Design of Microcontroller based intruder lighting system (MBILS)

Abstract

The microcontroller based intruder lighting system is an intelligent system which applies to automated lighting systems in homes, offices, industries, military zones etc. The research will feature design microcontroller based intruder lighting system that will activate light in environment in the presence of an intruder and inform the user about the coordinate position of the intruder.

The microcontroller AT89C51 and other electronic designs were employed for the above-mentioned purpose. The interfacing layer will make use of bi-directional communication. The sensors is used as input device to receive signal when the intruder obstruct signal path while the control program will translate the received signal from the sensors to useful information and activate lighting system and camera. The camera will capture image of intruder and save to external memory. The design is to achieve energy-saving techniques and increase security strength of target environment.

Keywords: Intruder, Light dependent resistor, bi-directional communication, control program

Introduction

There are various research works on intruder systems with different technologies [1]. This design of microcontroller based intruder system is based on the simple Boolean logic concept that a sensor's switch contacts can be either open or closed [1].

The need to secure home, industries and other related properties has been a major priority, since then, an aggressive development of technology in the area of security has exponentially been driven to today's trend.

26 A system cannot have high assurance if it has poor security and requirements in its
27 design. For maximum assurance, systems will logically include security protocol
28 requirement, as well as availability, reliability and robustness requirements to satisfy
29 prototype system design [2].
30 The intrusion techniques required logistic person workflow in the environment where
31 intelligent device is planted to measure Security Bridge or tendency of activating nearby
32 light in a matter of obstruction. Recently, it has become one of the most interesting
33 aspects of individual, national and even international concern. There are three procedures
34 to initiate a home intruder system before integrating any technological component: (1)
35 Install exterior lights and add either a timer or a motion detector device (2) Build security
36 at all exterior doors and windows with strong locks (3) Trim and cut down trees that may
37 cause obstruction especially around windows and doors. Many home intruder system
38 tasks are easy and simple projects to install which can offer paramount security [3].
39 Looking at trends of technologies, there are different kinds of properties invader systems
40 which are based on dynamic system protocols, for which the basic types of components
41 are:

42 **i.   Wireless Security Alarms** A wireless security system that offers user broad
43 coverage. This suits a home intruder system that will stop intruders before gaining
44 entrance and summon for help immediately to ensure home protection.

45 **ii.   Micro computer based security system**

46 This system senses the presence of an intruder and alerts the user of the obstruction
47 detected. It also displays the position of the intruder on a screen.

48 **iii.   Motion Sensor Lights**

49 Motion sensor lights system make intruders react like a deer with headlights. It is
50 difficult to break into a home or an office when there is a spotlight shining down right on
51 user.

52 **iv.   Access Control Gates:** This technology makes it hard for the intruder even to
53 penetrate property, let alone into an office or a house, by surrounding environment with a
54 high fence and installing an access control gate. An access control gate gives specific

55 points of entry and exit onto user properties, and this can be monitored from inside [4]. A

56 gate allows user, like family, co-worker and friends to enter and exit, but says "NO!" to

57 intruders on restriction. A home intruder lighting system saves energy and keeps

58 criminals further away from private or public properties.

59

60 **The MBILS Device Framework**

61 Microcontroller based Intruder lighting system (MBILS) device is an evolutionary

62 interface module that renders full duplex communication using microcontroller device.

