

PREVENTION OF ILLICIT TRAFFICKING OF NUCLEAR AND RADIOACTIVE MATERIAL BY USING HIDDEN DETECTION STATIONS

DRAGAN PAVLIĆEVIĆ
Podgorica, Montenegro
Email: drganpv22@gmail.com

Abstract

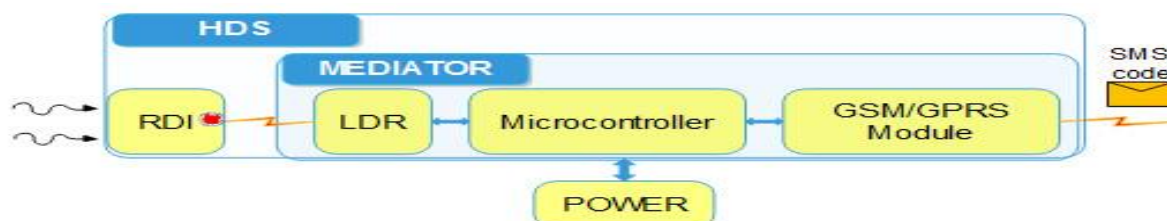
This method aims to detect illegal trafficking MORCs, where smugglers do not expect control. Hidden Detection Stations HDS are used to detect radioactive radiation when passing vehicles. A HDS consists of a Radiation Detection Instrument (RDI) and a device (Mediator) that detects an alarm from the RDI and sends a code message to the camera to identify the vehicle causing the alarm. RDI must have a visual alarm. Mediator detects the light indication of RDI and sends an SMS to the camera, SMS alerts to the monitoring center and if necessary, a phone call to the police patrol when passing a vehicle with radioactive material. The Camera receives an SMS code message, which is the trigger for taking pictures of the vehicle that caused the alarm. The Camera, HDS, and computer with monitoring program make up HDS system.

1. INTRODUCTION

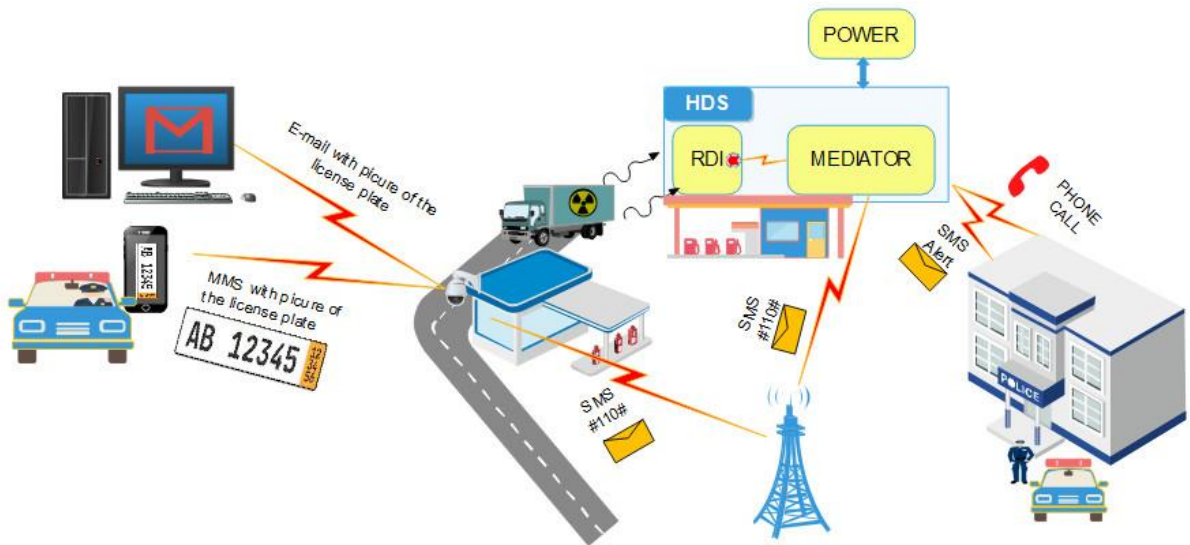
The goal of any illegal transit is to avoid possible control. So, in the illegal transportation of nuclear material, smugglers are expected to bypass border crossings and controls where their illegal operation can be detected. This method aims to place detection instruments in hidden places where smugglers do not expect control. HDS are used to send SMS messages to the alarm monitoring center when passing vehicles with radioactive material. Other tactical systems require human engagement. Alarms are not so frequent, which could discourage and demotivate users to use radiation detection equipment. For a small price, HDS can cover a large number of traffic locations over a continuous period of time. HDSs use reserve and little-used radiological radiation detection instruments, which have a visual alarm. HDS system enables the fastest response and regional cooperation through alerts, emails or MMS messages in case of illegal border crossing with radioactive material.

