ZigBee-based alarm system for pervasive healthcare in rural areas

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Abstract

- In this paper a alarm system suitable for pervasive healthcare in rural areas is presented
- The alarm system take advantage of ZigBee
- Small、long battery life and large coverage region

Introduction

- The aging population problem
- What is their need
- What's the problem of stay in the home

Table 1: Age and sex profile of the residents of Fortanete (2005 census)

	Under 25 years	25–65 years	65–80 years	Over 80 years
men	24	76	34	8
women	14	46	31	9
total	38	122	65	17

Description of the Method

- Development of Mobile End-device
- The system what is enable to those in need to receive assistance and easy to operate it for user
- Create a communication infrastructure(point-to-point link with user's device)
  - Telephone line and GSM modem have problem about cost efficiency
  - Cell phone and PDAs to exchange data via bluetooth, but bluetooth is more consuming
  - Using WiFi that is large for device

Mobile End-Device(1/2)

- The devices to detect the user's status via triaxial accelerometer
- Its function has three mode
  - Active mode
  - Rest mode
  - Deep monitoring mode

Mobile End-Device(2/2)

- It is necessary to optimise the time spent in active and rest mode for maximize the lifetime of the device
- It is periodically to measure acceleration and every 10s to poll its parent
- Sampling and processing their outputs take 3ms
- Polling the neighbor/relative takes 20ms

ZigBee Characteristics (1/3)

- Remote or internal control, standard defines network topologies：star、cluster tree and mesh
- ZigBee has active(transmit/receive) or sleep mode
- ZigBee devices will be more ecological than WiFi saving megawatts at it full deployment
  - WiFi RX power is 667 mW on 100 devices/home & 50000 homes/city = 3.33 MW
  - ZigBee power is 30 mW on 100 devices/home & 50000 homes/city = 150kW

ZigBee Characteristics(2/3)

- Rage：50m typical (5-500m based on environment)
- Extremely low cost and Ease of implementation
- IEEE defines two type of devices
  - Full function device(FFD)
    - Any topology
    - Able to be Network Coordinator、Router and End device
    - Can talk with any other device
  - Reduced function device(RFD)
    - Only star topology
    - Only can be End device
    - Only talk with Coordinator or Router
    - Simple implementation

ZigBee Characteristics(3/3)

- ZigBee
  - Sleep mode change to active = 15ms typically
  - Active channel access time = 15ms typically
  - 2+ years from ‘normal’ batteries
- Bluetooth
  - Sleep mode change to active = 3s typically
  - Active channel access time = 2ms typically
  - Power model a mobile phone(regular daily charging)
- ZigBee devices can quickly attach, exchange information, detach, and then go to deep sleep to achieve a long battery life.