63 This will be described using block segments as it's interfaced on framework.

64 *Figure 1: An overview of the internals of a MBILS network.*

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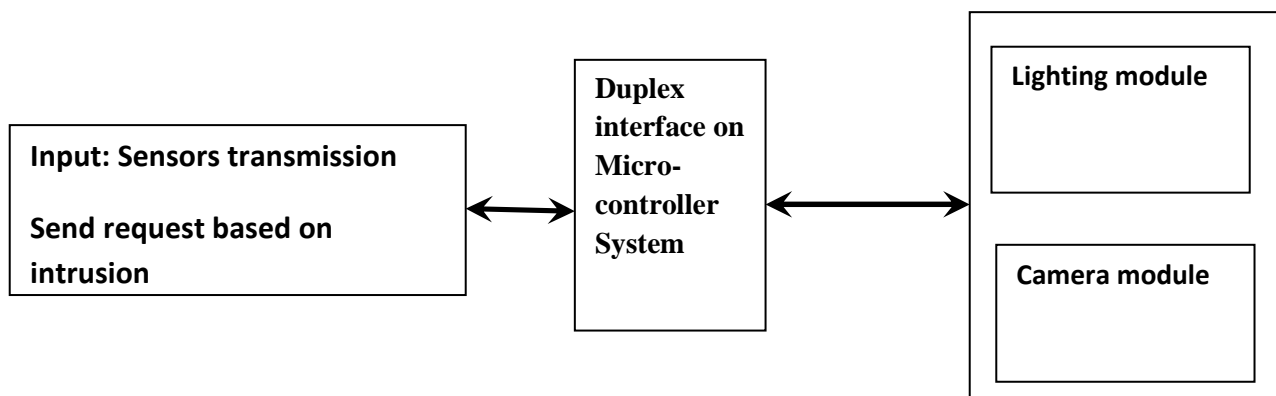
74 **An Overview of DMBILS Components**

75 From the figure 1 above, the microcontroller operate the bi-directional mode as seen at

76 the centre of design, receiving the input from intelligent sensor as well as the output from

77 the other peripheral components (camera module and light module). The block diagrams

78 consist of three stages, which are:

79 **Sensor Module**

80 The sensor module consists of the touch sensor, the light detector and the darkness

81 detector. Each of these alarm sensing units makes up the different type of intruder

82 detection system incorporated in this design.

83 The input transducers (sensors) vary their resistance and in most cases, voltage divider is

84 used to convert this to a varying voltage for activation. The voltage signal in this design

85 feeds as an input into a NPN (C945) transistor switch [5].

86 **Selection of resistor value**

87 The output voltage depends on resistor (R) values. Using an ohmmeter to calculate the

88 minimum and the maximum values of the sensor's resistances R_{min} and R_{max}:

89 In this context: $R_{min} = 1.50 \text{ k}\Omega$ and $R_{max} = 560 \text{ k}\Omega$

90 Which gives $R = \sqrt{R_{min}R_{max}}$ …..…………… (1)

91 Since the MBILS is capable of monitoring three different intruders from coordinate point,

92 the above design was repeated three times to represent the input to the parallel port status

93 pins.

94 **The transistor input state**

95 $V_{out} = \dfrac{V_{in}R_2}{R_1+R_2}$ $\equiv$ …………………….. (2)

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97 Taking $V_{in} = 5V$, $R_1\ 4.7 . 10^3 \ \Omega$ and $R_2\ 560. 10^3\Omega$

98 We obtain $V_{out} = 4.96V$

99 This increases the base current that drives the transistor to saturation.

100 In bright lights we have $R_1 = 4.7 . 10^3 \ \Omega$ and $R_2 = 9.5. 10^3\Omega$

101 So $V_{out} = 0.01V$

102 **Microcontroller (AT89C51) duplex mode:**

103 The specification for this design is AT89C51, an integrated circuit programmed with an

104 universal programmer to receive input signals and relating it to other interfaced sub-

105 module attached to it for its corresponding signals output [6].