HDS stations use appropriate Radiation Detection Instruments (RDI) and the device tasked with sending an SMS code to the camera, an SMS message to the monitoring center, and a phone call to the police patrol when the detection instrument detects radioactivity. Like the MDS and the backpack as tactical equipment, there is also a limitation on vehicle speed and distance between detection devices for the HDS. Therefore, the HDS should be positioned where the vehicle speed is low and the vehicle is a short distance from the HDS. These are gas stations, toll booths for highways, narrow roads used for illegal border crossings, traffic lights and other places that allow the slow passage of a vehicle or stop it near the HDS. Allies of the HDS System are rubber speed limiters, traffic jam, etc. This allows for a continuous control of a large number of vehicles, which increases the likelihood of MORC detection.

This paper aims to offer a technical solution to signal the state of the alarm being sent through phone mobile network. An RDI radiation detector (PRD or other) has a visual alarm in the form of a flashing LED or display light. RDI is used as a hidden station, therefore, it is in a darkened area, light of display or blink LEDs diode in alarm state can be a trigger that will send SMS code to the camera and execute alert in the form of phone calls and SMS messages, to predefined phones whose are enter the numbers into the microcontroller program. The aim of this paper is to make a device that has this function. To avoid possible confusion, I will refer to this device as the Mediator below. A photo resistor or Light Dependent Resistor (LDR) is an electrical component that changes its resistance by changing the light intensity. In this way, it is possible to detect a change in light, that is, an alarm state on the RDI display or LED diode. Mediator sends SMS messages with the code to the camera via the GSM / GPRS module.

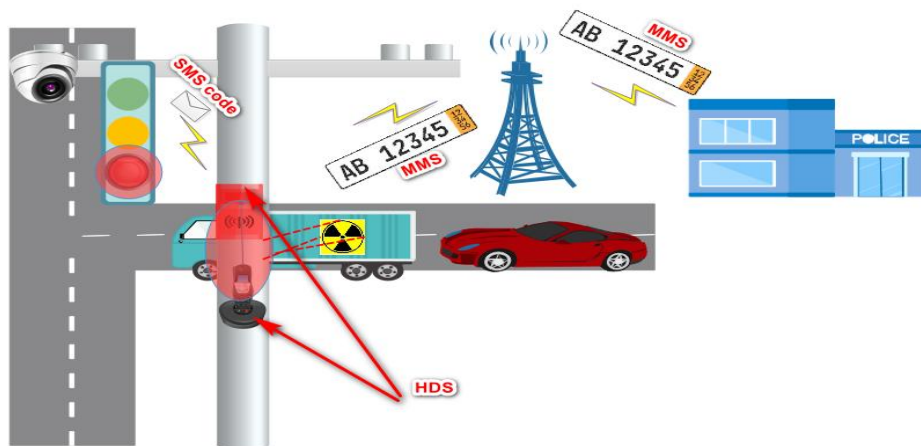


Camera take photo vehicle with the license plate and send pictures as MMS to until 4 mobile phone number and 4 e-mail address. Mediator can send SMS alert to monitoring center and mobile phone call, when start is alarm.



On the picture is scenario at petrol station

Vehicle identification is done by means of a camera or an existing video surveillance that is synchronized with the work of a HDS. Several HDS stations on one section of the road can measure the radioactivity of almost every vehicle, with regard that the vehicle will be stopped at least one of several traffic lights.



The Application of HDS on the road

It can also be used in conditions of illegal border roads. The system should be protected from low temperatures. Of course, this concept in one location not have a high price, which allows covering a large number of potential illegal crossings. In these conditions, the autonomy of the work can be greatly increased, because the external batteries can be hidden, buried, which allows for a great autonomy of operation. The same system can be added to devices such as motion detectors, external cameras used by border police and hunters. Although the border can be very long, monitoring can be carried out successively. Information on threat assessments, ITDB and other information can be used in the preventive action against illegal international transit of nuclear and other radioactive material.

2. COMPONENTS REQUIREMENTS AND TECHNICAL DETAILS

Content of HDS system is Radiation Detection Instrument RDI, Mediator, Camera, power supply and box for HDS. HDS is RDI and Moderator. Dimension of Mediator is 12 x 7 x 3 cm.



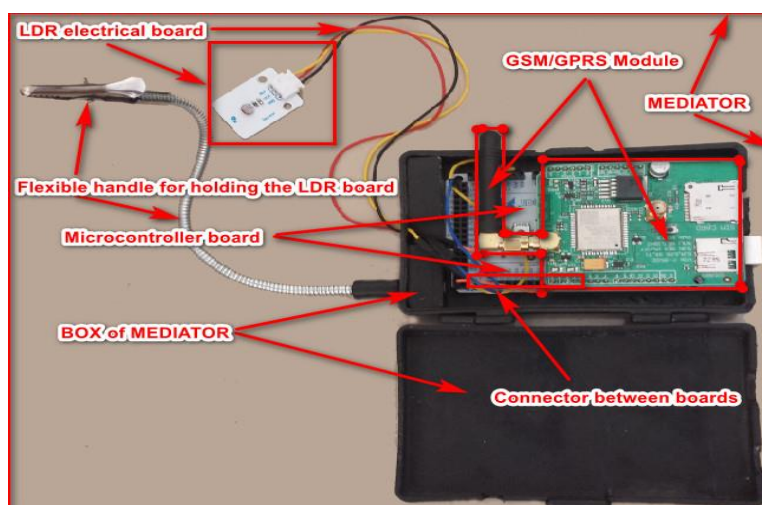
The HDS without power supply (test model)

2.1. Radiation Detection Instrument (RDI)

Every instrument which have visual alarm can use for a HDS. A Light of display or blink of a LED diodes is enough for send SMS messages. It is small number of device which have not this possibility. Such for a HDS can use instrument which are in reserve or are not use enough. For testing I have used blink LED diode of PM1703.

