

Smart Cities Simulation Environment for Intelligent Algorithms Evaluation

Pablo Chamoso, Juan F. De Paz, Sara Rodríguez and Javier Bajo

Abstract This paper presents an adaptive platform that can simulate the centralized control of different smart city areas. For example, public lighting and intelligent management, public zones of buildings, energy distribution, etc. It can operate the hardware infrastructure and perform optimization both in energy consumption and economic control from a modular architecture which is fully adaptable to most cities. Machine-to-machine (M2M) permits connecting all the sensors of the city so that they provide the platform with a perfect perspective of the global city status. To carry out this optimization, the platform offers the developers a software that operates on the hardware infrastructure and merges various techniques of artificial intelligence (AI) and statistics, such as artificial neural networks (ANN), multi-agent systems (MAS) or a Service Oriented Approach (SOA), forming an Internet of Services (IoS). Different case studies were tested by using the presented platform, and further development is still underway with additional case studies.

Keywords Smart Cities · Intelligent systems · Machine to Machine · Internet of Services · Big data

1 Introduction

The concept of Smart Cities (SC) is a current trend in technological projects. The balance with natural resources and the environment is responsible for these paradigms, which aim to increase the level of comfort for all citizens and institutions based on sustainable development.

P. Chamoso(✉) · J.F. De Paz · S. Rodríguez
Computer and Automation Department, University of Salamanca, Salamanca, Spain
e-mail: {chamoso, fcofds, srg}@usal.es

J. Bajo
Artificial Intelligence Department, Polytechnic University of Madrid, Madrid, Spain
e-mail: jbajo@fi.upm.es

© Springer International Publishing Switzerland 2016

H. Lindgren et al. (eds.), *Ambient Intelligence- Software and Applications (ISAmI 2016)*,
Advances in Intelligent Systems and Computing 476,

DOI: 10.1007/978-3-319-40114-0_20

When trying to make a city smarter, most of the efforts address energy areas because this will result in high resources saving which allow resources to be applied in other social areas. Therefore, improving the energy efficiency in cities is not only aims to reduce energy costs, but also to promote environmental and economic sustainability.

One of the main problems when developing hardware or software to increase citywide energy efficiency is the integration and deployment in real cities of a developed system, which can be tested and evaluated. In order to facilitate this integration task, a simulation environment that can test and evaluate both the hardware and the developed software or algorithms is presented.

SC can be represented as a three-level platform, where hardware represents the base, the communication mechanism represents the middle layer, and the top layer is represented by the intelligent software [1].

The presented platform consists of a series of heterogeneous sensors that use M2M for the communication, and applies different AI and statistics technologies to evaluate the system and increase energy efficiency in cities.

One of the main characteristics of the simulation environment is that sensors can be easily integrated with the system. In fact, the most commonly used sensors have already been integrated and developers can use them to get the information. In addition, there are some open data services available to provide useful information that sensors cannot provide under simulated conditions, such as the city's weather forecast or traffic.

M2M communication platforms take the role of controlling the communication among all the connected elements of the cities. The decline in costs of connectivity and the price of required devices are driving the growth of this kind of communications. This platform is shaped by combining services to add some intelligence to these connected elements in an interoperable manner that provides the system with a highly heterogeneous content. That intelligence is added in the upper layer of the system to provide the best results depending on the environment status.

The rest of this paper is structured as follows: Section 2 shows the state of the art concerning projects and research conducted in the field of SC, showing the most commonly used techniques and technologies in this field, and then carrying out a comparison between them and the system presented. Section 3 presents the developed system, its operation and details of the techniques used. Section 4 describes the case studies developed to test the platform. Finally, Section 5 presents some results and conclusions of the work.

2 Background

The concept of SC or smart environments [5] itself is still emerging. Making a city "smarter" is one of the main objectives of the researches as a strategy to reduce some problems caused by the rapid growth of the urban population. Problems such as pollution (visible in bigger cities), lack of resources, traffic congestion and