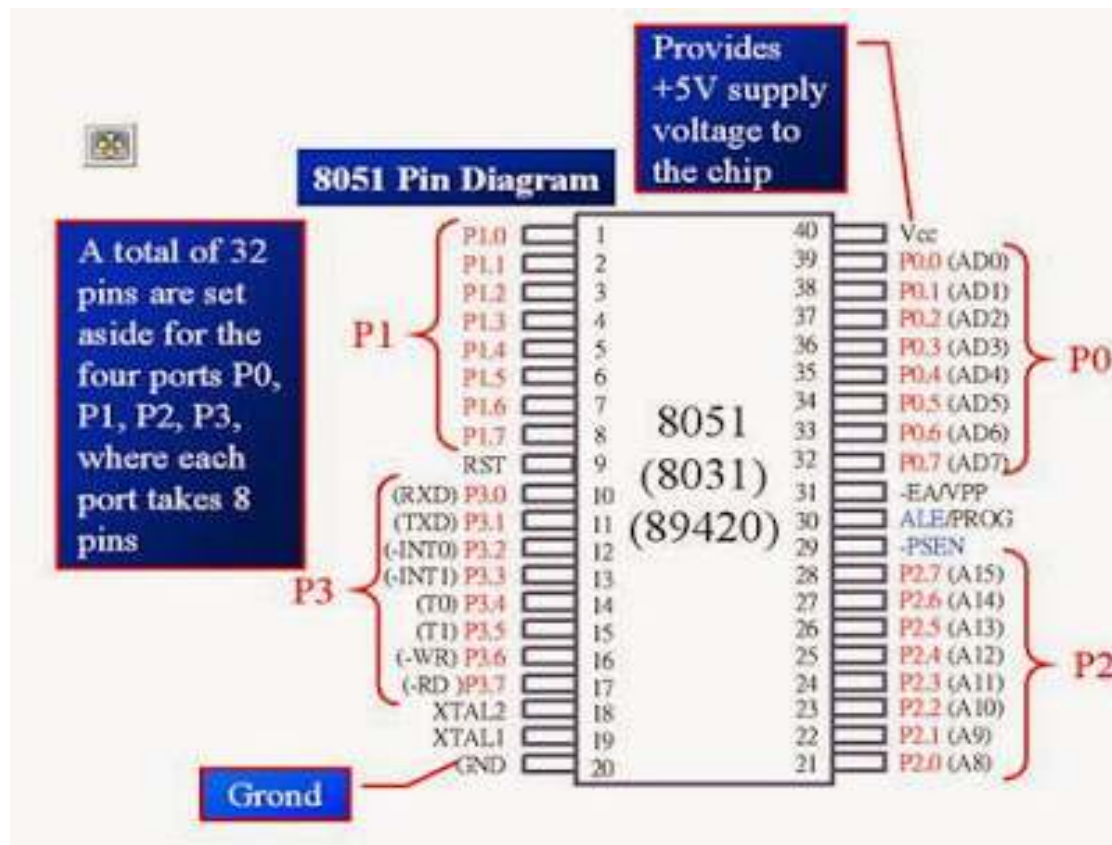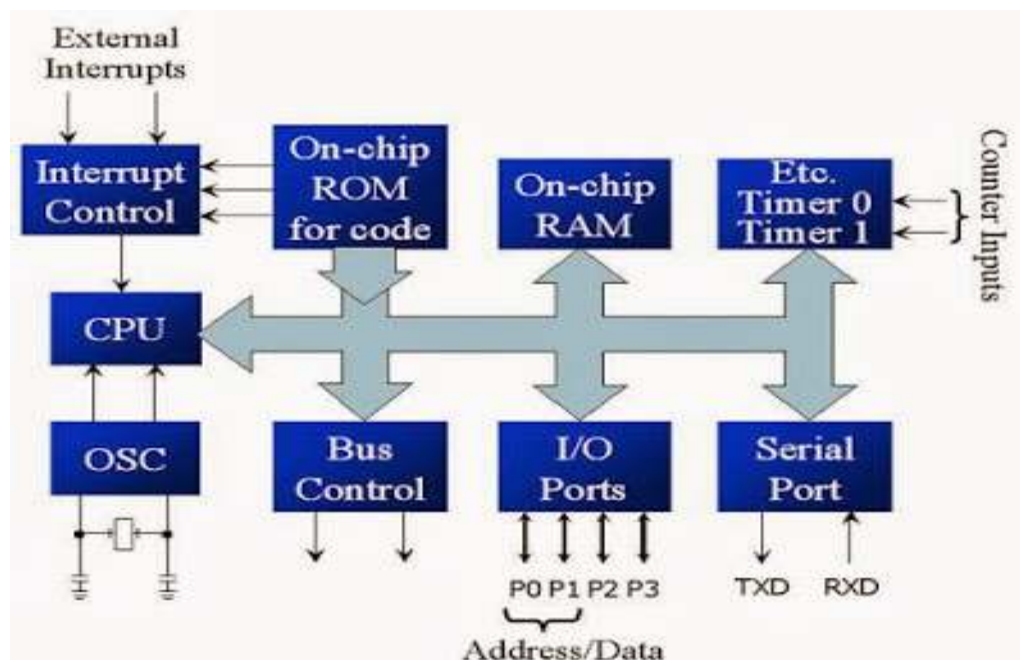106 *Figure 2: showing Pin description of 8051/AT89C51 microcontroller*