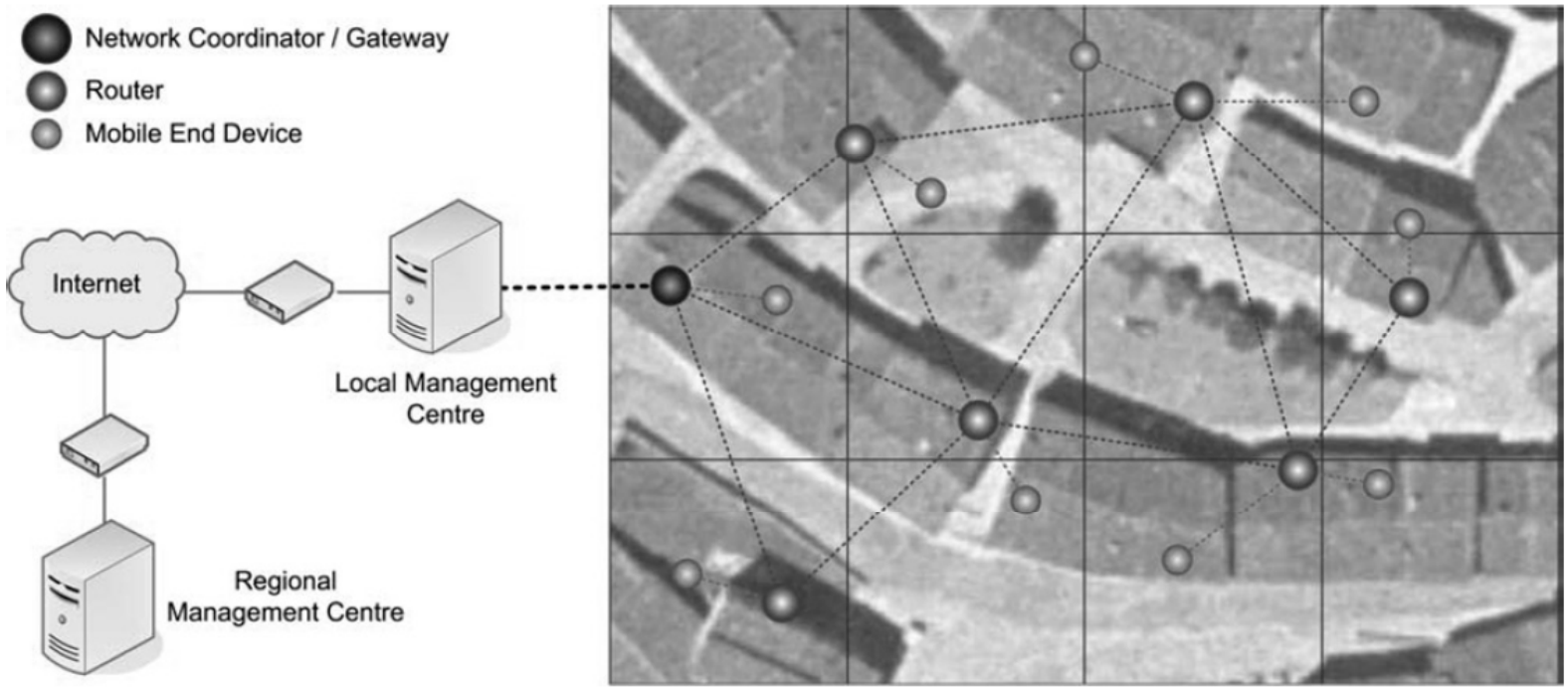
Network Architecture(1/5)

- A ZigBee-compliant network following mesh topology
- The nodes in the network have three different roles
  - coordinator
  - Routers
  - MED

Network Architecture(2/5)

- The coordinator initiates the network that is the sink for all the data and connect to a central computer
- Routers maintain a routing table to address data packets and exchange data with the mobile devices
- A mesh of routers form a backbone(with coordinator), with MEDs connected in star
- MED carried by people transmit data and receive messages from the coordinator

Network Architecture(3/5)

