Contexta-NET. A Data-Gathering system that supports Situation-Aware Applications: a Healthcare Example

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***Abstract*— Contexta-NET is an energy-aware data-gathering system conceived specifically for situation-aware applications that need to collect data about specific contexts.**
The system relies on a network architecture based on Wireless Sensor Networks (WSN) [1]. The network is composed of a group of devices (nodes) that gather data about the user and the environment.
Using Contexta-NET allows developing data-gathering solutions for many different application areas, helping to decrease development time and to improve interoperability among existing solutions.
We present the prototype of a healthcare monitoring application built using the Contexta-NET system.

I. INTRODUCTION

The world is full of sensors and their number is increasing, however most of them are not interconnected beyond a local control system.

Many applications in many different areas (e.g. independent living, people and object tracking, smart and active logistics, home automation and energy management, security on the job, precision agriculture, intelligent lighting, environmental and urban monitoring, etc.) strongly rely on some kind of knowledge about the particular situation in order to take decisions or adapt to the user behavior.

The lack of interconnection at sensor level is one the main reasons that make situation-aware systems difficult to realize and moreover limit their diffusion.

Therefore, it is necessary to develop new data-gathering systems that simplify sensor interconnection and that can be easily adapted to different application areas [3].

We propose Contexta-NET, an energy-aware data-gathering system conceived specifically for situation-aware applications that need to collect data about specific contexts.

The remainder of the demo abstract is organized as follows. In Section II an overview of the Contexta-NET system is given while Section III describes a prototype of a healthcare monitoring application built using the Contexta-NET system.

II. CONTEXTA-NET OVERVIEW

Contexta-NET relies on a network architecture based on WSN [1] using IEEE 802.15.4 [2]. The network is composed of a group of devices (nodes), interconnected using wireless technology. Most nodes operate on batteries; therefore there is no need to connect them to the mains socket.

The network is composed of an infrastructure of fixed nodes and of several mobile devices.

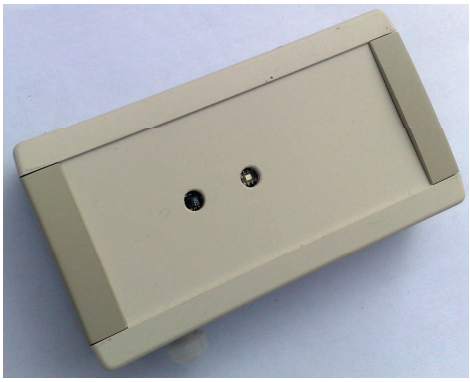

Fig. 1. The infrastructural "fixed" node showing holes for ambient-light, temperature/humidity sensors and movement sensor.

The infrastructural "fixed" nodes, besides providing RSSI data, include motion sensors (used for improving the accuracy of tracking) and environmental sensors (used for gathering contextual data, such as brightness, temperature, humidity etc. – see Figure 1). Moreover they are battery powered, and, in nominal conditions, can be active for more that one year.

Fig. 2. The infrastructural node and its wall-mounting bracket.

As shown in Figure 2, fixed nodes can easily be mounted on the walls of the areas to be monitored, in order to guarantee the monitoring of specific places, (e.g. main entry door, next to a window, bed, etc.)

Mobile devices are also battery powered and include, at least, a complete six-degrees-of-freedom (6DoF) inertial measurement unit (IMU) that is used to track users or object movements. Mobile devices can be easily extended with further sensors if needed by the specific application. Figure 3 shows the first prototype of the mobile device.

An intelligent concentrator, through a gateway node, collects and processes all data from all nodes and sensors making them available via Internet through serial or Ethernet connections.

The implementation of the Contexta-NET data-gathering system relies on a hierarchical organization of the WSN. The physical area where the data gathering will be performed is divided into several physical zones each containing several nodes.

Moreover, in every zone, the nodes are organized as logical clusters. Every cluster is controlled by one base node and contains several data-gathering nodes. All data-gathering nodes are within one hop of the base node of their zone. The mobile nodes can move from zone to zone without loss of connectivity.

This hierarchical organization makes it possible to cover large areas and entire buildings.

More details on Contexta-NET and its applications can be found in [4].

III. A Prototype of Healthcare Monitoring based on Contexta-NET

In order to demonstrate the Contexta-NET data-gathering system, we realized the prototype of a healthcare monitoring application. We choose this particular application because user localization in indoor environments is a fundamental component of healthcare monitoring and ambient assisted living (AAL) systems.

The main features of the monitoring application are the following:

- User localization within the environment being monitored. The system identifies a person's presence in defined areas - e.g. in bed, in the kitchen, etc. Moreover it identifies a user going through doors, and exiting the environment being controlled. This can be achieved even without the user carrying any mobile device: the overall system can still operate, albeit at a lower level of recognition capabilities.

  Using the data gathered with Contexta-NET to feed particle-filter-based localization algorithms we obtained a typical accuracy of one meter with a precision of 90%.

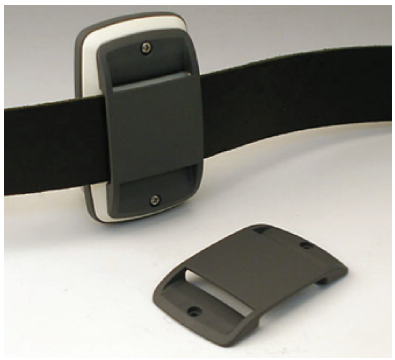

Fig. 3. The prototype of the mobile device, to be worn on the belt, used for healthcare monitoring and tracking the user position.

- Detection of movements in the monitored environment with special attention to the identification of events, which appear atypical for a given user (traumatic events like falling, but also detection of reduced activity, or unusual postures).
- Gathering of environmental data, e.g. temperature, humidity, ambient light conditions, etc.
- Preventive evaluation of dangerous situations. Alarms can be raised without any user intervention.

The system can be interfaced with various home automation systems, and its functionality extended.

Moreover it is possible to trace, view and analyze past events by storing historical data.

In the demonstration we will show the capability of the system, focusing on user localization and movement detection.

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