Virtual Environment for Solar Energy Systems Design and Testing

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Abstract: - This paper refers to a virtual environment which represents the main support for experiments with photovoltaic energy systems in the design and testing stage. This software environment is very useful because, comparing to the experiments with real energetic systems, it allow the testing and evaluation of different types of interfaces and different working environment conditions. A very important facility of this interactive software environment is the fact that the designers of the energetic systems sensors and interfaces are able to work in parallel to design test, optimize and realize different control devices for the energetic system.

Key-Words: - artificial intelligence, photovoltaic energy systems, virtual experiments, virtual environment, simulator, synchronization

1 Introduction

The target of the energetics was and will probably remain for a long time, to produce an autonomous photovoltaic energy system.

In the results communicated by different researchers, we can find developments in which different degrees of autonomy are obtained. Nevertheless even if they are not completely autonomous, the producing of intelligent energetic systems is insistently required.

The recent researches stage shows a tendency of merger of technics coming from distinctive fields of research as: energetics, microtechnology, automatic control theory, artificial intelligence, power electronics, microelectronics etc. All the works of these domains are integrated in the so-called "embedded system approach to artificial intelligence" (ES) and here, the teaching is considered a very important potential component inside a general method of designing the energetic systems control.

2 Simulators for energetic systems testing

Most of the simulators produced until now, are making unrealistic assumptions such as: static operating environments, ideal sensorial systems, but the working characteristics of the energetic systems are passive (do not lead to significant modification of the operating environment conditions). In practice, the requirements that has to be accomplished by the real autonomous energetic systems are much more complex and need the projection of adequate controlling programs.

The difficulties aroused by the conception and elaboration of a software environment for simulating controlling programs for the photovoltaic energy systems can be reduced by a modular conception. The simulation of the corelations between the energetic system and the operating environment is quite difficult because this is a dynamic process with a significant complexity, on one hand, the energetic environment configuration can be radically modified in time and, and, the modifications in the working environment need modifications in the programs controlling the functioning of the energetic system.

An element of novelty of this simulator is the fact that, in this stage, the focusing is realized on the corelation between the software system and the operation environment and not the separate consideration of these components. The corelations between the system and the environment are looked upon as to a dynamic coupled system in which the exit of the system is transformed into the entering of the energetic system placed in the real environment, and the exit of the last one is transformed into the entering of the simulation system. This simulator was made in a modular conception, each module having a very clearly set task: module generating the working environments, module for describing the energetic systems (working state, dynamic modelling part etc.), module for describing the controlling program and the module for coordinating and synchronizing the operation of the other components of the simulation environment. The simulation environment is composed from several modules each having very precise tasks:

“Operating environment” module – allows the user to generate, configure and modify diverse virtual working environments which will be used for testing the energetic systems and the controlling programs conceived for it.

“Energetic_System_Model” module – allows the user to generate in the environment one or more
photovoltaic energy systems, with different configurations and powers. The systems contain a series of transducers for measuring the energetic state of the environment.

**“Supervisor” module** – is responsible with the coordination and synchronization of the activity of the other components of the simulator.

**“Controlling program” module** – each photovoltaic energy system defined in the simulated working environment, has to have a controlling program. This controlling program has to have access to the information given by the sensorial system of the energetic system, to operate these signals following a preset algorithm and then elaborate a series of commands.

The “Energetic system Model” module takes over these commands and calculates the new position of the photovoltaic energy system. At the end of each step of the simulation, the new coordinates of the photovoltaic energy system will be taken over by the “Supervisor” module in order to update the scene.

3 **The simulator Implementation**

The simulator was developed under Visual C++ 6 environment and Open Gl library of graphical functions. A classification of the classes which may allow an easy as possible subsequent development was made. All the graphical primitives have as a parent class an abstract class called Prim Geom, which practically assures a mutual interface for all the objects and a possibility to work with generic lists of graphical primitives of any kind. The working at the environment module continued, and for facilitating the implementation of the energetic system module, some characteristics were added. The application was modularly constructed, to allow subsequent developments.
3.1 The “Operating environment” module

This module generates realistic and diverse working environments. This software module was integrally realized and was conceived to allow an easy interface with the other software modules which will finally form the complex simulating environment for the autonomous photovoltaic energy systems.

This software package is remarkable by its flexibility and the very friendly graphical realization manner. It responds to a very large application area: from the simplest ones (in which the environment is manually described by the user and is characterized by a small number of static obstacles), to the most complex ones (in which the energetic environment is automatically generated by an artificial prediction/evolution algorithm).

3.2 The “Energetic system Model” module

The major role of this software module is to allow the user to generate in the simulation environment one or more photovoltaic energy systems, with different configurations.

In designing this module, the following requirements were in view:
- to generate photovoltaic energy systems with bidimensional tracking (specifying for each energetic system the number, dimension and the power of the panels, motors and transmission types etc.);
- allows to equip the energetic system with sensors for orientation and available power measurement. For each sensor, regardless of its nature, the size of the “visual” angle, the placement of the sensor towards the direction of the energetic systems forwarding and the conversion table are specified;
- allows the development of the controlling program of the photovoltaic energy system in a software environment, the placement of this executable has to be specified;

3.3 The “Controlling program” module

The principle after which the control algorithm was developed was the one to assure an interface through which the information can be taken over from the energetic system and through which the energetic system is commanded, an interface easy to implement, and which does not need information regarding the way the application functions in the remnant. An abstract class Alg Control was implemented. Which has a virtual pure control function, which has to be implemented by all the subclasses.

3.4 The “Supervisor” module

This software module is responsible with the coordination and synchronization of the activities of the other components of the simulator: Environment Module, Energetic system Module and Controlling Program Module.
introduce inside this environment one or more energetic systems, the loading for each energetic system a controlling program on free choice and rolling the simulation using all these items. The exit is made partly of the data provided by the sensors (in a form of log files or data base – at free choice) and on the other hand, (if wanted) by a controlling program improved by evolution and/or learning.

The “Supervisor” module is responsible with the coordination and synchronization of the activities of the other components of the simulator. At the end of every step of the simulation, the new states of the photovoltaic energy system are taken over by the “Supervisor” module in order to update the “scene”. It allows the opening of an environment (previously edited), the possibility to introduce inside this environment one or more energetic systems, the loading for each energetic system a freely chosen controlling program and rolling the simulation using all these items. The exit consists of the data provided by the sensors, and by a controlling program improved by evolution and/or learning.

4 Results
One important result was obtained in testing the performance of different types of sensors and orientation algorithms in order to implement the orientation system. The implemented software systems can predict weather evolution using statistic algorithms, and based on these predictions, they can choose different working regimes. In our tests, the simulator was very useful to study and choose the optimal placement of some particular energetic systems in specific areas.

5 Conclusion
The virtual environment presented by this paper is used for developing, testing and optimizing the control devices and interfaces for an autonomous energetic system.

As final data, this environment present and also evaluate the nature of the interactions and the behavior of the autonomous energetic system in diverse testing scenarios, according to the degree of teaching, adaptability and accomplishing the requested working regimes through the training program.

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References: