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# BORDER SECURITY SYSTEM USING ARDUINO, ULTRASONIC SENSORS AND IOT

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**Abstract -** *Border surveillance is the most difficult and important task for national defence and security. Especially under certain circumstances when activities like terrorists infilterations, intrusions and illegal happenings between the borders, it has become utmost important to protect the borders with smart and advance technology. Our project is based on a Border security system which fabricates on border security, by using advance technologies. The main objective of the paper is to describe how the technologies used in this system works and how this will help the soldiers to secure the border of the country. To curb such happenings the least we can do is to constantly monitor across the border and detect intrusions. It takes a lot of man power to stretch over the border and constantly keep an eye, hence the need of the hour is to build such automated border surveillance which can eliminate man power. Moreover, if something suspicious is detected by the system, it must be able to perform necessary actions by issuing an alarm alert and weapon activation system. The central room can be set up within a distance from the border. Once the human controller is aware of intrusion it is upon them to take next course of action.*

*Following are the important components used in this project :- 1. Arduino 2.PIR sensor 3.GSM module 4. Laser etc.*

***Key Words*: Border surveillance, Border security, Advance technology, Alarm alert, Weapon activation.**

## 1. INTRODUCTION

Today our major concern is the security of the border of our nation. These borders are guided by our soldiers. These soldiers encounter threat to their lives due to infilterations, cross border terrorism, drug peddlers etc. Due to these malicious elements,they make supreme sacrifice. If we could have save even half of life, we would have an even mattlesome force. These may not have been possible in past warmtimes, but today the scenarios are changing. We are advancing to a technological more dexterous globe. Terrains like rivers, valleys, hilly areas, fissures ,etc which are comparatively more difficult to guard and where it is more likely for our soldiers to risk their lives and meet martyrdom can now be stopped because of the IOT based technology. If anything, which arises suspicious occurs then, execution of predetermined tasks take place. Intrusion detection system IDS are integral part of border surveillance. They are designed to operate in hostile environment, to monitor, detect and track ,the intruders (moving targets), around the clock. As it is really tiring for our soldiers to keep a track 24/7 through video streaming, intrusion detection which an generate automatic alerts can prove to be of great use.

### 1.1 Objectives

1.Defending the difficult terrains from infilterations from safe and secure manner.

2.Monitoring, sensing and identifying the human infilteration.

3. Activating alarm system and alerting the controller room.

4. Weapon activation as soon as the intrusion trespasses the border.

5. Alerting controller room through IOT and taking manually actions.

The proposed system called border security system using Arduino ultrasonic sensor and IOT is an border intrusion detection technique that uses IOT to alert the controller room. This system is fully automated which needs only one or two persons for maintenance purpose. This paper will basically concentrate on the human interfacing & knowledge towards our project system i.e. the detection & alerting the soldiers to take necessary action to the problems at the border. This system has ultrasonic sensors which are responsible for the detection of intrusion. As they are mounted over the section pillars. The sensors continuously rotate back & forth in the range of certain degrees (30-160) & show the intrusion over the radar with its location.

Another set of sensors which sense the intrusion & show over the LEDs & activation of the alarm. As the sensors detect the intrusion RF transmitter sends signal to the receiver & line following robot reach the border line & again detect the intrusion by sensor mounted over it. As it detects, the laser will fire towards the intruder & eliminate it. The ultrasonic sensor we use are HC-SR04. The controlling modules are Arduino UNO board. The laser used is Diode Laser.

The rapid growth that India is currently experiencing presents an array of opportunities and underlines the need for effective border management. India has a very large and complex border, covering around 15,106.7km, which it shares with Bangladesh, China, Pakistan, Nepal, Myanmar, Bhutan as well as small portion with Afghanistan. What further increase the complexity and criticality is the varied terrain, climatic conditions. By taking the disadvantages mentioned above the threat of terrorism has become a worldwide concern. Without any concern for human lives terrorist continue to strike with impunity, leaving a trail of death and destruction.

## 2. LITERATURE SURVEY

Subsequent to experiencing a portion of the project with respect to usage utilizing ultrasonic sensors and ARDUINO, it was found that this idea is searched a lot and is a mainstream idea which is still in advance. The advances utilized were not just productive and solid yet in addition financially achievable. Not only this, here other very useful applications of ultrasonic sensors were observed too.

This project discusses about a monitoring system which is designed measure to speed of waves and height of river through ultra-sonic sensor using microcontroller (Arduino). On the off chance that the waterway can't oblige the volume of water, then all the water will submerge with land and this phenomenon is called as flood or surge. We can overcome this flood problem by earlier identification in height of water and observing speed. If we identify problem earlier we can overcome this problem before it become crisis. By testing the system i.e. simple water level, it was observed that ultra-sonic have accuracy of 96.6%. But when it is implemented in the rivers there are many errors because of different type of water levels due to heavy waves and speed of water and also due to floating of heavy objects. Unlike Previous testing results, author directed this analysis on tracking of speed of water improvement or modification and level of water in flooding. The test was completed when the Arduino used as controller of application. For more research, information of depth level and speed of water of this system will be sent to database server website to be checked regularly.

Arjun et al. [1] present a survey of wireless sensor networks for Border Surveillance and Intruder Detection. The aim is to devise a multi-sensing system which is developed by combining different techniques of surveillance and intruder detection, for varying border scenarios such as, flat surface movement or water-body movement. Different sensors for human intruder detection such as, geophone, hydrophone, infrared and surveillance cameras are discussed

Jisha et al. [2] propose a system for intruder detection which employs an object detection technique using Wireless sensor networks. PIR (Passive infrared) sensors are used which are further connected to MICAz sensor node. The proposed system is expected to detect and track the intruder and report its speed and direction of movement to a central base station for further processing.

Singh and Khushwaha [3] propose a mechanism for smart border surveillance and automatic combat. It makes use of features extracted from optical flow information of the scene. Once the automatic detection of intruder takes place, suitable action is taken depending upon the relative position of the intruder with respect to the border fence. If the intruder happens to be behind the fence, mere tracking is followed. If the intruder is above the fence and trying to cross it, an alarm is raised. Auto-firing can be activated when the intruder has actually crossed the fence.

Jin et al. [4] present a method for detecting and classifying a target by using seismic and PIR sensors. The target can be classified into one of the three classes of vehicle, animal or human. A wavelet method called symbolic dynamic filtering (SDF) is used for feature extraction from the sensor signals. Zhang and Liang

Ye et al. [5] present a method to detect moving target via using the technique of background subtraction and shadow removal. The method is applied for RGB color space. Metrically trimmed mean and mean absolute deviation are the estimators used for background subtraction. The Chromacity difference and brightness difference are the estimators for shadow removal.

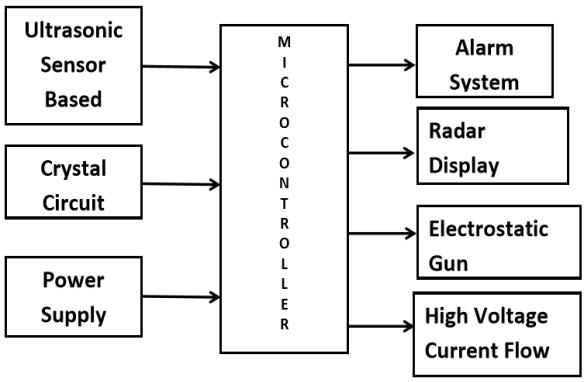
## 3. PROPOSED METHODOLOGY

The objective of the system is to build an implanted intruder identification framework in border by utilizing IR sensor using IOT. There are numerous IR sensors being used today

however the sensor that is utilized will identify the Infrared beams that are transmitted from the human body. It is able to provide round the clock video surveillance at the places where human deployment is not possible due to geographical, climatic or some other reasons. Multiple pyroelectric infrared sensors (PIR) are disguisedly installed on the border fencing which monitor the border area for any intrusion.