2.2. Mediator

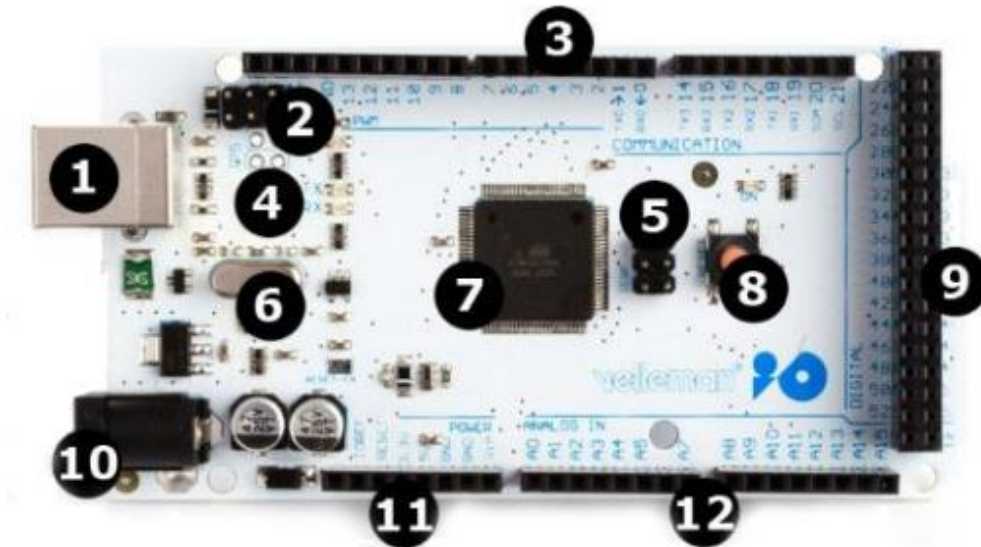
Mediator is device which receive light of visual alarm of RDI and send SMS messages. Content of Mediator is electrical board of LDR, Microcontroller, GSM/GPRS module, a box and movable and flexible handle for holding the electrical board for the LDR. Flexible handle for holding electrical board for the LDR is not necessary element. I have used it for easier testing. The LDR can be hooked for the box of Mediator, put in its box or attached for a light source of RDI.



Mediator without power supply

2.2.1. Microcontroller board (Arduino Atmega2560)

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins, 16 analogue inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, and a reset button. It contains everything needed to support the microcontroller. The board of microcontroller connect a computer over a USB cable if you want to programmed. The device power supply with an AC-to-DC adapter from 9V to 12V or battery. The Microcontroller board in Mediator have task to receive change of LDR on pin 9 and send SMS code to camera. If need The Microcontroller can send SMS alert to monitoring centre and a mobile phone call of police patrol. SMS and phone call send to number of SIM card which are programing in the microcontroller.



The Microcontroller board

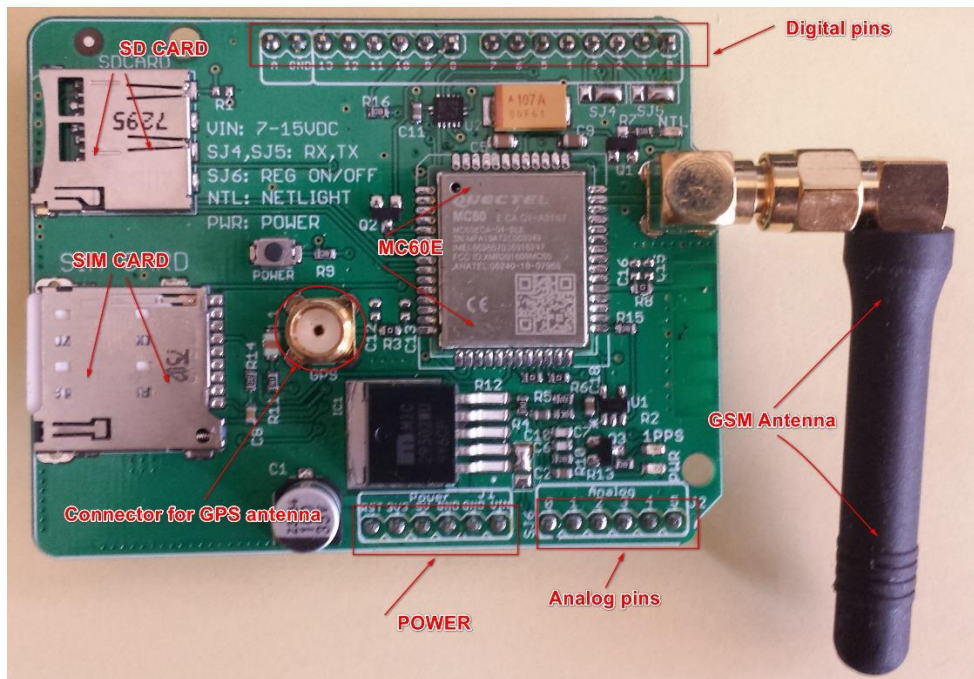
1	USB interface	7	Atmel mega2560
2	ICSP for 16U2	8	reset button
3	digital I/O	9	digital I/O
4	Atmel mega16U2	10	7-12 VDC power input
5	ICSP for mega2560	11	power and ground pins
6	16 MHz clock	12	analogue input pins

