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CALPINATOR: A CONFIGURATION TOOL FOR BUILDING FACADES

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Introduction

Energy consumption of residential and commercial buildings represents more than a third of the energy consumption in developed countries...

Energy consumption

- 44% in France
- 37% in Europe
- 36% in North America
- 31% in Japan

INTRODUCTION

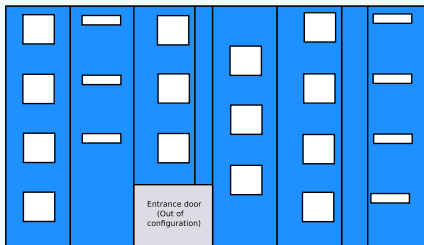
WHAT TO DO ?



One of the strategies to achieve a significant reduction lies on (thermal) building renovation.



(a)



(b)

INTRODUCTION

FACADE LAYOUT



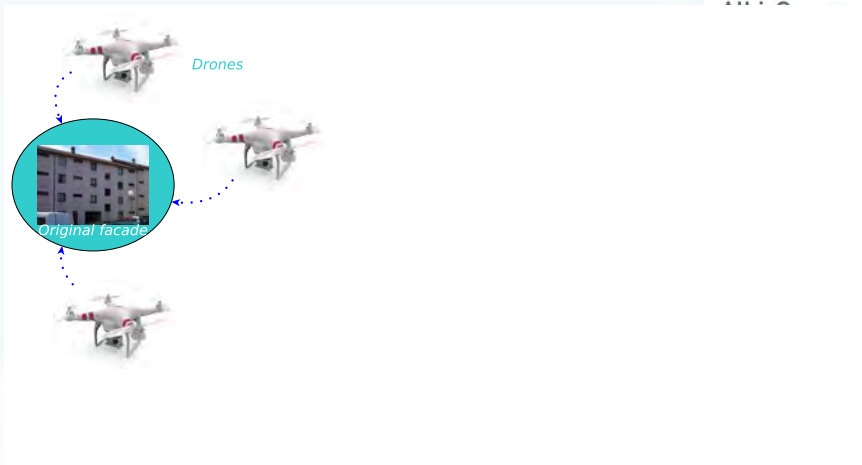
Original facade

INTRODUCTION

FACADE LAYOUT



x

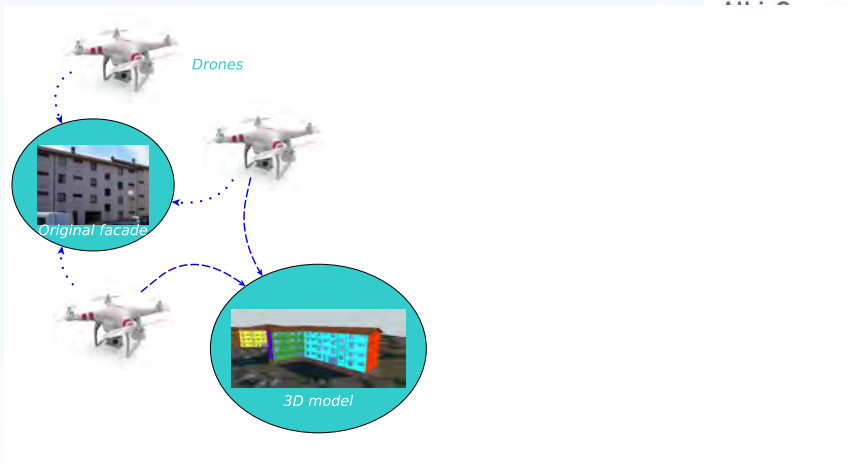


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FACADE LAYOUT



X

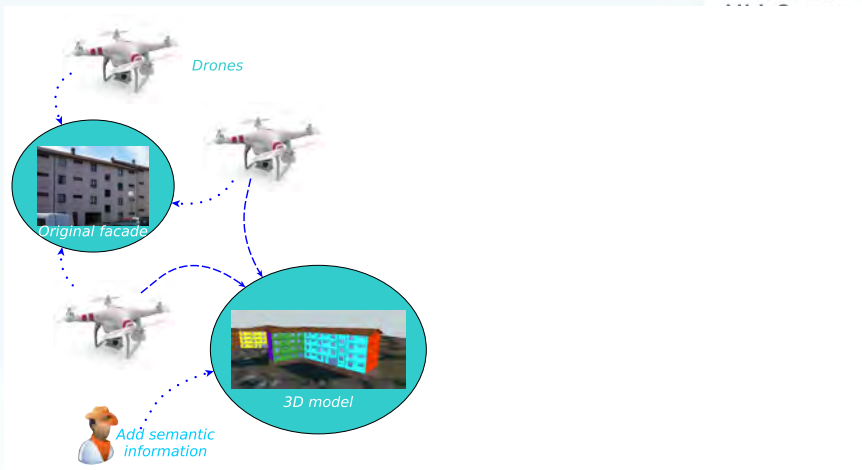


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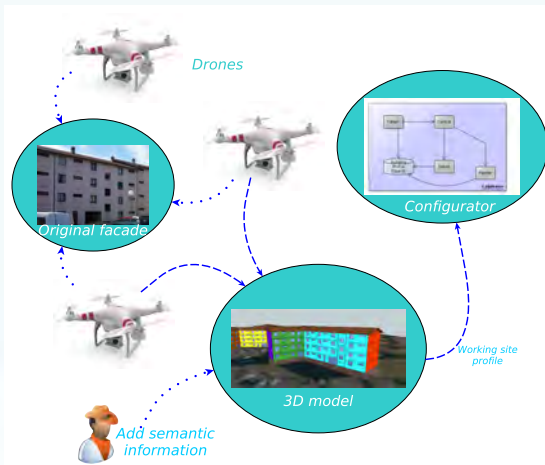


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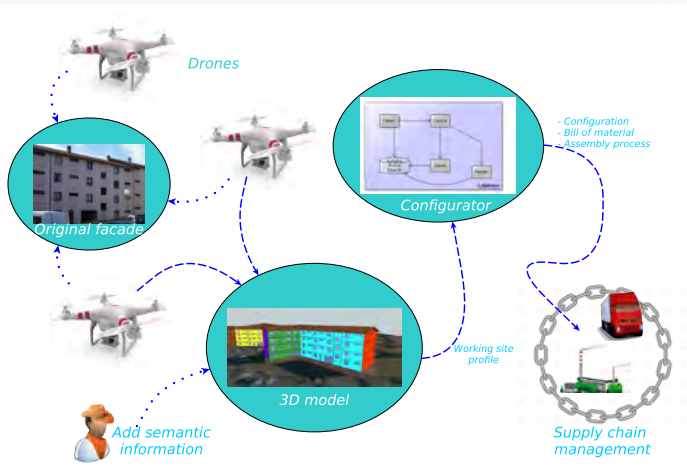


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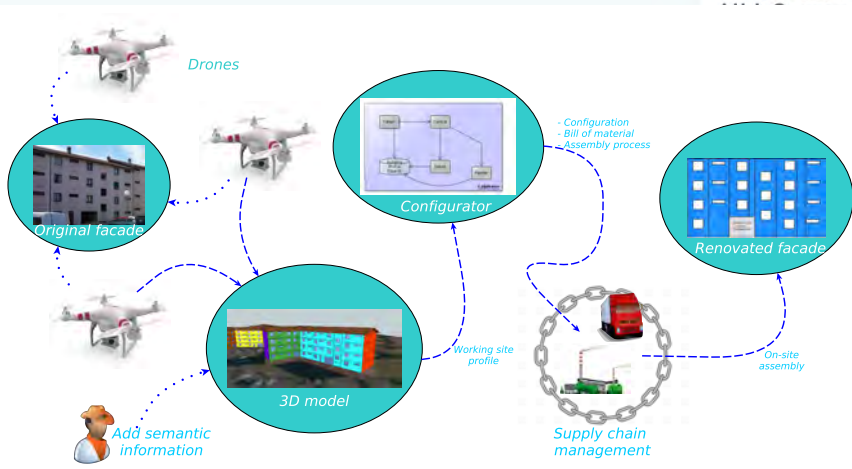


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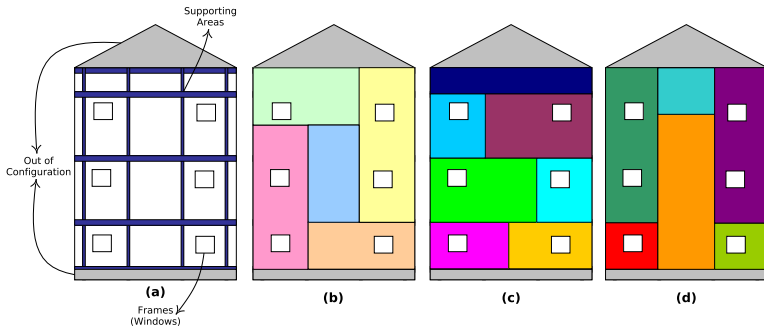
X



