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Design and Implementation of Raspinode for Surveillance and Border Intrusion Detection

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ABSTRACT: With the growing field of wireless sensor network (WSN) which is implemented in the field of surveillance, agriculture, monitoring of forest fire, monitoring of wildlife sanctuaries etc. if multimedia data is added in the form of voice or image then it explores more application as compared to the WSN. In this paper we are proposing a wireless multimedia sensor network (WMSN) for border intrusion detection for detection of any illegal activity around the border. Raspinode is the proposed node in the WMSN. Since the lifetime of the network is less because of power hungry nodes for that we are implementing proposed Dynamic Power Management algorithm (p-DPM).

KEYWORDS: Raspinode, Wireless Multimedia Sensor Network (WMSN), proposed Dynamic Power Management (p-DPM), border intrusion detection.

I. INTRODUCTION

Lot of development is done in the field of Wireless Sensor Network (WSN) leading to the low cost, low power, sensor nodes. These sensor nodes have their onboard processor which gathers data, process it according to the algorithm and then sends to the base station. Due to wireless communication between these nodes they are highly deployable and can be implemented in various applications for example military, home, industry, weather monitoring [1], remote environmental monitoring [2], and target tracking [2].Even though the WSN can be implemented in wide variety of applications depending on the algorithms and protocol used, but there are other issues which needs to be resolved like, security, management and node architecture [2].Besides the availability of WSN, with the available low cost CMOS camera, WSN are converted into the Wireless Multimedia Sensor Network (WMSN) which explores more apllication [3].

II. RELATED WORK

As reffered from [4] one of the multimedia sensor CYCLOPS developed by M. Rahimi et.al consists of an image sensor, a microcontroller, Complex Programmable Logic Device (CPLD), an external static RAM and an external flash memory. This node is required to be interfaced with the other sensor nodes such as MICAz for communication with other sensor nodes.

CMUcam3 is one of the multimedia sensors that are specifically designed for simple vision tasks. It consists of basically the components: microcontroller, a frame buffer, and a CMOS camera chip. It can be interfaced with the Telos B mote for communication with the other sensor nodes. It is best suited for low resolution video application.

MeshEye is the multimedia node designed taking into consideration low cost as the major parameter and less components are added to it. It is developed with the use of readymade components. It has one Video Graphics Array (VGA) camera and can host up to 8k pixel images on the Secure Data (SD) card. It has Atmel family microcontroller. There are many other multimedia sensors are also developed and these are Imote2, Panoptes, GARCIA, Fox board based sensor [4]. Multimedia sensors developed above have their own advantages and disadvantages. Some of the nodes required to be interfaced with other nodes for communication. Some nodes are applicable only to a given situation. Hence there is a need to develop the highly energy efficient and performance efficient node.

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III. PROPOSED WORK

The proposed work is targeted to the surveillance in the field of military application. There are many regions of a country which requires continuous monitoring of that region, but the most important region which requires continuous monitoring of a nation is the border area of that nation hence we have proposed an WMSN specifically for the border intrusion detection which will do the surveillance as well as detect the intrusion of human around that area.

Since the node discussed in the above section are only nodes they are not directly configurable for networking i.e. they cannot be used as it is in the formation of network for surveillance. Hence we have proposed a WMSN comprising of two nodes and they are interfaced with the base station. The base station is also interfaced with the LCD and buzzer. The LCD is interfaced to display the message of intrusion detection. And buzzer is interfaced to alarm the people if they were not present around the base station.

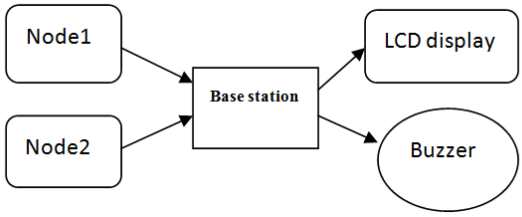

Figure 1: Block diagram of proposed network

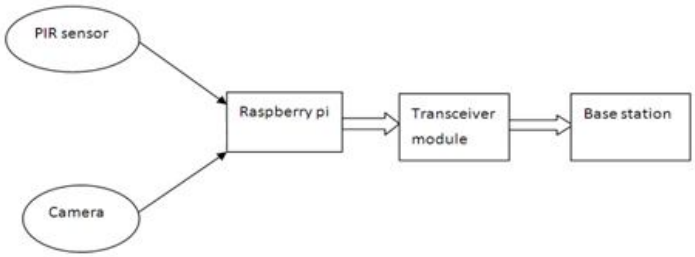

Figure 2: Block diagram of single Raspinode

The Raspinode consists of mainly three blocks:

1. Sensors
2. Controller(raspberry pi)
3. Transceiver module

The main part of the Raspinode is the microcontroller which takes the input from the sensors process it and sends the data to the transceiver module to transmit the data to the base station. In this work the Raspinode is implemented on the Raspberry Pi which has the core ARM11, which works on the speed of 700 MHz. It has four USB ports which provide easy interfacing. The sensors we are using is PIR sensor for detection of the human being, and camera which will capture the image whenever any intrusion is detected. Initially only PIR (Passive infrared sensor) sensor will be ON, which will detect the presence of any person over the specified area, if any person found then it will trigger on the camera to take the image of that event. And the captured image is send to the transceiver module which is Xbee series S1 module for the transmission of the image to the base station.

Specification of Raspinode:

1. PIR sensor- Power supply: 5V-20V but 5V is ideal.
   Power consumption: 65mA.
   TTL output 3.3V (when detected), 0V (no detection)
   Sensitivity range: up to 20 feet (6meters) 110° x 70° detection range.

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2. Controller-Raspberry Pi model B+ - Power required 5V, 0.7Amp
   40 GPIO (General Purpose Input Output) pins
   External memory support in the form of SD card (8-64) GB
   HDMI port
   One Ethernet port for remote access
   Based on ARM 11 architecture
   Operating System based on Linux
   Language: Python, C and C++ [6]

3. Raspberry Pi camera Module - 5 Megapixel CMOS camera
   Capable of capturing still images as well as high definition video
   Interfaced with Camera Serial Interface (CSI) cable

4. Transceiver module - Xbee Series S1
   3.3V @ 50mA
   250 kbps Max data rate
   300 ft (100 meter) range
   8 digital IO(Input Output) pins
   AT or API command set
   Trace Antenna
   Operating temperature: -40 to 85 degree Celsius
   Number of channels: 16 direct sequence channels

IV. IMPLEMENTATION

The above explained Raspinode is successfully implemented. Below figure 3 shows the completed Raspinode.

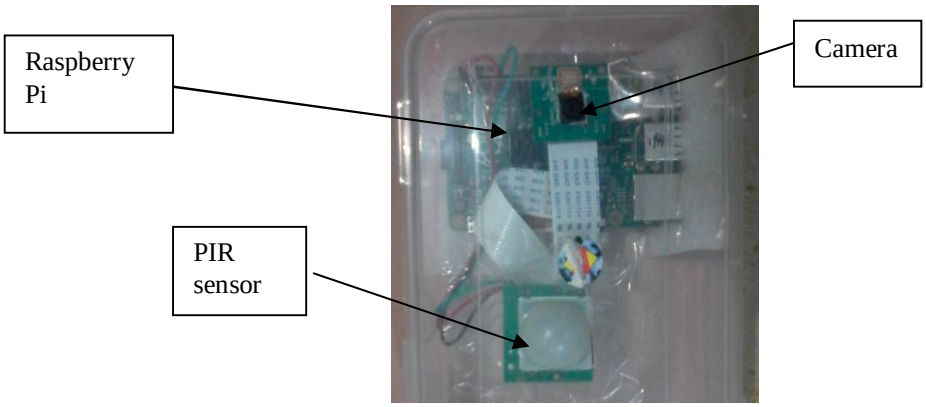

Figure 3: Raspinode

Figure 3 shows the completed Raspinode. The transceiver module is not shown in this diagram since the module is USB interfaced to the node so it can be attached any time when the node is operated. We have placed the PIR sensor below the camera module so that if the node is placed at the significant height than it can first detect the presence of human being because PIR sensor detects the infrared radiation and plant and trees don't emit infrared radiation.

After completion of the Raspinode next is the implementation of the Base Station (BS). The base station is interfaced with the Raspberry Pi module and which is interfaced to the LCD display and Buzzer. Also with the use of Ethernet port the data can be accessed through LAN (Local Area Network) cable using SSH (Secure Shell) Protocol. Hence this adds the advantage in controlling the Raspberry pi.

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Figure 4: Base station

Figure 4 shows the implementation of the Base Station. The base station consists of the Raspberry Pi which is interfaced to transceiver Xbee Series S1. In this figure the implemented OS is shown, which shows that we successfully implemented the OS. Hence whenever the intrusion is detected it will be shown on this monitor only. The WMSN faces lot of challenges i.e. limited bandwidth, requires more power than WSN, in network processing [5] [7]. For reducing the power consumed by a node we have proposed an event triggered Dynamic Power Management Algorithm. In this algorithm the event is considered as the detection of the intrusion by the PIR sensor. According to this algorithm whenever any event is detected then only the camera is switched to the active mode for taking the images and then the Xbee is also turned into the active state to transmit the captured image to the base station. In this algorithm the nodes are not switched to the deep sleep state because while waking up components from deep sleep state increases the latency time which is not desired performance for the node.