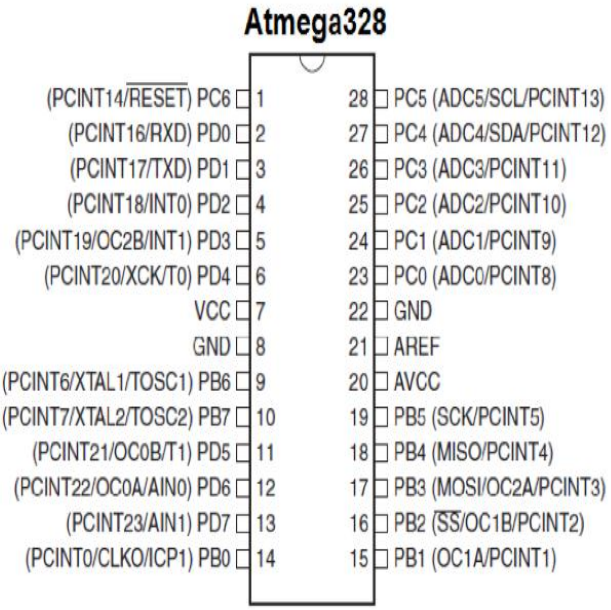
In order to testify the working of this system, after its designing, construction and programming we placed few objects in front of the ultrasonic sensor. As the motor started to rotate, our monitor started to display the output through processing IDE. Hence, when the sensor crossed over the object it showed a red segment with the distance and angle where the object is paced. The first object was placed at the distance of 29.5cm measured through a ruler and the system measured the distance at 31cm.While the second object was placed at a distance of 15 cm and the system measured it as 16cm. Hence the calculated efficiency turned out to be 95%

### 3.1 Functional Block diagram



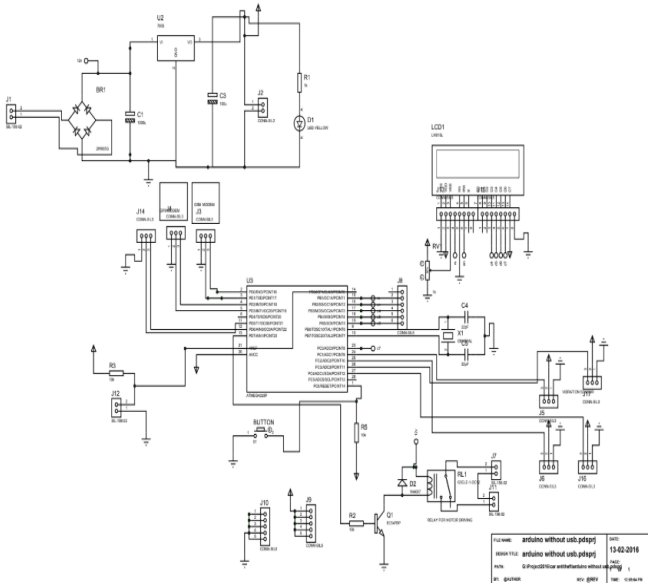

The above fig. shows the Block Diagram of the radar system. Here we have used Arduino Uno ATMEGA 328 microcontroller which is open source to implement embedded based system. ATMEGA 328 microcontroller sends 10 micro second pulse width to ultrasonic transmitter and thus echo back signal receives by TX module of ultrasonic. After this is done receive pulse width is calculated by micro controller. Here we have used servo motor on which ultrasonic module is mounted to receive 180 degree signal. Microcontroller and MATLAB are communicated through UART protocol with the baud rate of 9600. This protocol works on ASCII value. So this is calculated distance transmit from microcontroller to MATLAB COM PORT. Accordingly, sensing different obstacle which are around 180 degree and 250 cm range, visible as a red spot on MATLAB GUI.