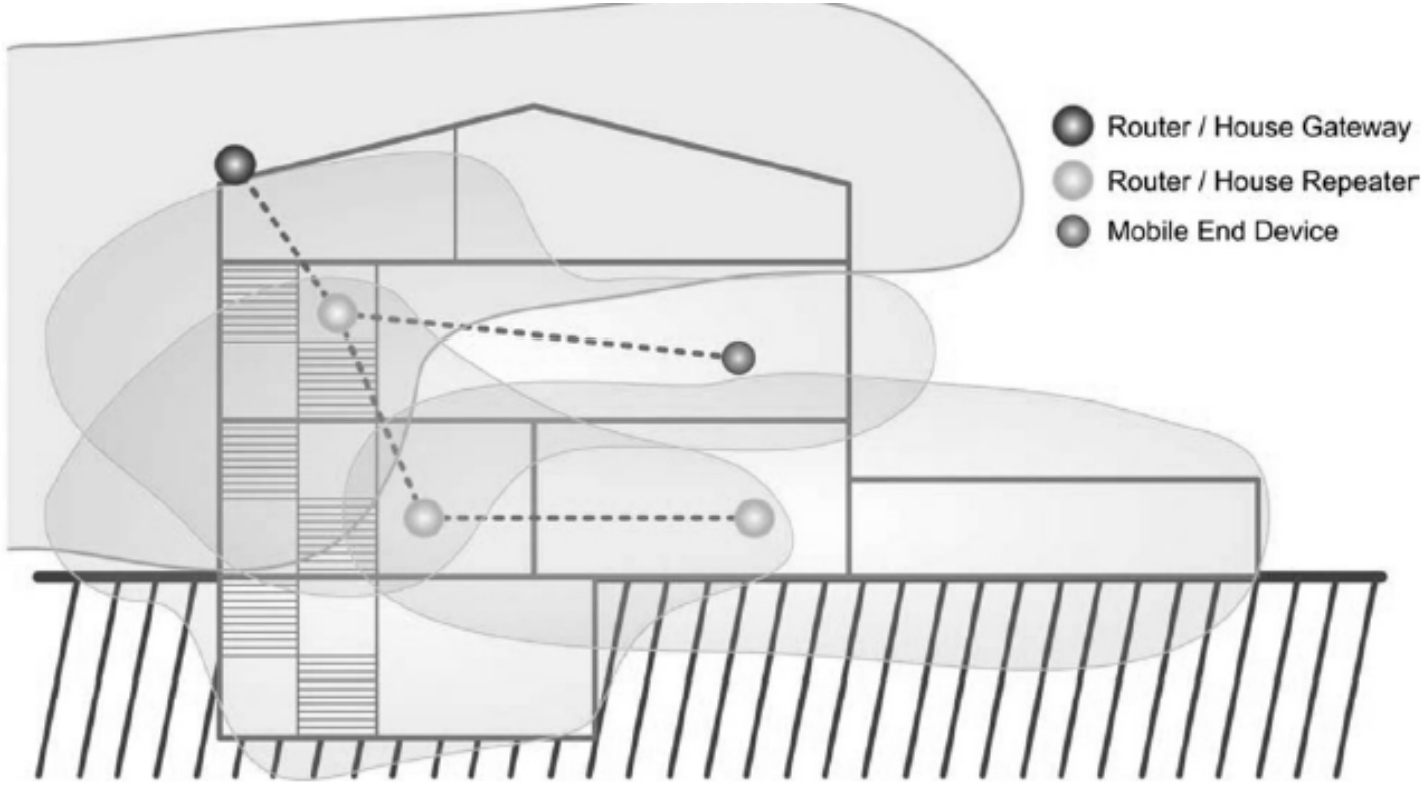


Network Architecture(4/5)

