Employing smart dust technologies to detect enemy activity on the border and on battlefields

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***Abstract*— The biggest threat to international security that crosses borders is terrorism. Due to the complexity and size of the borders, such as those between Bangladesh and Kashmir, neither military troops nor even satellites can keep an eye on the smuggling of terrorists. In this work, an efficient solution to these kinds of issues is presented. The major goal of this work is to develop a wireless sensor mote that resembles microscopic dust, has several sensors inside of it, and has a controller. Through the boundaries and fields of conflict, it is able to detect enemy intervention. This mote's unique feature is that it can be set up quickly across a broad region with a small number of people. These motes can band together to form a network. The networks are quick to establish, small in size, and provide wireless access to the outside world. Various sensors make up the on-board hardware, which also includes a microprocessor for routing sensor readings. A radio transceiver is what we use to communicate. The central monitoring station has a graphic LCD display that may be used to see the targets' tracking histories.**

Keywords—wireless sensor, smart dust, microcontroller, radio transceiver, graphic LCD display.

1. INTRODUCTION

A key issue in tactical border detection is intervention detection. Because it is impossible for men to visit those regions often, it is exceedingly difficult to identify the intervention in particularly large or arid areas. In this project, the intruder is found and categorised according to whether it is a human, a vehicle, or a combination of the three. Smart dust sensor motes, which are wireless and used for this, are used. The components of smart dust include a controller and on-board sensors that can recognise enemy activity across battlefields. The controllers and sensors are assembled into these motes. Thousands of intelligent dust motes may be deployed in the border in a short amount of time with just one or two men's assistance. These tiny motes develop their own network and transmit information to the outer world through wireless connections. A smart dust mote's battery life can range from a few hours to 10 years, depending on its size and functionality. Radio frequency transmissions are a typical method of communication for mote systems across somewhat small distances. As a result, designers may minimise mote size and lower power usage. When communicating, each communication is passed from the devices to a surrounding mote, which then transmits it to another neighbouring mote, and so on, until it reaches the central monitoring mote. Even if some of the motes' communication pathways stop working, the networks of motes still function. Once a mote is connected to an existing network, it adjusts to fit in with the other nodes to create a bigger network. When a mote malfunctions, the other network devices take up its load. The hardware is made up of a number of sensors, including a heat sensor, a PIR sensor, a metal detector, a vibration sensor, a microprocessor for regulating the values ofall these sensors, and a transceiver for wireless network connection. The dust mote is the collective name for the mote that houses all of this gear. A visual display and a controller are found in a controlling node known as the parent mote, through which it is possible to monitor the tracking history. The central monitoring node, which is connected in peer-to-peer wireless network mode, is the parent node.

2. LITERATURE SURVEY

The field of border surveillance has been the subject of several studies.

Kishore Kumar (20th October 2013) in his paper ‑To identify, categorise, and track enemy incursions using acoustic, magnetic, and thermal vibration signatures, smart dust for tactical border surveillance is used.‖ explains how the intruder can be classified, by the help of different sensors available.

Dough Steel (March 2005). in his paper ‑Smart Dust‖ explains the detail description about the smart dust.

T. J. Nohara (2010). by his study describes how the commercial approach to the utilisation of radar surveillance was used. In the literature, it is said that "surveillance solutions must be multimission-suitable, scalable, flexible, maintainable, upgradeable, interoperable, shareable, and affordable"—and this is certainly true of border surveillance and other security systems. The above-mentioned characteristics of the smart dust system are met, and its small size is a bonus when used on the battlefield.

P. Pratap and his colleagues (2010).) In their paper ‑Challenges of remote border monitoring‖ explains about the provision of dependable and efficient power, the provision of appropriate and prompt maintenance to reduce downtime, and networking technologies for efficient data transmission are the three fundamental challenges that must be solved in order to construct an effective ground surveillance system. A system that overcomes these obstacles would offer a "cost-effective solution requiring minimal support infrastructure to meet border monitoring and protection needs," according to the work's conclusion. It meets these problems thanks to the smart dust system.