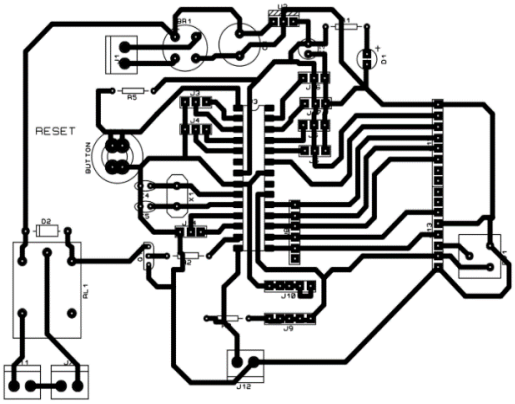
**ATMEGA 328 Schematic diagram.**




The Atmega328 chip has an analog-to-digital converter (ADC) inside of it. This must be or else the Atmega328 would not be capable of interpreting analog signals. Because there is an ADC, the chip can interpret analog input, which is why the chip has 6 pins for analog input. The ADC has 3 pins set aside for it to function- AVCC, AREF, and GND. AVCC is the power supply, positive voltage, that for the ADC. The ADC needs its own power supply in order to work. GND is the power supply ground. AREF is the reference voltage that the ADC uses to convert an analog signal to its corresponding digital value. Analog voltages higher than the reference voltage will be assigned to a digital value of 1, while analog voltages below the reference voltage will be assigned the digital value of 0. Since the ADC for the Atmega328 is a 10-bit ADC, meaning it produces a 10-bit digital value, it converts an analog signal to its digital value, with the AREF value being a reference for which digital values are high or low. Thus, a portrait of an analog signal is shown by this digital value; thus, it is its digital correspondent value.

### 3.2 – Circuit Diagram and PCB Layout






**PCB Layout**

Circuit diagram of our project comprises of following modules:

**POWER SUPPLY MODULE:**

1) TRANSFORMER: Transformer is the main component of the power supply module. There are two types of transformer namely Step up and Step Down. We have used Step down transformer as we have to generate 5 volts and 12 volts DC supply from the 230 volts input AC supply so we have used 15 volts / 500 mA transformers which means its output will be 15 volts AC with current rating of 500 mA.

2) RECTIFIER: Rectifier used to rectify the negative half cycles of the output signal of the secondary of the transformer. So at the input of the rectifier we have AC signal with both positive and negative cycles and at the output of the rectifier we have signal with only positive cycles but as this signal is also AC so we have to use capacitor to filter out the AC of the output signal. There are mainly three types of rectifiers namely Half wave, Full wave and Bridge rectifier. Out of these three we have used Bridge rectifier since it give more efficiency. A full wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output by reversing the negative (or positive) portions of the alternating current waveform .The positive (negative) portions thus combine with the reversed negative (positive) portions to produce an entirely positive (negative) voltage/current waveform. For single phase AC is center tapped, and then two diodes back to back (i.e. anode to anode or cathode to cathode) form a full wave rectifier.

Rectifier designing 1N4007 diodes are used to build circuit of full wave bridge rectifier

Surge overloads rating - 50 amperes peak

3) FILTER CAPACITOR: As mentioned above we have to use filter capacitor to remove the AC signal from the output of rectifier. Filter capacitor is used in order to remove ripples from the pulsating DC and convert it to unregulated DC. A capacitor is an electrical device that can store energy in the electric field between a pair of closely spaced conductors (called 'plates'). When voltage is applied to the capacitor, electric charges of equal magnitude, but opposite polarity, build up on the plate. Capacitors are used in electrical circuits as energy storage devices. They can also be used to differentiate between high frequency and low frequency signals and this makes them useful in electronic filters. These small deviations from the ideal behavior of the device can become significant when it is operating under certain conditions, i.e. high frequency, high current, or temperature extremes.

4) VOLTAGE REGULATOR: Two separate voltage regulators are used after the filter capacitor so as to generate constant DC voltage supply of 5 volts and 12 volts. We have used 7805 and 7812 as a voltage regulator. Both of them are three pin IC which are namely input, ground and output. We have to give output of filter capacitor to the input of regulator, and we get 5 volts and 12 volts supply at the output pin of the respective regulator.