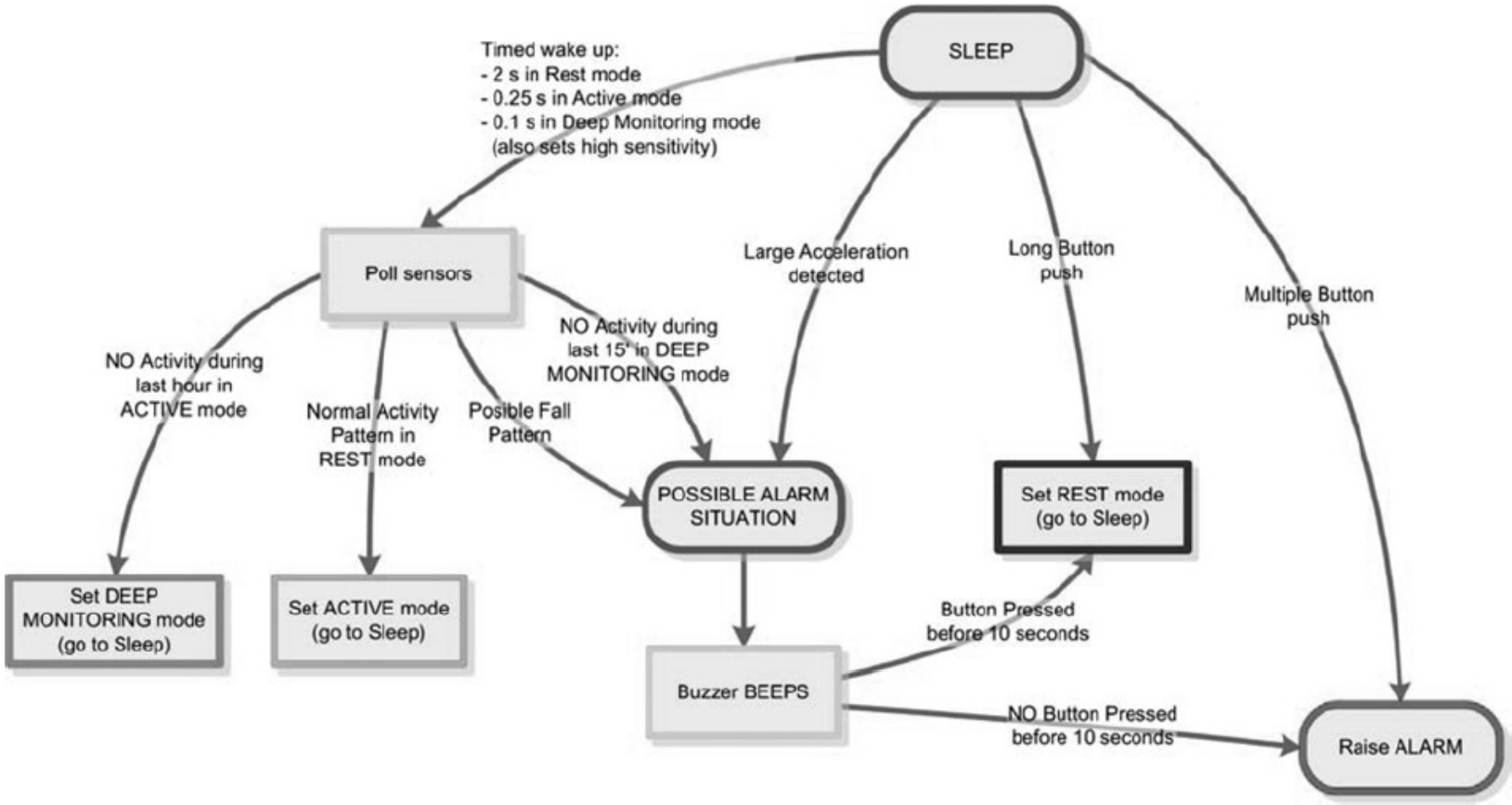
- The paper use two different type of antennas:
  - Directional antenna(21*21 cm)
  - SMD antennas(2*7 mm)
- Directional antennas are used to cover cover straight streets or to reach sites located far from coordinator
- SMD antennas are used in portable devices and routers

	SMD Johansson best, m	SMD Johansson worst, m	Directional Fractus, m
SMD Johansson best	155	120	385
SMD Johansson worst	120	70	220

