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DECENTRALIZED SMART SENSOR SCHEDULING FOR MULTIPLE TARGET TRACKING FOR BORDER SURVEILLANCE

Bini Joy[1], S. Wilson[2], K. M. Sathies[3], S. Jagadheeskumar[4]
Sri Ramakrishna Engineering College, Coimbatore, India [1] [2] [3][4]

***Abstract*:** Border surveillance requires regular patrolling to prevent intruders from crossing across, emphasizing the need for an automated network of sensing devices that is capable of detecting and estimating multiple moving targets. In this paper 32-bit ARM Cortex-M3 microcontroller and LPC1313, LPC1764 with IEEE 802.15.4 wireless network protocol along with sensors like MEMS Accelerometer, MEMS Magnetometer, Microphone Sensor, Camera Sensor and PIR Sensor were used to implement the same.

I. Introduction

The greatest threat to national security is "Terrorism", infiltrating through borders. In critical border areas, regular forces or even satellites cannot monitor the intruder terrorists, as the monitored is quite large and complex. This paper proposes an innovative and effective solution to this problem by designing a next generation, intelligent, ultra-small, dust like, wireless sensor motes with multiple onboard sensors and a processor for detecting enemy intrusion across borders and battlefields. As the project is conceptualized on 'smartdust technology', a brief elucidation of smartdust definition is provided.

Smartdusts are dust size devices which are light in weight [1]. Each smartdust mote can be considered as a tiny computer with one or more sensors, on-board power supply, a communication system and a controller. It can communicate with other smardust devices using the wireless radio network. The battery life of a smartdust mote can vary from a few hours to ten years depending on the size and capability of the device. A common mote communication scheme uses radio frequency signals to communicate over relatively short distances. This allows designers to minimize mote size and reduce power consumption. When communicating, the devices pass each message to a neighbouring mote, which, in turn, passes the message onto the neighbouring mote, and so on, until the message reaches the destination the central monitoring mote the network of motes continue to perform even if some of its communication parts fail to operate. And once a mote is placed in an other devices in the network take its load. In real time, thousands of such motes are deployed in the field for detecting intrusion but in the project we are employing only to smartdust sensor motes and a signal monitoring mote on experimental basis. There are several existing border surveillance systems are methods in use today [2].

There are several works carried out in the border surveillance. As an example, the study conducted by T.J.Nohara explains the use of commercial approach to the deployement of radar surveillance [3]. The literature says, "surveillance solutions must be multi-mission suitable, scalable, flexible, maintainable, upgreatable, interoperable, shareable, and affortable", which is very true when it comes to border surveillance and other security systems. Smartdust system satisfies the above mentioned features and its compact size is an added advantage the deployed in the battlefields. To give another example, the work done by C.Neumann and his collegeous explains about the production of our borderlines as well as military camps using radar surveillance method[4]. The challenges of remote border monitoring have been detailed in the work conducted by P.Pratap and his collegues [5]. This paper proposes a system based on smartdust for boarder surveillance applications that can help solve many of the challenges post by conventional system especially concerned to power consumption, maintainability, safty and coverage.

II. Methodology

There are several use cases where different sensors would be applied in a real world by using different protocols in this paper the implementation and demonstration using the following cases as shown with the block diagram