Output Current in Excess of 1.0 A

No External Components Required

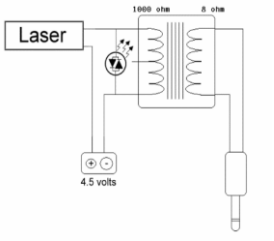
Internal Thermal Overload Protection

Internal Short Circuit Current Limiting

Output Transistor Safe–Area Compensation

Output Voltage Offered in 2% and 4% Tolerance

### 3.3 - P.I.R Sensor and LASER.



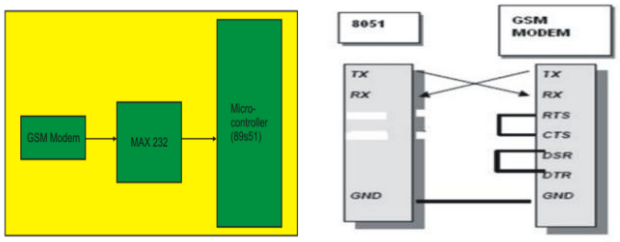

**P.I.R :-** Pyro-electric (Passive) Infra-Red (PIR) Sensors, (PIR) sensors allow sensing thermal radiations emitted by human body, motion, infrared radiations. These pyroelectric sensors detect levels of infrared radiation. These are mostly used to detect human crossing the range of the sensor. They are small, economic, consumes very low-power, easy to use and robust. We are aware that everything emits some low level radiation. The hotter elements like human body emit higher radiations**.** A P.I.R based sensor is basically used to detect movement of animals, people, or other objects. We have used this sensor to detect intrusion across the border. This sensor will be kept within the border. While this sensor, will detect human intrusions monitoring throughout the border, as soon as some suspicious object is detected it will inform the control room while releasing signals and by sending a message to the control room. Here we have implemented an IOT based system where this sensor will use IOT as a medium to reach out to control room.

**LASER:-** We have used this laser technology as a weapon system to fight against intrusions. Normally any guns, which are used today in military sectors, can be used there but there is a chance of getting shortage of ammos, thus this laser gun has been designed in keeping mind. This laser gun will eliminate intrusion thrice the normal weapon. As soon as it receives command from sensor, detecting intrusion, the laser gun activates. This laser gun will be kept near across the borders and at high security. This will be checked and maintained daily in order to eliminate any risk of errors in gun.

### 4. IOT

The internet of things (IOT) is an important part in this project, since it is responsible for the major part to send signals to the controller room. We have used a GSM module, where this module will be kept inside the controller room. As soon as the target is detected, this GSM module will help as to receive a message at the controller room. The message would be send within the seconds. Meanwhile the laser gun will activate. There, it is upon the security whether to take the manually weapon activation system or let the automated system eliminates the intrusion.

**GSM** :- A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through Radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate, controlling machines using gsm mobile sms services.



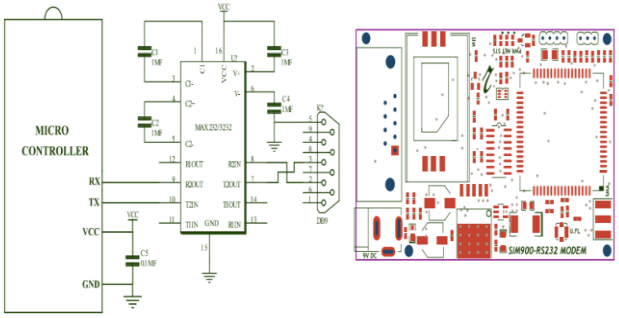

GSM modem receives the information signal, with the help of AT command the SMS is read by the microcontroller. Then the microcontroller recognizes the data and provides appropriate action to the relays to control the specified devices. The sending SMS through GSM modem when interfaced with microcontroller or PC is much simpler as compared with sending SMS through Modem in PDU Mode. Text message may be sent through the modem by interfacing only three signals of the serial interface of modem with microcontroller i.e.,TxD, RxD and GND. In this scheme RTS and CTS signals of serial port interface of GSM Modem are connected with each other. The transmit signal of serial port of microcontroller is connected with transmit signal (TxD) of the serial interface of GSM Modem while receive signal of microcontroller serial .Modem. The GSM module has a RS232 interface. The receive (Rx) and transmit (Tx) pin of the GSM module's RS232 port are connected to the transmit (Tx) and receive (Rx) pin of AT89C51's serial port, respectively. The microcontroller is interfaced with GSM Modem in mobile phone via MAX232 level convertor.