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108 *Figure 3: Internal registers of 8051/AT89C51 microcontroller*


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110 **The Serial ports interrupt:**

The 8051 family used in MBILS design is characterized with Serial Control (SCON). This can configure data bit (address bit) and baud rate by writing a SFR to write 'X' a value to serial port and set port mode to 1 or read SFR to read 'R' a value to serial port and set port mode to 1. The external as INT 1 are used by external CKT. It can be configured to either X' mission actionist or the external depending upon value at the units [7,8].

MBILS cycle and crystal frequency

The microcontroller used in the design contains on-chip oscillator and also requires an external clock to run it. In most cases, a **quartz-crystal oscillator** is connected to inputs terminals XTAL1 (pin 19) and XTAL2 (pin 18). The quartz-crystal oscillator connected to XTAL1 and XTAL2 pins require two capacitors of 33 pF value interface. One side of each capacitor is connected to the ground as shown in Figure 4

Figure 4: Crystal Oscillator
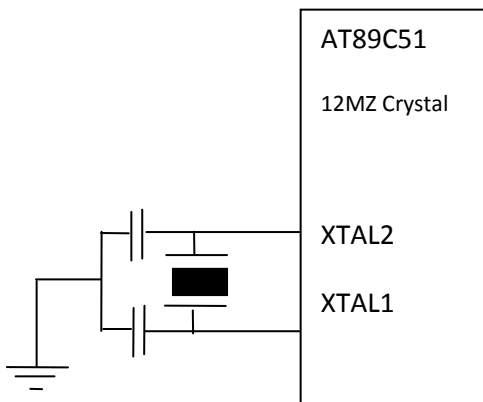
To determine BMONS cycle for compactable chips as follow; If XTAL = 11.0592MGZ

For (a) AT89C51 :- $1/11.05952MGZ = 90.42$ nanoseconds (ns)

Therefore MBILS cycle = 12 X 90.42 ns = 1.085μs

1 X 90.42ns = 90.42ns

4 x 90.42ns = 361.68ns

It must be noted for this designs various speeds of the 8051 family. Speed refers to the maximum oscillator frequency connected to XTAL (Crystal Oscillator). For instance, a 12-MHz chip is required to be connected to a crystal with 12 MHz frequency or less. Likewise, a 24-MHz microcontroller requires a crystal frequency of no more than 24 MHz to function well. When the 8051 is connected to a crystal oscillator and is powered up, the frequency from the pin XTAL2 is clearly observed over oscilloscope for its performance.

For this foresight the experiment deduced that the number of machine cycles it takes to execute an instruction is not the same for the microcontroller AT89C51 and DS89C4xO digital signal processing chip as narrated in [7,9].

Lighting Module

Relays are made up of electromagnet material and a set of contacts generally based on Single Pole Double Throw (SPDT) or Double Pole Double Throw (DPDT) switching method. It has 3 pins to perform functions

COM = Known as Common, always connected to NC pin; it is the moving part of the switch.

NC = Known as Normally Closed pin, (COM) is connected to this when the relay coil is off.

NO = Know as Normally Open pin, COM is connected to this when the relay coil is on.

The light device was connected to relay device interfaced with microcontroller with port 0 (P3.2). Relay will receive high and low signal from the microcontroller to enable to open and close the output terminal. This interface module as shown in figure 5 indicates mono-directional communication with microcontroller AT89C51.