Algorithm

Step1: Turn the node into active state
Step 2: Switch all the components except PIR sensor in the sleep state
Step 3: Monitor the output of the PIR sensor
Step 4: If the output of PIR sensor goes high turn the camera into active state and start taking images
Else continue with monitoring
Step 5: Send the data to the base station
Step 6: Check for another event if found then repeat step 4 and 5
Else go to step 2.

V. COMPARISON AND ANALYSIS

Table 1 shows the comparison of different implemented multimedia sensor node with the proposed Raspinode. Raspinode is build using Raspberry Pi having ARM 11 based SOC (System On Chip) i.e. BCM 2835, running at the speed of 700 MHz which is the highest among the implemented nodes. In addition with the implementation of Power Management Algorithm makes it best suited for the application of surveillance for long time.

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Device Name	Manufacturer	Processor	Memory	Multimedia Support	Wireless
Stargate	Crossbow	Intel PXA-255 Xcale processor at 400 MHz	32 MB Flash 64 MB RAM	High computation power,embedded linux OS	802.11 Compact Flash, 802.15.4 through MICA2/z
Imote2	Intel	32-bit PXA271 Marvell processor at 13-416 MHz	32 MB Flash 64 MB RAM	MMX co-processor for audio/video imaging acceleration	Integrated 802.15.4
CMUcam3	CMU	32-bit NXP LPC2103 microcontroller at 60 MHz	128 KB Flash 64 KB RAM	On board cc3-open source image processing library	-
MeshEye	Stanford University	32-bit ARM7TDMI RISC processor at 55MHz	128 KB Flash 64 KB RAM	Multimple resolution support	-
WiCa	XNP and Philips research	IC3D Xetal II processor at 84 MHz	10MBit RAM	Dedicated parallel processor, multiple camera module	-
Cyclops	Agilent technologies	8-bit Atmel ATmega 128L microcontroller	512Kbyte Flash 512 Kbyte RAM	On-board image processing, low power, cost and size	-
Raspinode		32-bit ARM11 at 700 Mhz	512 RAM Extendable memory upto 64GB	implemented power management algorithm	Integrated with 802.15.4

Table 1: Comparison of multimedia sensor nodes

VI. CONCLUSION AND FUTURE WORK

In the proposed work the implementation is compared with the multimedia sensors developed earlier. The Raspinode has shown the advantages over the other nodes also. Performance of Raspinode and intrusion detection capability can be increased by adding more sensors and switching to the video surveillance.

Since this is the hardware implementation hence we are only limited to two nodes. The performance of the proposed algorithm will be clearer if we go for more nodes and implement this on the software tools.

REFERENCES

1. Ian F. Akyildiz, Weilian Su, Yogesh Sankarasubramaniam, and Erdal Cayirci, "A survey on sensor networks," IEEE Communications magazine, August 2002.
2. Jennifer Yick, Biswanath Mukherjee, and Dipak Ghosal, "Wireless sensor network survey", Elsveir Computer networks, pp. 2290-2330, April 2008.
3. Yun ye, Song ci, Aggelos k. Katsaggelos, Yanwei liu, and Yi qian, "Wireless Video Surveillance: A survey" , IEEE Access practical innovations: open solutions, Vol No.1, pp. 646-660, August 2013.
4. Shailendra Aswale and Dr. Vijay R. Ghorpade, "Wireless Multimedia Sensor Network: A Survey on Multimedia sensors", Proceedings of International Conference on Recent Trends in Information, Telecommunication and Computing, 2013.
5. Ian F. Akyildiz, Tommaso Melodia and Kaushik R. Chowdhury, "A survey on wireless multimedia sensor networks", Elsveir Computer Networks, 2006.
6. Vladimir Vujović and Mirjana Maksimović, "Raspberry Pi as a wireless sensor node: Performances and Constraints", In Proc. of MIPRO, 2014, pp. 1247-1252.
7. Amit Sinha and Anantha Chandrakasan, "Dynamic power management in wireless sensor networks," IEEE Design and test of Computers, pp.62-74, April 2001.

BIOGRAPHY

Rajni Shakya is a Master of Engineering student in the Electronics Department, MIT AOE, Savitribai Phule Pune University. She received Bachelor of Engineering (BE) degree in 2012 from AISSMS's IOIT, Pune, Maharashtra,India. Her research interests are WSN, WMSN, Embedded Systems. Etc.

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