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NANODUST NETWORK FOR TACTICAL BORDER SURVEILLANCE SYSTEM

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ABSTRACT

The greatest threat to national security is "Terrorism"infiltrating through borders. In critical border areas such as Kashmir and Bangladesh regular forces or even satellites cannot monitor these intruding terrorists as the area monitored is quite large and quite complex. This project provides an innovative and effective solution to this problem.

Keywords: IEEE 802.15.4, PIR Sensor, Buzzer, PCB Antenna

I. INTRODUCTION

The small dust like wireless sensor motes which has multiple onboard sensors and a processor, which has the ability to detect an enemy intrusion across borders and battlefields. Thousands of these smart dust motes can be deployed within a large area in a few hours by one or two men. The motes can form a network on its own among them, are small in size, rapidly deployable, have wireless connection to outside world. They detect the intrusion and classify it into vehicles or individuals and groups. Onboard hardware include a variety of sensors for vibration/seismic, magnetic, acoustic and thermal signature recognition, a microcontroller for processing these sensor values and a radio transceiver for communication over a wireless network. The system process the sensor readings, classify the targets and the tracking history can be viewed in the Graphics LCD display attached in the central monitoring unit. The central monitoring node acts as the parent node in a peer to peer wireless network model. The dust motes communicate with central parent node using wireless radio network.

II. RELATED WORK

POCW is found mostly in military applications such as battlefield's targets monitoring, or in environmental applications such as contaminant flow control. We will describe POCW in more detail later in this paper. The application in POCW is interested in finding association (relationships among events) around the targets, in contrast to Sensor Association Rules interested in the relationships among sensor nodes.Multi-target tracking (MTT) is a process of estimating the trajectories and velocities of mobile targets. Collaborative target tracking uses a multi-sensor scheme to improve the tracking accuracy compared with single-sensor tracking. Physical limitations of sensor nodes in terms of battery supplied energy, processing capability, communication bandwidth and storage have driven the desire for sensor and sampling interval selections to improve the energy efficiency.

III. PROPOSED SYSTEM

The project aim is to design a next generation intelligent ultra small dust like wireless sensor motes which has multiple onboard sensors and a processor, which has the ability to detect an enemy intrusion across borders and battlefields. Thousands of these smart dust motes can be deployed within a large area in a few hours by one or two men. The motes can form a network on its own among them, are small in size, rapidly deployable, have wireless connection to outside world. They detect the intrusion and classify it into vehicles or individuals and groups. Onboard hardware include a variety of sensors for vibration/seismic, magnetic, acoustic and thermal signature recognition, a microcontroller for processing these sensor values and a radio transceiver for communication over a wireless network. The system process the sensor readings, classify the targets and the tracking history can be viewed in the Graphics LCD display attached in the central monitoring unit. The central monitoring node acts as the parent node in a peer to peer wireless network model. The dust motes communicate with central parent node using wireless radio network.

IV. BLOCK DIAGRAM

V. MIWI P2P WIRELESS PROTOCOL

The Microchip MiWi™ P2P Wireless Protocol is a variation of IEEE 802.15.4, using Microchip's MRF24J40MA 2.4 GHz transceiver and any Microchip 8, 16 or 32-bit microcontroller with a Inter Integrated Circuit (I2C). The protocol provides reliable direct wireless communication via an easy-to-use programming interface. It has a rich feature set that can be compiled in and out of the stack to meet a wide range of customer needs – while minimizing the stack footprint.

The MiWi P2P protocol modifies the IEEE 802.15.4 specification's Media Access Control (MAC) layer by adding commands that simplify the handshaking process. It simplifies link disconnection and channel hopping by providing supplementary MAC commands. However, application-specific decisions, such as when to perform an energy detect scan or when to jump channels, are not defined in the protocol. Those issues are left to the application developer.

- Provides 16 channels in the 2.4 GHz spectrum (using an MRF24J40 transceiver)
- Operates on Microchip PIC18, PIC24, dsPIC33 and PIC32 platforms
- Supports Microchip C18, C30 and C32 compilers, Enables frequency agility (channel hopping)
- Supports a sleeping device at the end of the communication
- Enables Energy Detect (ED) scanning to operate on the least-noisy channel
- Provides active scan for detecting existing connections
- Supports all of the security modes defined in IEEE 802.15.4.