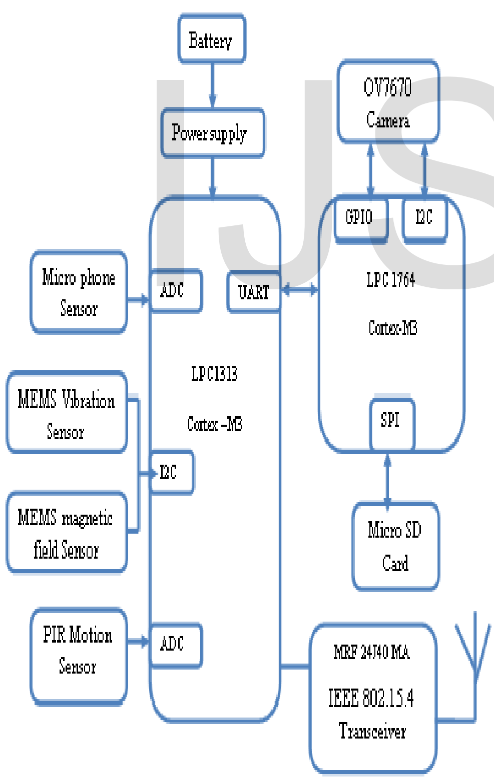

Fig 1: Block diagram of the sensor mote

ARM Controller [6]: The project uses ARM Cortex M3 controller, which is the next generation 32 bit ARM Processor for embedded application based on ARM v7-M architecture. The speciality fo this ARM Controller is its Harvard architecture. The separate instruction and data buses allow parallel instruction fetching and data storage. The ARM Cortex-M3 controller has been choosen in this work for the following reasons: butter energy efficiency, more functionality out of battery life and ability to meet increasing energy demands for low energy products when compare to another controllers. It also as the smallest code size for any microcontroller. Reducing the code size is the key to sequeezing our application code into minimum amount of flash.

Magnetic Sensor[7]: The magnetic sensor used is KMA199E which is a magnetic angle sensor system. The MagnetoResistive (MR) sensor bridges and the mixed signal Integrated Circuit (IC) are integrated into a single package. This angular measurement system KMA199E is pre-programmed, pre-calibrated and therefore, ready to use. The KMA199E allows user specific adjustments of angular range, zero angle and clamping voltages. The settings are stored permanently in an Electrically Erasable Programmable Read-Only Memory (EEPROM).

MEMS Microphone [8]: MEMS microphone is similar to the standard ECMs (Electro condenser microphones) found in modern consumer electronics, except that the components are built onto a single chip using CMOS technology, rather than assembled from discrete parts. It can sense the acoustic signals. The MEMS microphone used is SPM0404HE5H.

PIR Motion Sensor [9]: The motion detector module used is SB0081, which is a pyroelectric sensor module developed for human body detection (numbered 1 in Fig.6). A PIR detector combined with a Fresnel lens are mounted on a compact size PCB together with an analog IC, SB0081, and limited components to form the module. It has a very compact size and operates at 3.3V.

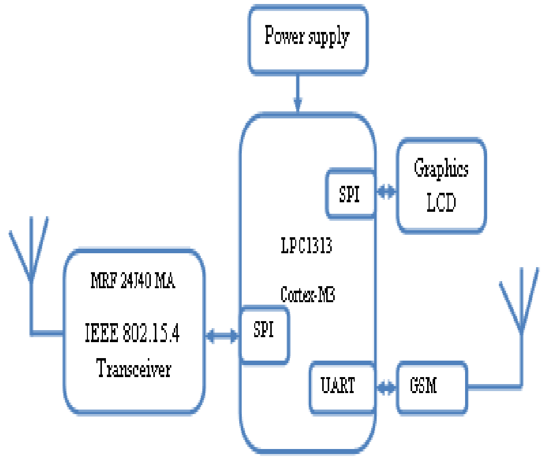

Fig 2: Base Station mote

Vibration Sensor [10]: It is a piezoelectric transducer, which when displaced from the mechanical neutral axis; the bending creates strain within the piezoelectric element and generates voltage. We have used PHIDGETS 1104 type in the project. The type of measurement used by the device is ratiometric.

Camera Sensor : A Camera sensor will be used to recognize movement caused by humans or vehicles and the pictures will be stored in a permanent memory for future reference. OV7670 image sensor, small volume, low operating voltage, providing all functions of a single chip of VGA camera and image processor. Ommivision image sensor has been in application of unique sensor technology.