Figure 5 Camera/Light Modules
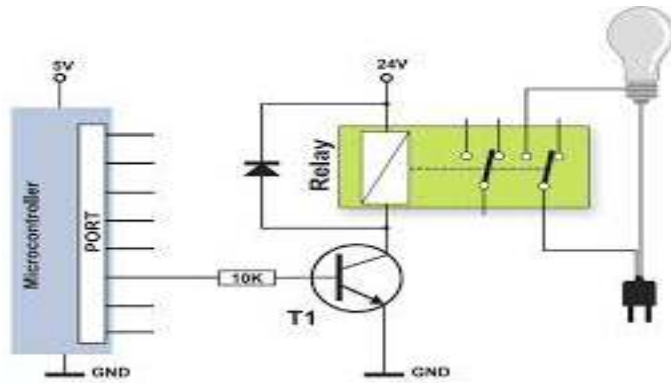
The camera display module is made up of intelligent 4.5 pixels to display the point of intrusion from camera view. The circuit design indicates open terminal output for IP camera and its interface with microcontroller on pin P_o_1. Other open ports (P_3_6 and P_3_7) are used to Light Systems. The display unit is used in the design to make it easy for security operatives and users using the system to locate the intruder position.

Power Supply Transmission Model

The 220/12V step-down transformer was used for transformation of AC signal, bridge rectifier diodes IN4141 was used as rectification, capacitors (16V/100uf, 0.01uf) used as filter by allowing AC components to pass by block DC component and lastly, a voltage regulator LM705 was used to regulate output to voltage to +5 V [11].

Figure 6 Power Configuration to sub-systems
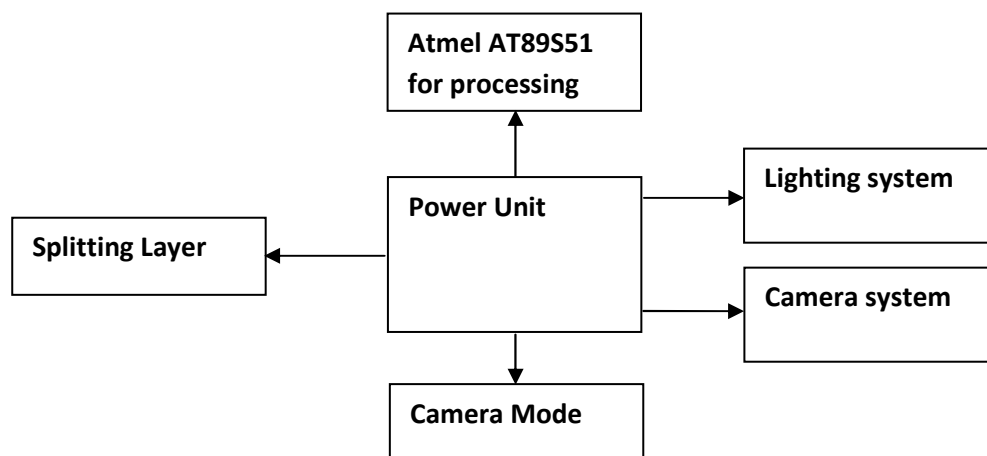
Benefit of MBILS Device

The MBILS helps detecting unauthorized entry onto a target environment. The system sends a signal to central processing and monitoring centre when activated. The processing and monitoring centre provide 24/7 service and will alert owner, security units and other authorities on the nature of invasion scene [10,12].

DESIGN ANALYSIS

The design methods and then analysis employed in the design of the microcontroller based provided duplex communication between input and output [13]. These analyses are required to make the correct choice of component values for effective performance. The analysis is divided into modules namely

i. The power supply module

ii. The light detector module

iii. The darkness detector module

iv. The processor module

v. The camera module

Design of the Light Detector Module

The design of the light detector module was achieved using a Light Dependent Resistor (LDR) interfaced to an NE555 timer to detect the presence of light in the dark environment. When an intruder flashes a light device in the restricted zone, the LDR resistance decreases and the NE555 is triggered through pin 2 and then sends out an output through pin 3 to the microcontroller pin as a high signal [14].

The light detector detects an intruder either trying to open a door in a secured area kept in darkness; therefore, once light is detected, this will trigger or activate the camera to snap image at the scene and initialize video stream with support of activated lighting module to ensure clear image detection over active camera as (shown in figure 4).

Design of the Darkness Detector Module

The design and implementation of the darkness detector unit was achieved using a Light Dependent Resistor (LDR) interfaced to an NE555 timer to detect the absence of light. When an intruder obstructs a lighting point or casts a shadow to block light falling on the

207 sensor in the activated area, the camera will be activated and the screen displays the zone
208 where the intrusion is coming from [14,15].

Design of the Processor Module

210 The design of the processor unit was achieved using AT89C51 microcontroller. The
211 processor unit takes care of taking the signals from the sensors and activating the camera
212 to show the point of intrusion or enable lighting system for clear vision or illumination of
213 the target facility [16]. Therefore it makes it easy for the intruder to be caught. The
214 processor unit controls the overall function of the system since it takes the signals from
215 the sensor inputs and determines the necessary action to take by showing the zone of
216 intrusion points and also directing the authority in modality to apprehend the criminal by
217 giving away the position of the criminal scene [17].

The Software Design Module

219 This program is written in C language and it contains the bearer's intension. The aim of
220 this program is to control the sensors, camera and light device [18]. The software
221 development was executed in the following phases;

222 i. Writing of the source code in C language.

223 ii. Compiling the source code using Keil micro-vision compiler.

224 iii. Programming the microcontroller with the output hex file from the compiler using
225 Unipro Universal programmer.

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Discussion

228 During the design and construction of this project, testing was carried out at different
229 stages to determine if the results obtained at each stage met the desired output. Then the
230 sub-system module was built and tested for durability, efficiency, and also to ascertain if
231 there is need to modify this design. The system was first assembled using a breadboard.
232 All components were properly inserted into the breadboard from whence some tests like
233 (reliability, performance evaluation and service response test) were carried out at various
234 stages.

Figure 7: internal structure of sensors, and light device

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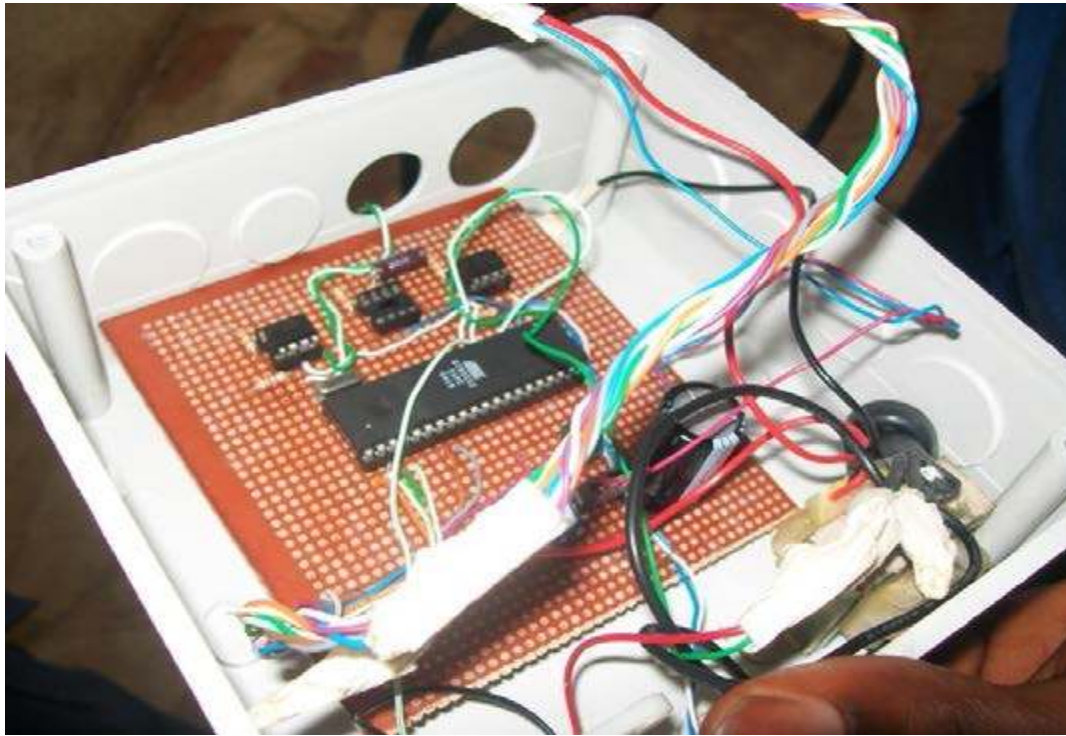
In figure 6, the sensor is used as input signal while camera depends on illumination of the environment to capture image of intruder and store in external memory to compensate alert signal at the security unit for further investigation. The other way around, this is efficient for safe energy usage because light system in environment where there is no human or intruder passage will remain off till the system detects obstruction on sensors path.

