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Use of advanced information technologies in building web applications, designed to manage parameters of the mathematical model of induction motor

***Abstract**. The aim of this paper is an attempt to create a web-based application for parameters of the mathematical model of induction motor management. These parameters are stored in a relational database and designed application allows to perform the appropriate calculations and present the results in a dynamically generated web pages. The extra features contained in new internet-based technologies enable performing calculations on the Web platform. This article aims to verify whether this new, quite interesting idea, can be practically applied in numerical calculations.*

***Streszczenie.** Celem artykułu jest sprawdzenie możliwości zbudowania aplikacji webowej do zarządzania zestawami parametrów modelu matematycznego silnika indukcyjnego. Parametry te mogą być przechowywane w relacyjnej bazie danych, a zbudowana aplikacja, oprócz funkcjonalności związanej z obsługa bazy danych, pozwoli przeprowadzić odpowiednie obliczenia i zaprezentować wyniki na stronie internetowej. (**Zastosowanie zaawansowanych technologii informatycznych w budowie aplikacji internetowej przeznaczonej do zarządzania parametrami modelu matematycznego silnika indukcyjnego**).*

Keywords: Web application, mathematical model, parameters estimation, induction machine.
Słowa kluczowe: aplikacja internetowa, model matematyczny, estymacja wartości parametrów, silnik indukcyjny.

Introduction

The standard, which is commonly used in construction of web applications, enables creating content of sites in a dynamic way. The old, static way of web sites creating, has one huge disadvantage. Each sub- page, which is a part of a larger web site, had to be individually prepared by the author. Also, the final shape and structure of that site, had to be known at the design stage. Dynamic pages, as a opposite of static ones, are generated on fly by the HTTP server on the basis of variables and parameters provided by a web browser. In the process of web pages generation the specialized server module or an external program is involved in interpretation of the commands in the script. The document, generated this way, is entirely based on HTML code (tags). Dynamic websites operate on the basis of templates that contain both constant and variable elements, which are taken from a database. Thanks to this improvements, it is very easy to modify a content of the web page without changing html files.

The original purpose of Internet was only presenting information. Observed in the recent period improvement of Internet technology has caused, that the tools for creating Web pages can be used not only for the automatic generation of their dynamic content, but also can be used for implementation of any other programming algorithms. The essential feature of the described tools is that they both help users easily combine different technologies, which are necessary to prepare the web application and allow, by the use of the selected tool, preparing various components of the developed applications (database access, data analysis, generate web pages).

The most popular technology used to create the dynamic webpages is based on open source tools: Apache web server, PHP script language and MySQL as a database system. There are many other tools designed for these purposes - the most known are based on Microsoft .Net technology (ASP.NET) and Java technology (JSP, Java Servlets). Selection of programming tool is usually a matter of personal preference, but it is possible to define the features, which can be useful in the process of application development.

Django as a tool for create a Web application

In this paper authors' experience in building the websites by the use of Django framework is presented. Django is an open source web application framework, written in Python, which follows the model-view-controller architectural pattern [1]. A remarkable feature of this framework is that all steps of designing a web application, including project of a database system, access to databases and generating html pages, are being implemented in Python programming language.

Python programming language is now one of the fastest developing programming languages. Its clear and well thought out syntax, a wide field of applications, multiple extensions, allows realizing the various types of tasks, starting from the three-dimensional graphics (Visual Python library [2], game engine module in Blender [3]), through a low-level system programming, use of a database (present in the basic distribution of Python there is a SQLite3 - relational database management system) to engineering calculations (Matplotlib library [4, 5], the NumPy, SciPy libraries [6]).

Web application architecture

The overall structure of a web application in terms of the logical grouping of components into separate layers that communicate with each other is presented in Fig. 1. Layers are concerned with the logical division of components and functionality. The request from the user goes to the server. The server processes the request using the algorithms implemented in the application logic layer. To implement these algorithms, may be necessary to use data stored in a database. Created response is being prepared and displayed as a web page. The diagram presented in Fig. 2 shows the structure of web application prepared in Django framework. This framework fits the Model-View-Controller (MVC) pattern for web-based application, but replaces View with the idea of Template and replaces Controller with View. This design pattern is called Model-Template-View (MTV). The next feature of Django framework is its database component, the Object-Relational Mapper (ORM). Django supports several popular database engines (MySQL, SQLite, PostgreSQL, Oracle) and gives the possibility to create a database system of the web application regardless of selected database engine and implement the access to the data stored in database in Python programming language.