The MiWi P2P protocol is a variation of IEEE 802.15.4 and supports both peer-to-peer and star topologies. It has no routing mechanism, so the wireless communication coverage is defined by the radio range.

Guaranteed Time Slot (GTS) and beacon networks are not supported, so both sides of the communication cannot go to sleep at the same time. If the application requires wireless routing instead of P2P communication; or interoperability with other vendors' devices; or a standard-based solution, for marketability.

VI. IEEE 802.15.4 SPECIFICATION AND MIWI P2P WIRELESS PROTOCOL

After the initial 2003 release of the IEEE specification, a 2006 revision was published to clarify a few issues. Referred to as IEEE 802.15.4b or 802.15.4-2006, the revision added two PHY layer definitions in the sub-GHz spectrum and modified the security module.

Most of the market's current products, however, use the original, IEEE 802.15.4a specification – also called IEEE 802.15.4-2003 or Revision A.

The Microchip MRF24J40MA radio supports Revision A of the specification.

The MiWi P2P stack uses only a portion of the IEEE 802.15.4 specification's rich PHY and MAC layers' definitions. The specification defines three PHY layers, operating on a spectrum of 868 MHz, 915 MHz and 2.4 GHz. The MRF24J40MA radio operates on the 2.4 GHz, Industrial, Scientific and Medical (ISM) band – freely available worldwide.

That spectrum has 16 available channels and a maximum packet length of 127 bytes, including a two-byte Cyclic Redundancy Check (CRC) value. The total bandwidth for the IEEE 802.15.4, 2.4 GHz ISM band is, theoretically, 250 kbps. In reality, for reliable communication, the bandwidth is 20-30 kbps.

IEEE 802.15.4 and the MiWi P2P stack support two topologies: Star and Peer-to-Peer.

VII.PIR SENSOR MODULE

Compact and complete, easy to use PIR Sensor Module for human body detection. Incorporating a Fresnel lens and motion detection IC, suitable for a wide range of supply voltages and with low current drain. Adjustable delay time with high sensitivity and low noise. Output is a standard TTL output signal

Features

• Complete with PIR, Motion Detection IC and Fresnel Lens

• Dual Element Sensor with Low Noise and High Sensitivity

• Supply Voltage: 5-20Vdc

• Delay Time Adjustable: 5 seconds to 18 Minutes

• Standard TTL Output

• Module Dimensions: 28mm Length, 38mm Width, 40mm Height

Fig 3 SB0061 Sensor

SB0061 is a pyroelectric sensor module which developed for human body detection. A PIR detector combined with a Fresnel lens are mounted on a compact size PCB together with an analog IC, SB0061, and limited components to form the module. High level output of variable width is provided.

Features and Electrical Specification

- Compact size (28 x 38 mm)
- Supply current: DC5V-20V (can design DC3V-24V)
- Current drain :< 50uA
- (Other choice: DC0.8V-4.5V; Current drain: 1.5mA-0.1mA)
- Voltage Output: High/Low level signal： 3.3V
- (Other choice: Open-Collector Output)
- TTL output
- High sensitivity

- Delay time：5s-18 minute
- Blockade time：0.5s-50s (acquiescently 0 seconds)
- Operation Temperature: -15oC -70Oc
- Infrared sensor: dual element, low noise, high sensitivity
- Light sensor: CdS photocell (can be add as customer requirement)

VIII. TRANSMITTING MESSAGES

There are two ways to transmit a message: broadcast and unicast. Broadcast packets have all devices in the radio range as their destination. IEEE 802.15.4 defines a specific short address as the broadcast address, but has no definition for the long address. As a result, broadcasting is the only situation when the MiWi P2P stack uses a short address. There is no Acknowledgement for broadcasting messages.

Unicast transmissions have only one destination and use the long address as the destination address. The MiWi P2P stack requires Acknowledgement for all unicast messages. If the transmitting device has at least one device that turns off its radio when Idle, the transmitting device will save the message in RAM and wait for the sleeping device to wake-up and request the message. This kind of data transmitting is called indirect messaging. If the sleeping device fails to acquire the indirect message, it will expire and be discarded. Usually, the indirect message time-out needs to be longer than the pulling interval for the sleeping device.