Fig 8 *: Indicate Unauthorised Entry with ON Light from Door opening*

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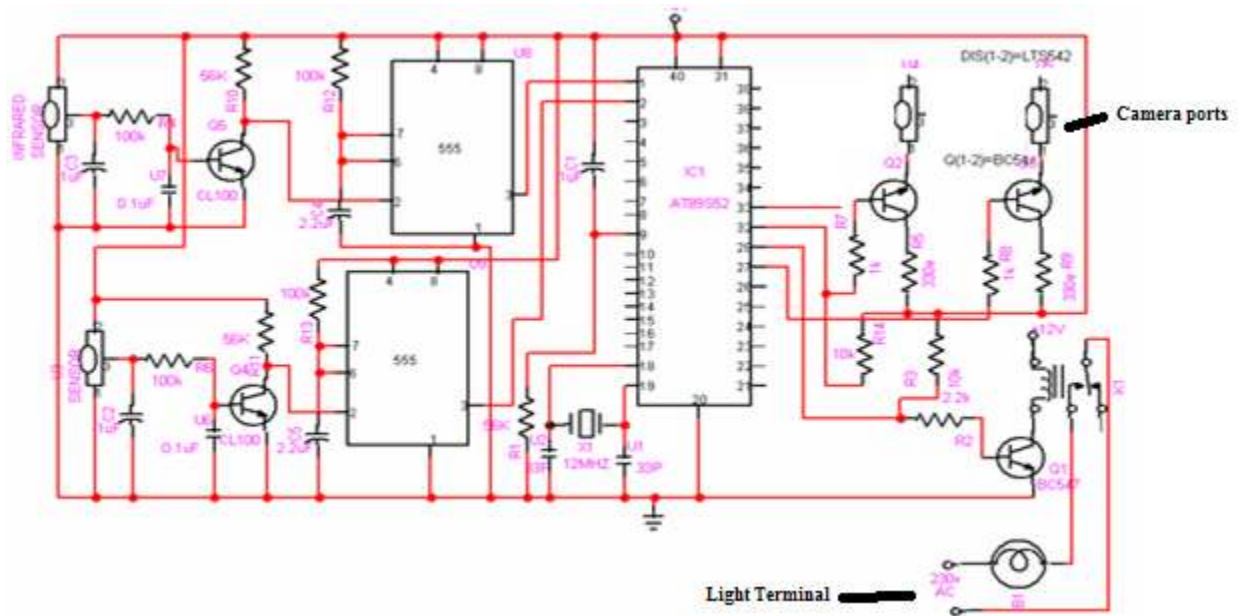
248   *Fig 9: ON state at 25^{0}c on object intruderion*

259   *Fig 10: Indicate Unauthorised Entry with ON Light*

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261   *Fig 11: MBLS system*

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264   *Fig 12: MBILS Cirtcuit Design*

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266   <mark>The figure 7 is used to construct MBILS device shown in figure 6 therefore further</mark>

267   <mark>modifications can improve our design by improvising motion detector device with</mark>

268   <mark>sensors.</mark>

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Conclusion and Recommendation

MBILS devices are installed in buildings to protect human being and properties. When lighting and camera is triggered, a captured image from the camera is needed for investigation. Normally, the authority must set up investing panels to capture the intruder using security protocol at their disposal. On the other hand the device can serve as energy saving device for situation when light has to be used and customize energy-consumption patterns when necessary, using intrusion automation to activate light in the environment. This project undergoes sequential experimental design and construction. These included power unit, controller unit, input and output that were interfaced as a system. This research can be use to solve problems in workshop, houses, offices, etc. Further work is required in aspect of casing and portability.

Therefore, this research work has involved the use of both hardware and software to bring about the project entity. Going through the facility planning, flow process, design and software implementation the system had extensive prototype but there are multiple numbers of security systems which are available to protect life and properties likewise energy-saving devices for electrical and electronic systems. Future work is required to develop extension link for adaptive alert module and wireless network intrusion but this will having additional cost and resources for future upgrade using Atmel AVR ATmega16 microcontroller.

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