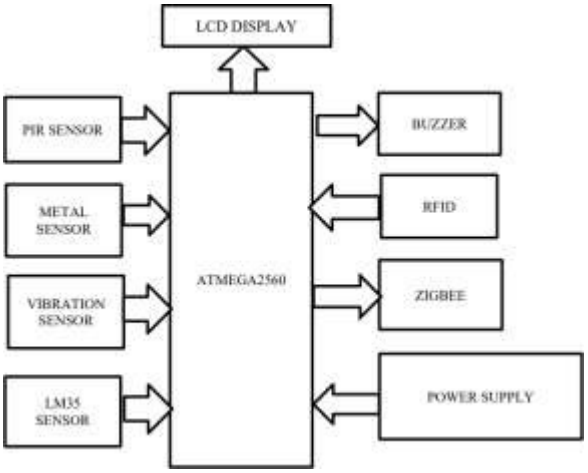
Jisha R C, Maneesha V Ramesh, Lakshmi G S (2010).) in their paper ‑Wireless sensor network for tracking intruders‖ presented that The wireless sensor network may be used to track the enemy.

3. METHODOLOGY

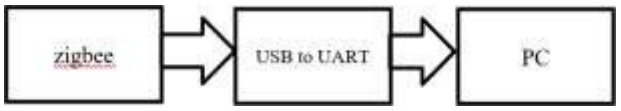
Dust particles make up the system that is presented. When

communicating, these dust motes send each message on to a nearby mote, which then passes it on to a nearby mote, and so on, until the message reaches its target, which is the central monitoring mote. Even if some of the motes' communication routes stop working, the network still functions. When a mote is added to an existing network, it adjusts to fit in with the other nodes to create a bigger network. When a mote fails, the network's other devices take up its burden, and a central monitor mote with a pic microcontroller and LCD display takes over the load.

BLOCK DIAGRAM



3.1 Block diagram of Smart Dust Mote Transmitter unit



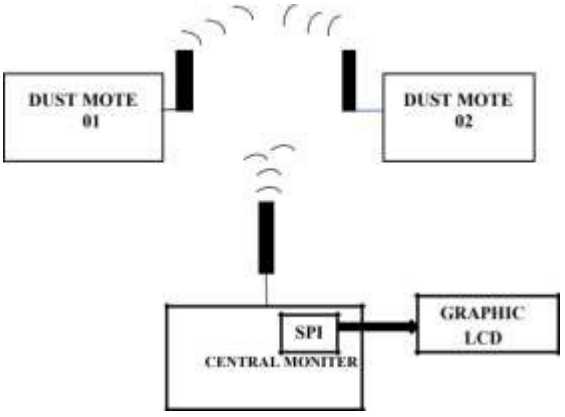
3.2 Block diagram of Smart Dust Mote Receiver unit

Description:

The smart dust mote is made up of many sensors and components, including

1. MICROCONTROLLER: The smart dust particle is controlled by ATMEGA2560
2. COMMUNICATION: Motes communicate via the Zigbeeprotocol.
3. VIBRATION SENSOR: MEMS accelerometer is used to sense the vibrations.
4. TEMPERATURE SENSOR: It is used to sense the temperature
5. METAL DETECTORThis sensor can identify enemies moving with weapons and travelling in vehicles.
6. PIR SENSOR: This sensor is able to distinguish between humans and animals.
7. RFID: A transceiver (transmitter or receiver) and antenna are typically coupled to form an RFID reader, one of the three parts of RFID systems. An RFID tag is created by combining a transponder (transmitter or responder) and an antenna. An RFID tag is scanned when a reader puts out a radio signal that activates the transponder and causes it to communicate information back to the reader.

All of the sensors are linked to the microcontroller, as indicated in the above diagram. All of the sensors are linked to the microcontroller, as seen in the above figure [Fig.3.1]. When the intruder is a person, the PIR sensor notifies the microcontroller that a human has been discovered, and if the intruder is carrying metal, the metal detector notifies the microcontroller that metal has been detected. The vibration sensor notifies the user that there has been a vibration when a group of people or a vehicle enters the boundary. The temperature sensor detects any forest fires and relays this information to the controller. Now, the controller gathers all of this data and sends it across Zigbee to the receiver. The receiver shows all the data that was obtained on a computer.



3.3 Smart Dust Motes System

The above figure shows the connection between the motes in the network, as shown in the figure the two motes in the network connect each other and forms a network among themselves. This network is used to transfer the data acquired from motes at transmitter end to the central monitor at the receiver end. The data received will be displayed on graphic LCD or on the monitor at the receiver end.

HARDWARE REQIREMENTS

Liquid Crystal Display

Through an output port, the LCD screen used in this block is connected to the microcontroller. This LCD module, which has 16 characters and 2 lines, can show numbers, characters, and drawings. The display has two internal bytes-wide registers: a command register (RS=0) and a character register (RS=1). Additionally, it has a user-programmable RAM region (also known as a character RAM) that may be used to create any desired character using a dot matrix. The display RAM address 00h will be indicated by the hex command byte, which is distinct between these two places.