IX.RECEIVING MESSAGES

In the MiWi P2P stack, only the messaged device will be notified by the radio. If the messaged device turns off its radio when Idle, it can only receive a message from the device to which it is connected. For the idling device with the turned off radio to receive the message, the device must send a data request command to its connection peer. Then, it will acquire the indirect message if there is one.

X.PCB ANTENNA

The PCB antenna is fabricated on the top copper trace. Figure 2-8 shows the trace dimensions. The layers below the antenna have no copper traces. The ground and power planes under the components serve as a counterpoise to the PCB antenna. Additional ground plane on the host PCB will substantially enhance the performance of the module. For best performance, place the module on the host PCB following the recommendations in “Mounting Details”.

The Printed Circuit Board (PCB) antenna was designed and simulated using Ansoft Designer ® and HFSS 3D full-wave solver software by Ansoft Corporation. The design goal was to create a compact, low-cost antenna with the best radiation pattern. The performance of the antenna is dependent upon the orientation of the module.

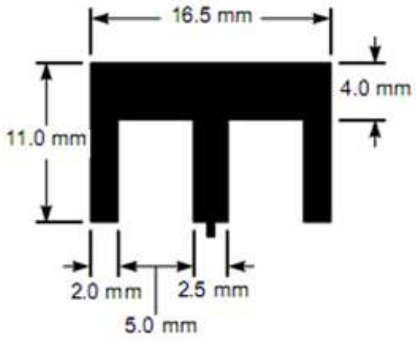

Fig 4 PCB Antenna

XI. BUZZER

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Son alert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

Fig 5 Buzzer

In game shows it is also known as a "lockout system," because when one person signals ("buzzes in"), all others are locked out from signaling. Several game shows have large buzzer buttons which are identified as "plungers". The word "buzzer" comes from the rasping noise that buzzers made when they were electromechanical devices,

operated from stepped-down AC line voltage at 50 or 60 cycles. Other sounds commonly used to indicate that a button has been pressed are a ring or a beep.

Operating frequency : 3.1 ± 0.5 KHz

Operating voltage: 3 ~ 20 V dc

- Current consumption : 14 mA
- Sound pressure level : 73 db
- Rated voltage : 12 V dc
- Tone : continuous
- Operating temperature: -30 ~ +85° C
- Storage temperature : -40 ~ +95° C
- Dimensions : Ø23.8 x 14.5 mm
- Material : ABS UL-94 1/16" high heat (black)
- Weight : 4.5 g

XII. RESULTS AND DISCUSSION

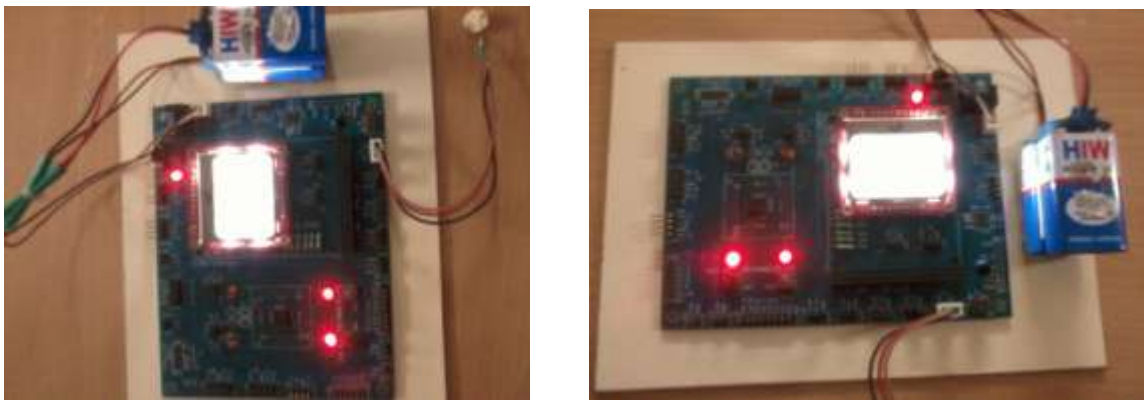

Fig 6 Snapshot of Hardware Kit (Transmitter and Receiver)

XIII CONCLUSION

The motes can form a network on its own among them, are small in size, rapidly deployable, have wireless connection to outside world. They detect the intrusion and classify it into vehicles or individuals and groups.

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