PIR		Fingerprint Sensor Condition	Condition of Ignatian Key on Ready to Start (ST)
		Logic	Voltage (*volt*)		
"OFF"	OFF	"0"	0	OFF	Analogous with Blower Fan Condition "OFF" (not operated)
"ON"	"ENGINE READY, STARTING NOW"	"0"	0	OFF	Analogous with Blower Fan Condition "OFF" (not operated)

IV. CONCLUSIONS

Based on the results and discussion, then drawing the conclusion that according to the research's objectives. As a whole, a minimum system based on a microcontroller can be used as a preliminary safety that is integrated into the immobilizer system. As a whole, a minimum system based on the ATmega32 microcontroller can be used as a preliminary safety that is integrated into the immobilizer system. Programming for the microcontroller consists of the algorithm and writing syntax. An algorithm is a minimal form that meets the criteria for operating a minimum system based on a microcontroller. The writing syntax consists of seven stages as the minimum limits for operating a minimum system based on a microcontroller. Performing the verification tests are accordance with: i) the existence of the system in detecting, but not detected by the PIR sensor because not the original end-user; ii) the existence of the system in detecting, but the original end-user has not been present, and iii) the existence of the system in detecting and the original end-user has been detected. The minimum system based on ATmega32 microcontroller system with the boards for electronic circuits is original of creation provides five main ports used for (i) 12-volt dc power supply connector, (ii) passive infrared receiver and fingerprint sensor, (iii) 2x16 LCD, (iv) downloader, and (v) output. The integrated wiring to the minimum system is a connection to all electronic components on the board so that it is obtained a minimum acquisition of ATmega32 microcontroller-based integrated system for actuator operation. Carrying out of the validation tests are a) the system is successful in detection, but not the original end-user detected; b) the system is per the existence of the system in detecting, but the original end-user has not been present; and c) the system is per the existence of the system in detecting, and the original end-user has been detected.

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