PIR sensor

You can detect motion with PIR sensors (PIR Directional Infrared Radial Sensor D203S), which are nearly always used to determine if a person has entered or exited the sensor's detection range. They are lightweight, affordable, low-power, simple to operate, and durable. Because of this, they are frequently found in devices and appliances used in homes and businesses.

Infrared Radiation:

At a wavelength that is longer than visible light, infrared radiation may be found in the electromagnetic spectrum. Though invisible, it is nevertheless detectable. Animals and the human body emit infrared radiation, which is highest at a wavelength of 9.4 um, and are examples of items that emit both heat and infrared radiation. Many forms of material, including common window glass and plastic, that pass visible light but not infrared will not be penetrated by it in this range. Materials that are opaque to visible light, such as germanium and silicon, will allow it to pass through with some attenuation. For usage outside, a waterproof housing and an uncooked silicon wafer form an excellent IR window.

Pyro electric Sensors :

The crystalline substance that makes up the pyroelectric sensor produces a surface electric charge when heated by infrared radiation. The charge may be detected with a sensitive FET device that is incorporated into the sensor when the amount of radiation impacting the crystal changes since it also changes. The TO5 package includes a filter window to reduce detectable radiation to the 8–14 mm range, which is particularly susceptible to radiation from the human body. Because the sensor elements are sensitive to radiation across a broad range, this approach is used to protect delicate components.

Vibration sensor

Due to its inertia, a mass applies compressive forces to a piezoceramic element in the shape of a ring at the same time as the oscillation that causes the excitation. These pressures within the ceramic element cause charge transfer, which causes a voltage to be created between the top and bottom of the ceramic element. Contact discs are used to take up this voltage, which is frequently filtered and integrated before being made accessible as a measurement signal. Vibration sensors are fastened with bolts to the measuring item in order to direct the vibration into the sensor.

Temperature sensor (LM35)

According to the LM35 datasheet, these ICs are precision integrated-circuit temperature sensors, and their output voltage is directly proportional to the temperature in Celsius (Centigrade). Due to the fact that the user does not need to deduct a significant constant voltage from the LM35's output in order to get suitable Centigrade scaling, it has an advantage over linear temperature sensors calibrated in Kelvin. The LM35 can give average accuracies of 14 C at room temperature and 34 C across the whole temperature range of 55 to +150 C without the need for any external calibration or trimming.

7805 Regulated Power Supply:

A DC power supply system that maintains constant voltage regardless of variations in the main supply or the load is referred to as a regulated power supply. The 7805 IC is a fixed positive voltage regulator that produces a fixed voltage of 5 volts. The 7805 regulator is sometimes referred to as a fixed voltage regulator.

MEGA 2560:

An ATmega2560-based microcontroller board is called the Mega 2560. It features a 16 MHz crystal oscillator, 54 digital input/output pins (of which 15 may be used as PWM outputs), 16 analogue inputs, 4 hardware serial ports (UARTs), a USB connector, a power jack, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; to get started, just use a USB cable to connect it to a computer or an AC-to-DC converter or battery to power it. The majority of shields created for the Uno and previous boards, such as Duemilanove or Diecimila, are compatible with the Mega 2560 board.

SOFTWARE REQUIREMENTS

ARDUINO IDE:

The main purpose of the open-source Arduino IDE software is to write and compile code for the Arduino module. The code compilation process is so simple, thanks to the standard Arduino software, that even a layperson with no prior technical understanding can get started.

Programming

The boot loader on the Mega 2560's preprogrammed ATmega2560 enables you to upload fresh code to it without a third-party hardware programmer. It uses the standard STK500 protocol for communication (reference: C header files). You may alternatively use the Arduino ISP or a similar device to programme the microcontroller directly through the ICSP (in-circuit serial programming) header, bypassing the boot loader altogether. For instructions, check out this page. The firmware supply code for the ATmega16U2 (or 8U2 withinside the rev1 and rev2 boards) is to be had withinside the Arduino repository. Activating the DFU boot loader, which is pre-loaded on the ATmega16U2/8U2, requires:

• For Rev1 boards, attaching the solder jumper underneath the Italy map and then resetting the 8U2 are the two procedures.

• A resistor pushing the 8U2/16U2 HWB line to ground is included on Rev2 or later boards, making it simpler to enter DFU mode. A fresh firmware may then be loaded using the DFU programmer (Mac OS X and Linux) or Atmel's FLIP software (Windows). The DFU boot loader may be replaced by using the ISP header with an external programmer. More information is available in this user-contributed tutorial.