III. Design and Discussion

The hardware description of the implementation is as follows: It uses Microcontroller: 32-bit ARM Cortex-M3 microcontroller, LPC1313, LPC1764. IEEE 802.15.4: wireless network protocol used to communicate between the sensor mote to base station control : camera sensor used capture the picture : MEMS Accelerometer used to sense the physical vibration : MEMS Magnetometer used to sense the metal : PIR Motion sensor used to detect heat from the body.

Its Software Tools Used includes Embedded C and its development Tool: LPCXpresso IDE Embedded Protocols Used : IEEE 802.15.4, I2C, SPI Software Libraries Used: Graphics Library and device driver for TFT display and GLCD Touch screen IC driver firmware using SPI IEEE 802.15.4 protocol stack using SPI MEMS Compass sensor driver firmware using I2C MEMS Accelerometer sensor using I2C Cortex-M3 peripheral device sensor library CMSIS from ARM.

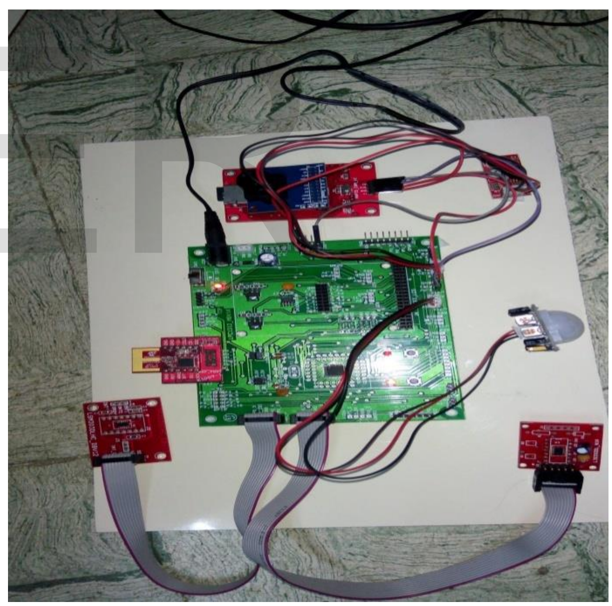

Fig 3: The sensor mote

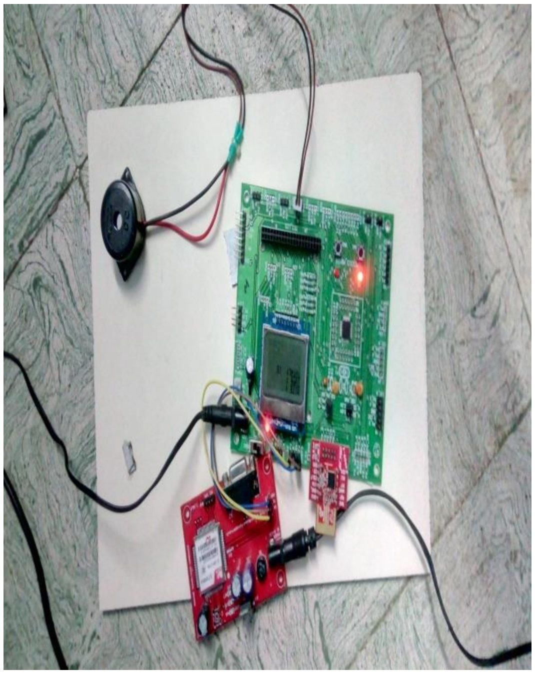

Fig 4: The control base station

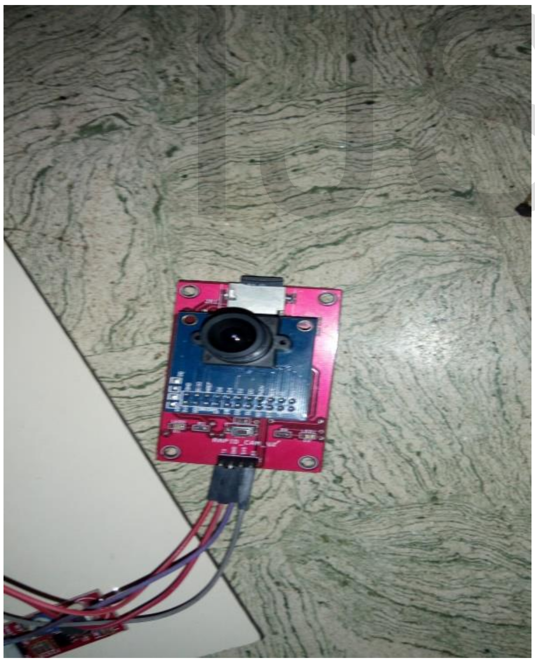

Fig 5: The camera sensor

The figure 4 is the base station controlling unit. The figures 3 and 5 were the two are sensors units with its respective sensors and display unit.

IV. Conclusion

The proposed system of smartdusts for border surveillance applications was designed, developed and tested in the laboratory. Few suggestions for the betterment of the project would be to make a distinction between animals or humans that is intruding based on the comparison of temperatures. PIR sensor can make out the difference in the body temperatures or the heat from animal and human bodies. Another major point of apprehension would be the availability of the smartdust chips. Smartdust motes are not yet available on a large scale and even if they do most of the motes are of the size of a deck of cards. We could hope for the future motes to be of dust size at the same time available at a reasonable rate. The key downsides of using smartdust networks in border surveillance is the pollution it causes because once deployed the smartdust mote remain in the soil for years. Therefore, let us hope for greener smartdust mote circuits to be developed on a large scale. Also, solar powered batteries can be of great benefit to the smartdust circuits as the circuits once deployed must remain in soil for years without maintenance. Another area of enhancement that we could suggest is that the smartdust motes could be made to give details such as the position of the intrusion and the weather conditions at the place of intrusion.

References:

[1] Doug Steel, Smartdust, *UH ISRC Technology briefing, March 2005.*

[2] Pratap.P, Kallberg J.M, Thomas L.A, Challenges of remote border monitoring, *2010 IEEE International Conference on Technologies for Homeland Security (HST)*

[3] Nohara, T.J;A commercial approach to successful persistent radar surveillance of sea, air and land along the northern Border, *2010*

IEEE International Conference on Technologies for Homeland Security (HST)

[4] Neumann, C.; Weiss, G.; Wahlen, A.; Brehm, T.;Ground Surveillance With Mmw Radar For Border Control And Camp Protection Applications, *EuropeanMicrowave Conference, 2007.*

[5] Pratap, P.; Kallberg, J.M.; Thomas, L.A;Challenges of Remote Border Monitoring, *2010 IEEE International Conference on Technologies for Homeland Security (HST)*

[6] Girard, A.R.; Howell, A.S.; Hedrick, J.K;Border Patrol And Surveillance Missions Using Multiple Unmanned Air Vehicles, *2004. CDC. 43rd IEEE Conference on Decision and Control*

[7] Owen, Arch; Duckworth, Gregory; Worsley, Jerry, Optasense: Fibre Optic Distributed Acoustic Sensing For Border Monitoring, *2012 EuropeanIntelligence and Security Informatics Conference (EISIC)*

[8] X. Jin, S. Sarkar, A. Ray, S. Gupta, and T. Damarla, "Target detection and classification using seismic and pir sensors," IEEE Sensors Journal, vol. 12, no. 6, pp. 1709–1718, 2012.

[9]Xingbo Wang, Minyue Fu, Huanshui Zhang, "Target Tracking in Wireless Sensor Networks Based on the Combination of KF and MLE Using Distance Measurements", IEEE Transactions On Mobile Computing, Vol 11, No. 4, April 2012.

[10] ShyamSadasivan, An introduction to the ARM Cortex-M3 Processor, *October 2006, Open journal*