Dynamic System Modelling with Text Based Component Description for User Maintained Energy Systems

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1 Introduction

The development and continuous improvement of a comprehensive component-modelling system is part of international efforts to improve consumer understanding and predict the behaviour of the various designs for renewable energy systems. Renewable energy systems introduce a high user maintenance and awareness component to energy provision, hence the provision of user learning course and model systems continues to be a high priority of renewable energy system designers and manufacturers.

Existing systems are highly technical and do not provide flexibility for adding new components according to a specification file. This proposal is for the development of a prototype system which enables users to select the components of a proposed, or existing, energy supply system. The components can be connected into the model by the user and a simulation of the system can be run for an extended period.

The features of each components are entered in Standard Generalised Markup Language (SGML) file, which can be edited by manufacturers. The attributes of components include electrical rules governing the manner in which they can be connected into the system and their internal properties and operation that are enter in Latex mathematical notation. Finally the textual information on the system can be entered at various levels or depths of understanding, and the view of the textual information can be selected depending on the users level of understanding.

2 Specification

The features of the system as proposed are:

1. Components are self contained and hence can be installed in any system. The features of the component alone determine its ability to be connected in a system. For instance the input energy type must match (water pressure, rotational energy, or watts); number of connections available; voltages must match; current limits are checked; and power overload avoided.

2. Rules governing component linkages are set within the software so will be generic. Information relating to the features of each component

which are referenced by the generic connection rules will be prompted for when editing the SGML files for each component.

3. Components can be viewed in the system as images, textual information or as a table of attributes with initial values. A separate editor will be provide to enable this information to be entered into the component SGML file.

4. Environmental data will be able to be uploaded from a text format to the system for such factors as water flow (micro hydro), insolation (PV) and wind speeds (Wind systems).

5. User data in terms of load use can be uploaded also from a text format to enable the system to model the daily/seasonal load patterns

6. The textual information on a component will be entered in at least three levels, being:

    - User level or a person who plans to have a self monitored system installed in their home or community.
    - Technical person who has some knowledge of power generation and supply and will be maintaining the system.
    - System designer who may be showing a user the options for their site, or may wish to explore new possibilities, depending on the accuracy of the physical model provided for each component and the environmental data available.

7. Simulation of the system performance, including deterioration factors if this information is entered in the component models, can be run using varying time intervals for varying accuracy and scope. The simulation data will be displayed in a line chart showing the time varying values of each feature, as selected by the user from those available for each component.

8. System memory of previous models used so that these can be reloaded as a starting point for user's model.

3 Existing Systems

The existing modelling systems provide different approaches to modelling renewable energy systems. For instance the Homer tool for optimising grid connected and stand-alone small energy systems [1]. Homer can be integrated with DView to view real time graphs of model output.

Furthermore the user can enter data for a new component (such as battery type) and save this for future use. However, there is a delay for different component types to be added as these require reconfiguration of the software, which is avoided in the present approach.

Also Homer does not focus on training, and is not easy to learn for the novice. A system that does consider training was developed by Canadian RETScreen International. Their software [2] provides excel spread sheets to access and analyse climate data from NASA [3].

Also the RETScreen software is linked to a complete training course in renewable energies. However this does not include a practical modelling system and this software would be able to use the NASA data and provide such a practise model.

Both systems are focused on decision support for system designers. The present approach will not initially provide sufficiently accurate models to support design optimisation. However, the training system will provide the background for learning to using such a design tool, by enabling the user to experience and understand the factors which lead to design decisions.

The project is focused on the growing need for users to be energy system savvy in order to use and maintain effectively a small local energy supply. With the move from large centralised systems, we hope that such knowledge will also improve user energy conservation and thus reduce local energy demand.

4 Prototype

A prototype has been developed in Java version 1.5. This enables components to be viewed and static system features are assessed, but does not yet run simulations. It is purely a demonstration of the principle of providing SGML component description and the resulting ability of the system to use this to model the mathematical functions from the latex provided.

A simple Micro Hydro system is show in Figure 1 with the components

as images connected by the user as a circuit. Figure 2 shows a view of the data on each component for the same system model.