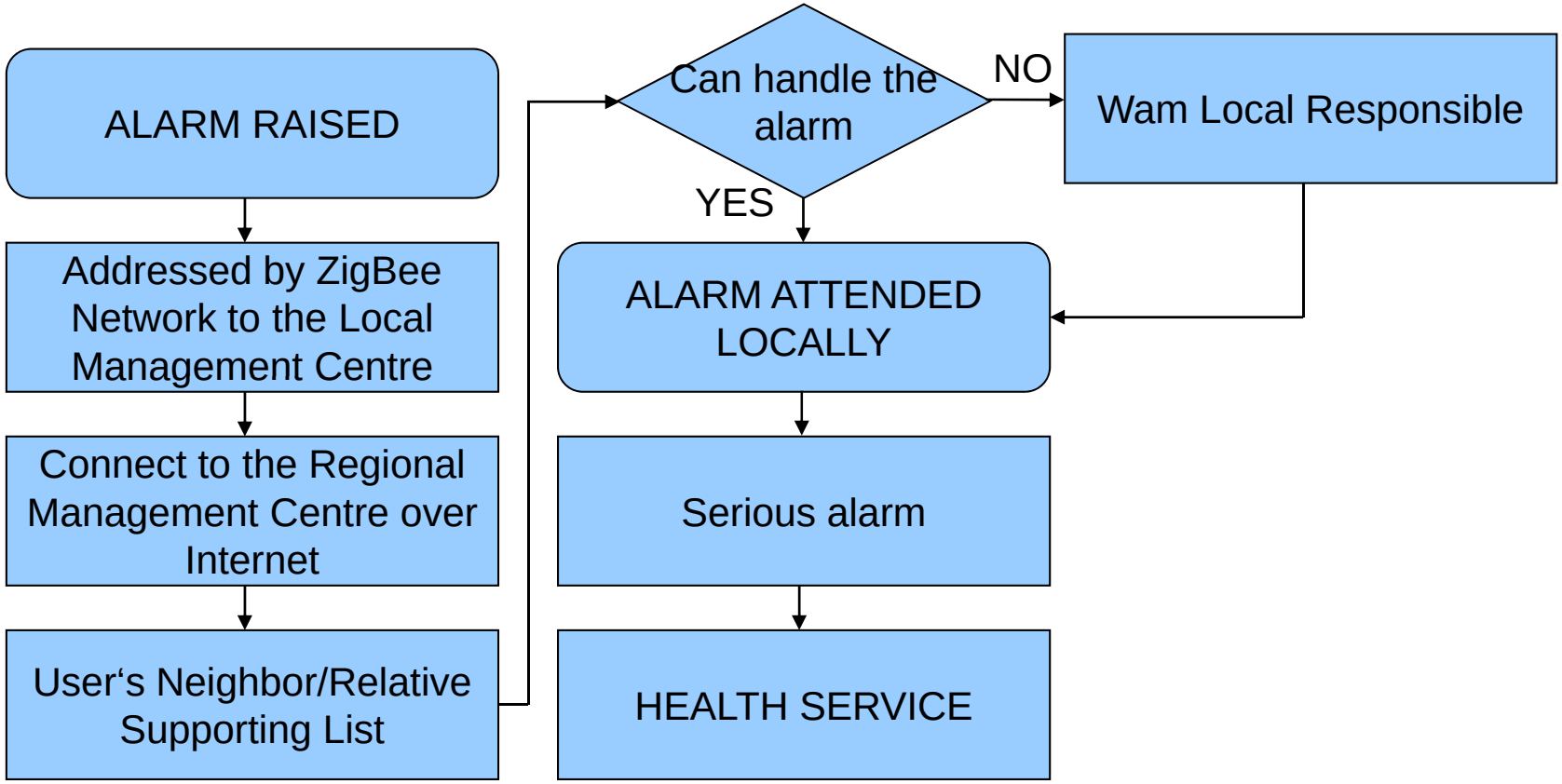
Network Architecture(5/5)



System's flow diagram(1/2)



System's flow diagram(2/2)



Energy consumption(1/2)

- When it sampling and processing the output about the accelerometer data
  - That is a current consumption of 95.7μA/s in active mode
  - That is a current consumption of 22.7μA/s in rest mode
- When it polling the neighbor/relative
  - That is a current consumption of 70μA/s in active mode
  - That is a current consumption of 70μA/s in rest mode

Energy consumption(2/2)

- The paper use a 3V battery with 1000mAh capacity
- It will provide more than 8 months of continuous monitoring in active mode

	Current in active mode	Current in sleep mode
microcontroller	6 mA	5 μA
wireless transceiver	30 mA	10 μA
accelerometer	500 μA	2 μA

Conclusions

- The approach provides security to the users, enabling them to move freely in their habitual environment: home and surroundings
- The system has obvious benefits, but it can also invade the users' privacy
- The use of ZigBee give the village with a wireless infrastructure that enables the integration with many other systems that might potentially improve the users' quality of life; for example control of the environment and remote medical monitoring

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Thanks for your listening