microcontroller	ATmega2560
operating voltage.....	5 VDC
input voltage (recommended)	7-12 VDC
input voltage (limits).....	6-20 VDC
digital I/O pins	54 (of which 15 provide PWM output)
analogue input pins.....	16
DC current per I/O pin.....	40 mA
DC current for 3.3 V pin.....	50 mA
flash memory	256 kB of which 8 kB used by bootloader
SRAM	8 kB
EEPROM.....	4 kB
clock speed	16 MHz
dimensions	
length	112 mm
width	55 mm
weight	62 g

The Specification of Arduino Atmega2560 board

2.2.2. GSM/GPRS Module (MC60E)

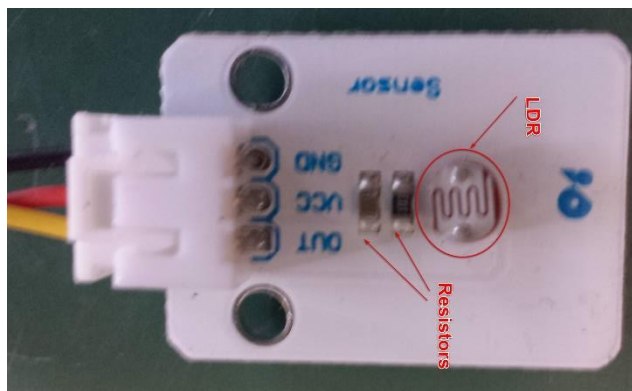
MC60E is GSM/GPRS/GNSS/BLE module. It has task to send SMS code to the camera when changing state on pin 9 of Microcontroller board through GSM/GPRS network.



MC60E Module compatible with Arduino Atmega2560

2.2.3. LDR board

This part of Mediator has role when appear a light of RDI that changing state pin 9 on Atmega2560 and so became trigger for send SMS coda to the camera. The resistances on electrical board have role to decrease current in microcontroller.



LDR board

operating voltage.....	3.3 VDC or 5 VDC
output.....	analogue voltage
pull down resistor.....	10kΩ
dimensions.....	25 x 15 mm

Specifications of LDR board

2.3. Box of HDS

The box must be enough space for HDS. The box must be full dark. This way will be avoiding false alarm. Material of box must be waterproof and low density material for better detection radioactive material.

2.4. Power supply

Depending on the location of the HDS, a power adapter or battery with suitable cables is used. The autonomy of HDS and RDI will depend on the size of the battery respectively the space available to it. Checking of Mediator power supply can be done using an SMS delivery report supported by your mobile phone network operator. The status check can be done through the HDS monitoring software.



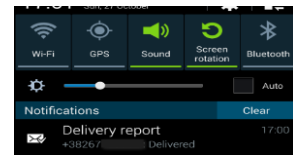
The Cable for Battery



The Battery



The Power Supply Adapter



A message successful delivery

2.5. The Camera

The camera is used to determine the cause of the alarm. It is positioned so that it can take pictures of license plates and details of vehicle. The picture of the vehicle triggered by the alarm is forwarded via MMS and e-mail. In the rural part, cameras used by border police and hunters are used.