Communication:

A computer, another board, or additional microcontrollers may all be reached via a number of facilities on the Mega 2560 board. Four hardware UARTs for TTL (5V) serial connections are provided by the ATmega2560. An ATmega16U2 on the board channels one of these over USB and gives a virtual COM port to software on the computer (Windows computers will need a.inf file, while OSX and Linux machines will recognise the board as a COM port immediately). The ATmega8U2 on the revision 1 and revision 2 boards channels one of these over USB.

4. Working:

Our project work on 2 phases

1. Authorised condition.
2. Unauthorised condition.

Initially in an unauthorised condition, whenever any person or vehicle enters into the field allthe sensor will be in active mode. At the transmitter unit of a vibration sensor, certain vibrations are picked up. Here, the digital pin of the Arduino controller is coupled with a high-granularity potentiometer (RV2). The output pin of the Arduino controller is wired up to an LCD display. If there are any vibrations created by a group of intruders or by the movement of vehicles, the vibration sensor's value will climb from zero at first. The LCD display displays the greatest value, which denotes that a gang of intruders or a vehicle has crossed the boundary when there is greater vibration. This solution uses a zigbee module to transmit vibration data from a vibration sensor, represented by RV2, to a reception device. PIR sensors can determine if an invader is human or not. A PIR sensor and an Arduino controller with peripheral interface are linked here. The Arduino controller is wired up to an LCD screen. Since there were no humans in the area, the PIR sensor output was initially set to 0. When a human is present, the PIR sensor detects body heat and outputs a logic 1 value. This value interfaces with an Arduino controller, and the same data is transferred to a zigbee transmitter. The LM35 temperature sensor that we used at the receiver is referred to as a high accuracy temperature sensor. The temperature sensor, which is linked to the analogue pin of the Arduino, transmits data to ZigBee when the temperature range exceeds the usual temperature, for example, if the temperature is greater than 50 degrees. Arduino. The metal sensor's chosen conductivity and proximity specification The sensor output was originally logic 0 if there was no metal or vehicle in the field. If a metal or vehicle is detected in the field due to a magnetic field, the sensor logic changes to logic 1. This sensor is attached to the digital pin of the Arduino.

If authorised person gets access through RFID, all the sensors will be in disable state and there is no further action in the sensor. RFID reader that we are using, it works on I2C protocol which communicates with the Arduino controller. If the tag matches it, grants the authorised person to access or else it gives unauthorised access and all sensors get activated.

Zigbee is the communication device between transmitter and receiver by using 2.4GHz frequency range.

5. RESULT AND DISCUSSION

In the area where we have placed the small dust mote particle which consists of various sensors works in the 180° mode. To enter the area an authorized person will be given a RFID tag likewise the ID card. The working of the dust mote will be inactive where authorized person will be present. Before leaving the area, the authorized person should lock the entire system with the RFID tag, where the small dust mote will be in active mode.

When an unfamiliar person tries to enter the border, the system will be in active mode. The PIR sensor which is known for the living being detector, detects the living being as unauthorized person which can be human being or animal.

When an unknown person tries to enter the border, the system will be in active mode. The PIR sensor which is known for the living being detector, detects the living being as unauthorized person which can be human being or animal.

When there is a climate change or forest fire and sudden increase in temperature that isat certain temperature that we are entered in the program ,temperature sensor becomes active andautomatically the buzzer goes ON.(The temperature can be changed in the program according tothe situation).

If any group of people or an unauthorized vehicle arrives or

when there is a huge vibration due to break in the wall, the sensor will get activated and automatically the buzzer goes 'ON'.

6.CONCLUSION:

After studying the results of various approaches described in this paper, we propose small dust mode for detection of enemy intervention in borders and battle fields using different sensors in this technology. The smart dust mote consists of Arduino mega. Rather than the complex system which is very difficult to detect the enemy intervention in the borders and battlefield to perform these functions with these sensors we use this technology. The process of this smart dust mote will be done as the enemy enters into the field the sensors get activated. The datawill be shared from the sensors to the control monitor through ZigBee communication device. This, the complexity and the time will be less and enemy will be detected within the fraction of second. Enemies will be tracked by the given algorithm programed into processor as well as the communication will be initiated as per the interfacing algorithm the sensor will sense the enemy and the weapon that are carried by them. Depending on the values given by the sensors, the processor will process the values to the LCD display and control monitor. Thus, with the ease of this process enemy intervention will be detected using this smart dust mote technology.

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