Problem

PROBLEM

FACADE LAYOUT



PROBLEM

SCIENTIFIC ISSUE



Layout configuration

- 1 Reference plane is vertical (gravity and other natural forces) not addressed by previous studies [3, 6, 9]
- 2 Number of panels not know in advance, contrary to most studies [3, 5, 8]
- 3 Deals with geometric properties (e.g. windows positions) as well as structural ones (e.g. panel weight) [2, 4, 7]

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Hypothesis : Artificial Intelligence

HYPOTHESIS : ARTIFICIAL INTELLIGENCE

AN IDEA

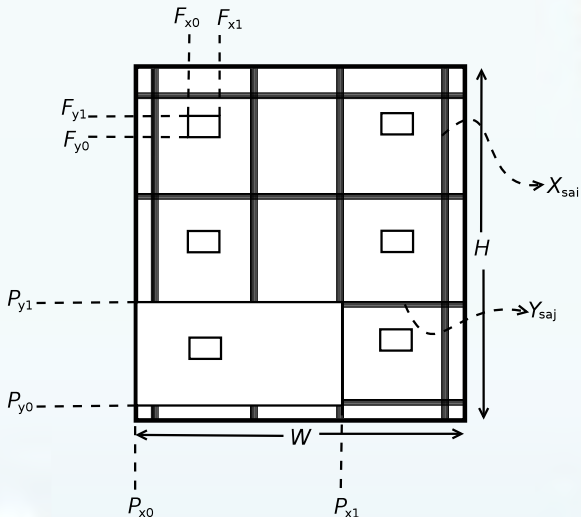


Never send a human to do a machine's job.

Agent Smith. The Matrix, 1999.

HYPOTHESIS : ARTIFICIAL INTELLIGENCE

VARIABLES



- 1 Dimensions : Constraint width and height of panels.
- 2 Facade area : Cover all facade area.
- 3 Non-overlap : No overlapping of panels.
- 4 Panels versus frames : Respect panel structure.
- 5 *Weight (not implemented in first version)* : Facade supports envelope weight.

Local decisions

Use a quick algorithm that place with panel at a time [1] :
Greedy algorithms.

- Intuitive and fast
- Implemented in any language

Constructive Approach

Add one panel to the facade and configure it. If everything works add next panel. Otherwise backtrack to previous panel.

HYPOTHESIS : ARTIFICIAL INTELLIGENCE

EXAMPLE



A Configuration Tool : Calpinator

A CONFIGURATION TOOL : CALPINATOR

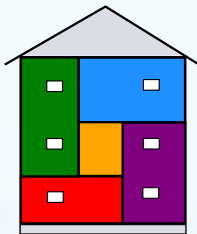
JAVA-BASED PROGRAM



Prototype

A configuration tool for building facades.

Calpinage + Configurator = Calpinator



Calpinator



A CONFIGURATION TOOL : CALPINATOR

FEATURES



- 1 Input and output using JSON format.
 - 2 Select horizontal or vertical orientation of panels.
 - 3 Set the lower and upper bounds for panel dimensions (a random selection is also provided).
- A debug option to incrementally visualize the solving process (only greedy algorithm).

Lets see some examples.

Remarks and future work

Our work is interesting and our results are novel because :

- 1 Reference plane is perpendicular to the Earth.
- 2 Combines a diverse set of constraints (e.g. manufacturing, transportation, geometrical, structural, global constraints) and domains (e.g. integer and real).
- 3 Number of panels to configure a facade layout is *not know in advance*.
- 4 Use of a fast greedy algorithm is an approach underestimated but generates good performance.

In this work we have introduced Calpinator :

- 1 Generates layout plans for building facades.
- 2 Uses a greedy algorithm following constructive approach.
- 3 Open source Java implementation.

- There is plenty of work to do, mainly :
 - Gradually addition of variables and constraints taken from the problem domain.
 - Add to Calpinator the implementation of weight constraint.

REMARKS AND FUTURE WORK

FIN



C'est fini.

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BIBLIOGRAPHY I



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