UM785-3G SMS 12MP Full HD

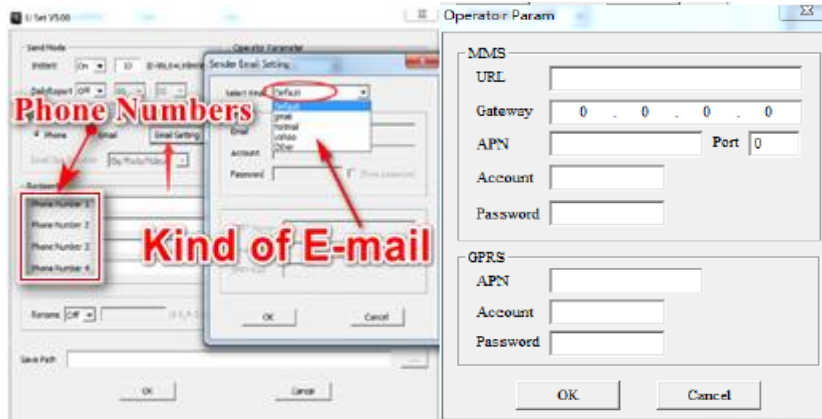
This camera has the ability to send MMS and e-mail when receiving an SMS code. Depending on the position of the camera, into the microcontroller will be programmed an appropriate type of SMS code

SMS commands UM785-3G

Command	Function
#110#	Take picture and send it
#360#	Location
#370#	Camera status request
#330#1#5#	5sec HD video capturing: res 720P HD / 5 sec
#330#1#10#	10sec HD video capturing: res 720P HD / 10 sec
#310#0#	Camera mode: Still pictures
#310#1#	Camera mode: Video imaging
#310#2#	Camera mode: Still + Video
Remote and sending:	
#240#0000#0000#	SMS remote ON 24h
#240#1830#2030#	SMS remote ON for example between 18.30 – 20.30
#220#0#10#	Instant sending, max 10pics per day (value 0 = unlimited sending, other values 1-99)
#220#1#2030#	Daily report 20.30
#220#2#10#2030#	Instant sending max 10pics day + Daily report 20.30
#230#0#	Send to phone by MMS
#230#1#	Send to e-mail by e-mail sending
#230#1#0#	Send to e-mail with high resolution (Big picture/Video)
#230#1#1#	Send to e-mail with low resolution picture

List of SMS commands

The Camera will send picture of car and number license plate when receive SMS code which sent HDS, on email address and number mobile phones which set up in camera. This camera can send pictures on four of number mobile phones and four e-mail address.



Setting up email

Setting up MMS

This The Camera is very suitable and immediately make photo and send to authorized in case alarm for identify car. They should be used and in an urban environment, and their appearance should be adapted to avoid attention. They can be fitted in a suitable camera case which will not attract attention.

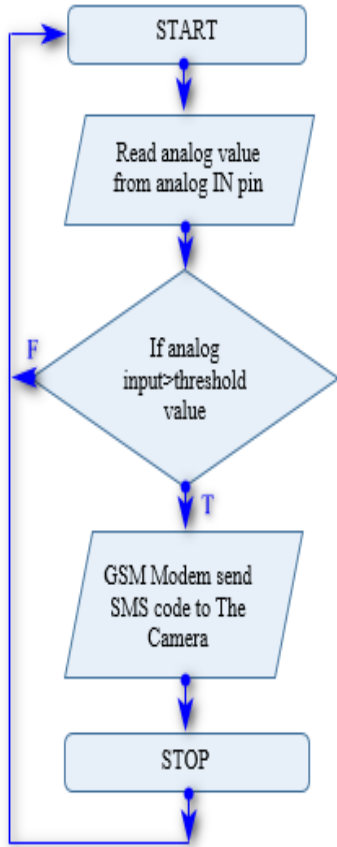
3. SOFTWARE

3.1. Software for Atmega2560

Programming of microcontroller operation is done on PC over USB cable. A program was coded in Arduino IDE Sketch.



