Renewable Energy Production Distribution Map of Catalan Homes

by

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Submitted to the Department of Service and Information System Engineering
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Abstract

In this thesis, I designed and implemented a compiler which performs optimizations that reduce the number of low-level floating point operations necessary for a specific task; this involves the optimization of chains of floating point operations as well as the implementation of a "fixed" point data type that allows some floating point operations to simulated with integer arithmetic. The source language of the compiler is a subset of C, and the destination language is assembly language for a micro-floating point CPU. An instruction-level simulator of the CPU was written to allow testing of the code. A series of test pieces of codes was compiled, both with and without optimization, to determine how effective these optimizations were.

Thesis Supervisor: Carles Farré Tost
Title: Associate Professor

December 6, 2013 **DRAFT**

Acknowledgments

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Chapter 1

Introduction

The Center for Ecological Research and Forestry Applications (CREAF) is a public research institution that was created in 1987. The members of the Governing Council of CREAF are the Generalitat of Catalonia, the Autonomous University of Barcelona (UAB), University of Barcelona (UB), the Institute for Research and Technology (IRTA), the Institute of Catalan Studies (IEC) and the Spanish National Research Council (CSIC).

Its objective is to generate knowledge and create new methodological tools in the field of terrestrial ecology, with special emphasis on forest ecology, in order to improve environmental planning and management in rural and urban areas. This is achieved, among other means, through the development of methodological and conceptual tools designed to facilitate decision-making and improve environmental management.

Since its creation, CREAF has made very important contributions to the field of terrestrial ecology and towards a sustainable management of the environment. This has been achieved through research, development, training and technology transfer. Some of its outstanding breakthroughs are the design and implementation of the Ecological and Forest Inventory of Catalonia (EFIC), innovative at the international level due to the incorporation of new ecological parameters, the production of the Land Cover Map of Catalonia (MCSC), a high-resolution digital map for environmental assessment and territorial planning and management and the development of the MiraMon©Geographic Information System, widely adopted in Catalan administration and currently being used in over thirty countries around the world.

1.1 Motivations

The motivation for this master thesis arise from the idea that the wide development of the web technology such as HTML5, PaaS, IaaS, NoSQL and the steady increase in Open Source adoption in recent years make possible the implementation of powerful systems with significant cuts on budget. Moreover these technologies often come with (entail?) considerable improvements in maintainability, performance and complexity reduction.

I am firmly convinced that this set of technologies and tools could improve research in centres such as CREAF, providing them with better and affordable infrastructures that allow to reduce the timespan of common processes and calculations. Moreover, they provide new means for the dissemination of the valuable data that results from these processes.

I tend to think that some computer engineering ought to be a tool to push forward the development of other sciences. In particular, as recently graduated engineers we can contribute with our acquired knowledge to the society attemting to solve problems that benefit us all. Therefore, I wished to develop a project whose outcome could benefit the work of some public research centre becoming a useful tool.

Given my discovered interest in topics like distributed computing, sensor networks and resilience systems arouse in my recent stay in University of Antwerp I am eager for expanding my knowledge farther and dig deeper into these fields relating them in a real-world use case.

1.1.1 CREAF future tools

On the other hand, CREAF wishes to expand its methodological tools by adopting sensor web. The reduced cost of hardware devices like Raspberry Pi and Arduino and their general-purpose features make them an affordable option as sensor devices and facilitates the development of sensor client software. For these reasons, CREAF aims to deploy its own sensor devices in wild nature in the near future.

Although, some points were already clear, some others such as the architecture of the whole system to which the sensor clients will connect to as well as the software they will be shipped with were unknown for CREAF.

Additionally, within in the context of volunteered geographic information (VGI) and renewable energies, wants to solve the problem of knowing the distribution of renewable energy produced in Catalan homes, whose impact is that the actual distribution of the energy produced by either wind or solar systems and their performance and evolution over time are unknown.

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Chapter 2

Requirements

They have been obtained throughout some interviews with the CREAF researcher in charge of the project.

Real use-case data (number of owners) has been obtained to ”scope” the system qualities properly.

2.1 System-Wide Functional Requirements

- The system must be fed with the data collected by the sensor devices
- The system must require an authentication system for the sensor devices and the web application users
- The system must provide software tracing

2.2 System Qualities

2.2.1 Usability

- The system must be user friendly and easy to use by means of a GUI
- The sensor devices must be easy to set up by end users
- The sensor device must collect and deliver the data automatically
- All the command line interfaces must be scriptable and configurable

2.2.2 Reliability

- The system must be reliable in low bandwidth and high network latency
- The system must be reliable in high-load scenarios
- The system must be reliable in high user concurrency scenarios

2.2.3 Performance

- The system must able to show new available data in the real time visualization before the next observation is sent from the sensor device
- The system must be able to process observations received from [X] sensor devices

2.2.4 Supportability

- The system must have some sort of event logging system

- The system must support SOS standard in order to be interoperable
- The system must be horizontally scalable
- The codebase must be maintainable and extendible

2.3 System Interfaces

2.3.1 Interfaces to External Systems

- The system must integrate 52 North SOS implementation to provide a standard interoperability layer

2.4 System Constraints

- The sensor devices must send [X] power observations within an hour
- The system must be able to run in commodity servers
- The software must be portable in order to be deployed in any platform including PaaS and IaaS

SOS

2.5 System Compliance

- The system and all its components must adhere to [Open Source license] license

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Appendix A

Tables

Table A.1: Armadillos

Armadillos	are
our	friends

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Appendix B

Figures

Figure B-1: Armadillo slaying lawyer.

Figure B-2: Armadillo eradicating national debt.