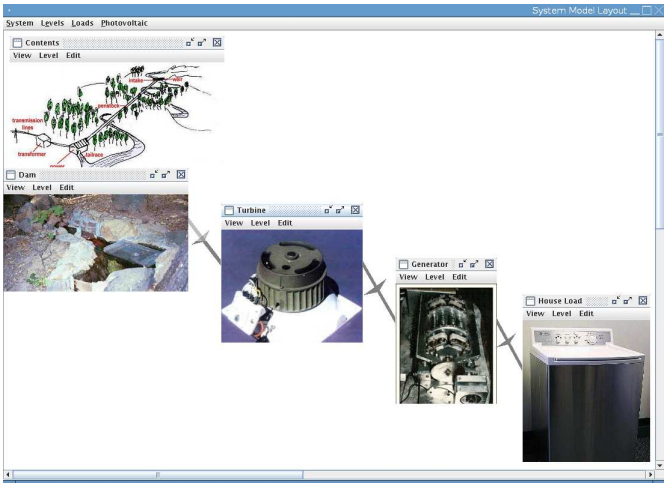

Figure 1: Prototype system showing basic micro hydro system

5 Component Based Architecture

The code is designed using a component structure that ensure that all data on the component creates a full description of that component for for the system modelling. Generic electrical rules for modelling the system as a combination of components, including wiring properties, are stored in the ModelComponent Class.

An editor will enable technicians to provide data on any new component to be added to the system. The single file records attributes and intial value (such as running voltage, power consumption); name of image file; and text description at different levels. Each of the attributes which are set in this file can be selected by the user for display on the linchart, which monitors system progress.

Formula are entered as latex such has the examples below:

```
\( powerOut = \frac {2 \sqrt{powerIn + \rho g h}} \rho \)

\[ \int_a^b f(x)\,dx.\]
```

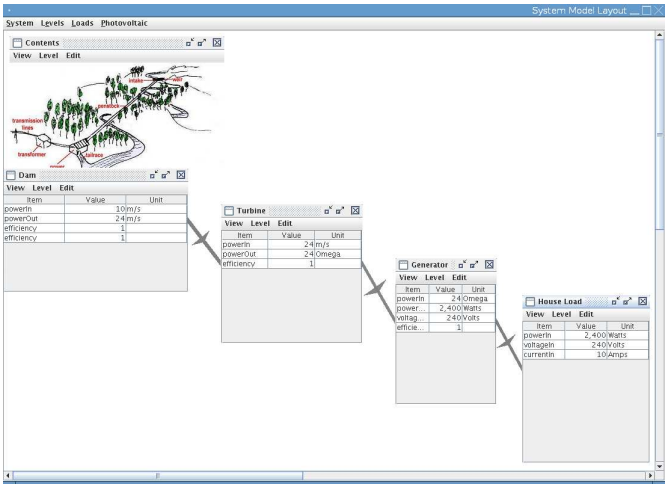

Figure 2: Prototype system showing data view

These equations are parsed by latex to read as: $powerOut = \frac{2\sqrt{powerIn + \rho g h}}{\rho}$ and
$\int_a^b f(x)\,dx$.

The equations are read by the component class to establish its attributes and operation rules and the latex output provides an equation format viewable within the text document

6 Research Focus

The research will cover the following areas:

1. Integrated system modelling of an well defined but complex system through individual component definitions, including deterioration factors. In the software development stage this can then be compared back to live systems for verifying accuracy of component and system models and improve accuracy of general model.

2. Structuring domains of learning to suit different entry levels and provide a gradually increasing complexity in the learning environment to enable students to construct their learning on their previous experiences in the learning domain.

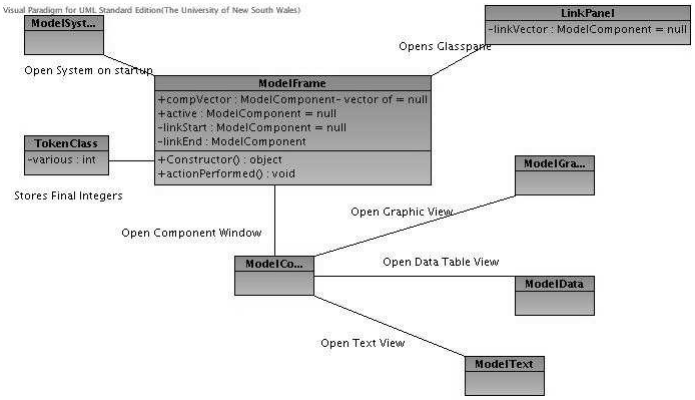

Figure 3: Class Diagram for System Components

7 Funding

The funding cost will be in the range of $80,000 to $100,000. This will cover software development and resources required for the project. We are looking for local suppliers who would like to combine to support such a project, and will be interested in using the resultant software with their product installations.

8 Conclusion

This proposal is for consideration for funding of a software system for small energy supply modelling with the view to linkage with renewable systems development and training of students in renewable energy systems.

9 References

References

[1] HOMER system modelling tool available at http://www.nrel.gov/homer/

[2] RETScreen International is available at http://www.retscreen.net/ang/index.php

[3] NASA environmental data for RETScreen International http://eosweb.larc.nasa.gov/cgi-bin/sse/ionp?page=globe$_m ain.ionapp = retemail = rets@nrcan.gc.ca.$