USB cable



Workflow of Mediator

```

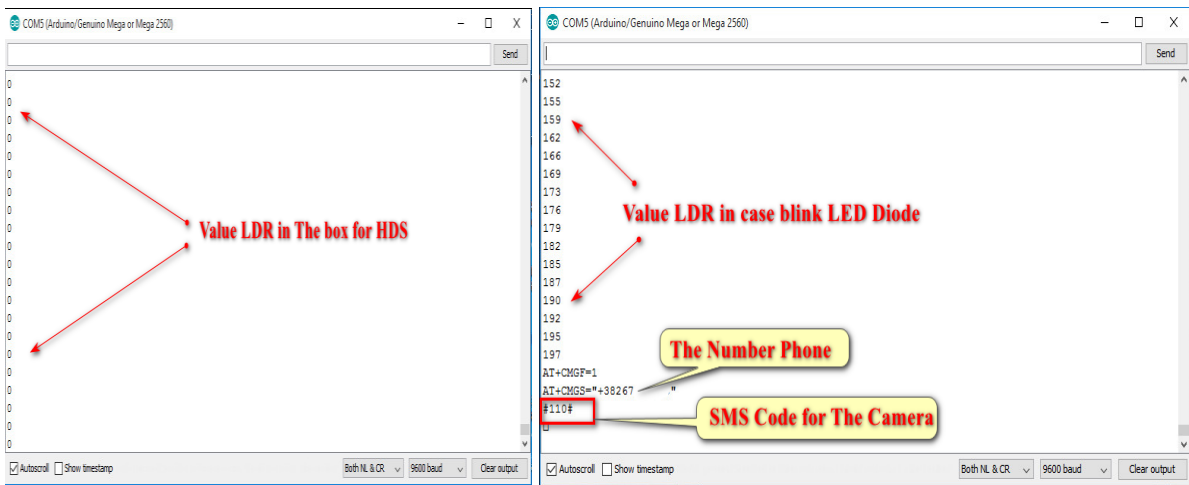
    void loop()
    {
      int ldrStatus = analogRead(ldrPin);
      if (ldrStatus >= 200) {
        Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
        delay(1000); // Delay of 1 second
        Serial.println("AT+CMGS=\"+38267xxxxxx\"\\r"); // Mobile number
        delay(1000);
        Serial.println("#110#");// The SMS text
        Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of
        //delay(10000);
        delay(2000);

        Serial.println("ATDT+38267xxxxxx;");//Phone Call//
        delay(10000);
        Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
        delay(1000); // Delay of 1 second
        Serial.println("AT+CMGS=\"+38267xxxxxx\"\\r"); // Mobile number
        delay(1000);
        Serial.println("ALARM1:Petrol Station MORC?");// The SMS text
        Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of
        //delay(1000);
        //delay(10000);
      }
    }
  
```

Programme of the Microcontroller Atmega2560 in Arduino IDE Sketch

The List of AT commands for control GSM/GPRS modem:

- AT+CMGH.....To choose text mode.
- AT+CMGS..... Send message to a given recipient.
- ATDT.....Phone Call (Tone Dial).



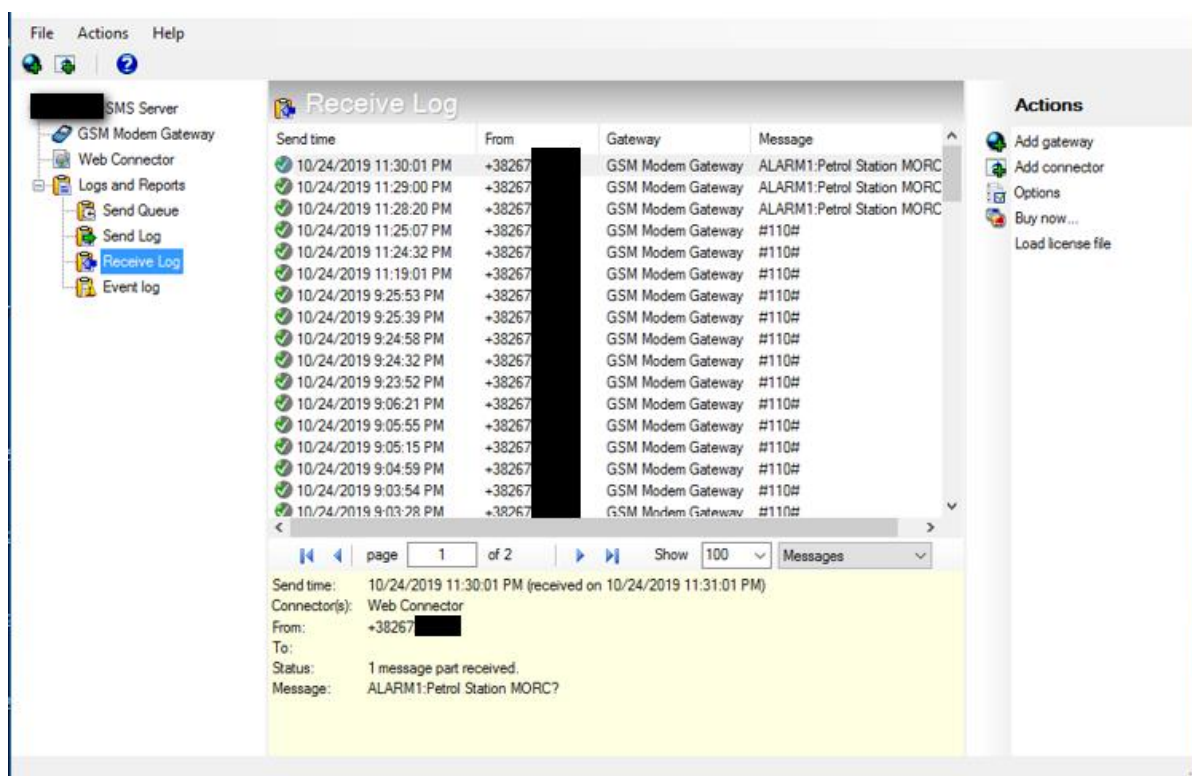
The Serial Monitor in Arduino IDE Sketch in case without and with an alarm

3.2. The Software for Monitoring HDS

For more HDS need software for monitoring stations. For software need PC and 3G modem.



A 3G Modem



The Software for Monitoring HDS stations

4. CONCLUSION

HDS is station which measure radiation in air. In case alarm The Camera takes pictures of a car and such send information about the car. HDS have role similar as station for monitoring quality of air. So I think for HDS will have no problem to be part of law in most country.

HDS stations use RDI (which have visual alarm) which are not use or not use enough. The low cost of a station allows tactical placement of a large number of stations, which operate continuously. This increases the probability of detection. The data is currently send to all responsible. In this way, it is also possible in the regional integration of several countries not only to prevent MORC in transit but also to monitor the detection of organized smuggler networks. In this way, the global threat gets a global response.

REFERENCES

- [1] ARDUINO ATMEGA2560 DEVELOPMENT BOARD, VMA 101. User Manual, [Online]. Available from: <https://www.velleman.eu/products/view/?id=435498> [Accessed: November 2019].
- [2] ARDUINO MC60E GSM/GPRS/GNSS/BLE Shield Ver. 0.9. Support User Manual, [Online]. Available from: https://produktinfo.conrad.com/datenblaetter/1900000-1999999/001925472-da-01-en-ARDUINO_MC60E_GSM_GPS_BLE_SHIELD.pdf?direct= [Accessed: November 2019].
- [3] LIGHT DEPENDER RESISTOR (LDR), VMA 407. User Manual, [Online]. Available from: https://www.velleman.eu/downloads/29/vma407_a4v01.pdf [Accessed: November 2019].
- [4] UM785-3G SMS 12MP Full HD, Wireless Camera Instruction Manual, [Online]. Available from: https://www.superjagd.com/docs/superjagd_shop_2016_bedienungsanleitung.pdf.
- [5] AT Commands, [Online]. Available from: <https://m2msupport.net/m2msupport/at-command/> [Accessed: November 2019].
- [6] BRIAN W. EVANS, Arduino Programming Notebook, First Edition Publisher, San Francisco, California, 94105, USA (August 2007).