**Working of GSM**:- First, the microcontroller has to send "AT". A response "OK" should be returned from the mobile phone or GSM modem. Reading of message from the SIM card inserted into the modem is done by sending the appropriate AT command to the modem.

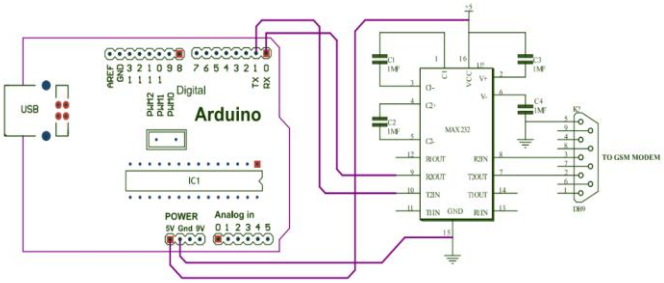
**Components used** :- AT89C51, MAX232

### 4.1 INTERFACING THE GSM MODEM WITH MICROCONTROLLER

The Modem can be directly interface with 5V microcontrollers like PIC, AVR, 8051 Derivatives, Arduinos and 3V3 Microcontrollers like ARM, ARM Cortex XX ect. Make ensure V_INTERFACE pin is supplied with same voltage level as the microcontroller VCC. As per the Fig there is only 2 connections are required to use the modem. Connect RX pin of the modem to the TX pin of the microcontroller and TX pin of the modem to microcontroller's RX pin. The connected power supply (4.2v to 12v dc) should be capable of handling current up to 1 A




### 4.2 CONNECTING THE MODEM TO THE ARDUINO




**Getting started :-**

**1. Insert SIM card**: Open the SIM cardholder by sliding it as per the arrow mark and lift up. Insert the SIM card, so as to align the chamfered corner suits in card holder .After inserting the SIM card, lock the holder by sliding it to the opposite direction of arrow mark.

**2. Connect the Antenna**: Fix the Supplied RF antenna to the SMA Antennae connector and tighten it by Rotating the Nut (Never rotate the antennae for tightening).

**3. Connect the Pins: Connect** the GSM modem as per the circuit diagram provided

**4. Power the Modem**: Power the modem from suitable power supply, which is having enough current capacity (>1A).

**5. Check the Status of the LEDs:**

PWR LED - Red LED will lit immediately

STS LED - Green LED will lit after 1-2 seconds

NET LED -Blue LED will starts to blink in fast for few seconds (Searching for Network)

**6. Network LED:** The Network LED indicates the various status of GSM module eg. Power on, Network registration & GPRS connectivity.

**7. Baud rate**: The Baud rate supported by the modem is between 9600 and 115200. Make sure the host system is set to the supported baud rate.

The modem automatically sets to the baud rate of the first command sent by the host system after it is powered up. User must first send "A" to synchronize the baud rate. It is recommended to wait 2 to 3 seconds before sending "AT" character. After receiving the "OK" response, Your Device and GSM Modem are correctly synchronized. So there is no need for setting the baud rate using commands.

## 5. CONCLUSIONS

Security of the nation is a major and prime concern. But at the same time the lives of men safeguarding at the borders must be protected. Warfare does not depend upon manpower only; it needs smart weapon system as well. The advancement in our technology are quite helpful in providing security without causing threats to our soldiers. The concepts mentioned above not only secures border effectively, but also avoid life threats. We need to accept such technologies and avoid loopholes at border areas due to difficult terrain. However, this amalgamation of technologies needs further investigation and refinement for an efficient management of borders.

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