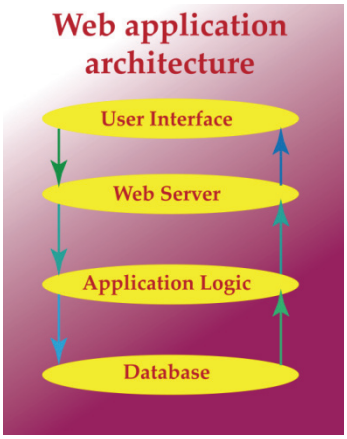

Fig.1. Architecture of a typical Web application

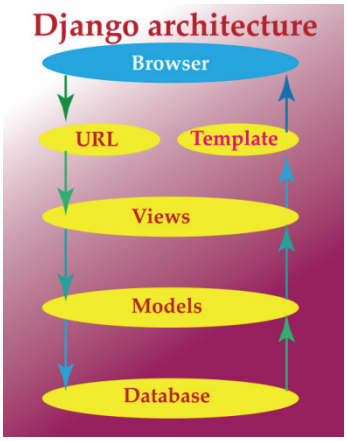

Fig.2. Architecture of the Django application

Database support in Django

In Fig. 3. a piece of Python code with class, which defines structure of the table in database system is presented. Django automatically prepares a SQL code for the chosen database system. Fig. 4 presents the SQL code for creating the table in SQLite3 database system. Similarly, any references to data stored in the database is realized using the Python code, so the programmer does not need advanced knowledge of SQL.

```
from django.db import models
class Parameters( models.Model ) :
  catalogNumber =models.CharField( max_length = 3 )
  motorType = models.CharField( max_length = 20 )
  ratedOutput = models.FloatField( )
  ratedSpeed = models.FloatField( )
  ratedCurrent = models.FloatField( )
  poles = models.IntegerField( )
  Rs = models.FloatField( )
  Xm = models.FloatField( )
  Rr1 = models.FloatField( )
  Rr2 = models.FloatField( )
  Xsr1 = models.FloatField( )
  Xsr2 = models.FloatField( )
  Xss = models.FloatField( )
```

Fig.3. Definition of the table structure in database

The fact, that the project of a web application is programmed in a single, general-purpose, high-level programming language, gives a chance to implement an online application for estimation of parameters of induction motor's mathematical model on the base of static characteristics. Additionally, thanks to the fact that web applications are based on the database systems, it can be very easy to implement an appropriate database to manage the estimated parameters. This is typical principle of web application operation (see Figure 1. and 2.). Taking the advantage of the Django technology, that database of estimated parameters will be created easily

```
CREATE TABLE "motorDatabase_parameters" (
   "id" integer NOT NULL PRIMARY KEY,
   "catalogNumber" varchar(3) NOT NULL,
   "motorType" varchar(20) NOT NULL,
   "ratedOutput" real NOT NULL,
   "ratedSpeed" real NOT NULL,
   "ratedCurrent" real NOT NULL,
   "poles" real NOT NULL,
   "Rs" real NOT NULL,
   "Xm" real NOT NULL,
   "Rr1" real NOT NULL,
   "Rr2" real NOT NULL,
   "Xsr1" real NOT NULL,
   "Xsr2" real NOT NULL,
   "Xss" real NOT NULL,)
```

Fig.4. Automatically generated SQL code for creating a table in the database

Estimation of parameters

Parameter estimation algorithm, described in [7], was developed in FORTRAN programming language. In [8] a new version of that algorithm, after some modifications, was prepared in C++ programming language. Proposed web application will implement original version of algorithm in Python programming language.

An assumed equivalent circuit of a deep-bar induction motor is shown depicted in Fig. 5. Although the model is relatively simple, the main advantage of using it is that it contains only five parameters to be estimated. The stator resistance R_s and magnetising reactance X_m are considered as known parameters. The unknown parameters are stator reactance X_s, and rotor parameters R_{r1}, R_{r2}, X_{r1} and X_{r2}. These parameters also define the sufficient set of parameters to prepare the circuit model for the analysis of dynamic characteristics [9].

The estimation of parameters of equivalent circuit form Fig. 5. is performed in terms of nonlinear least squares curve fitting problem with selected lower and upper limits for calculated parameters. The starting values of estimated parameters are predicted using basic knowledge [7]. The parameters are estimated from current-slip and torque-slip characteristics.

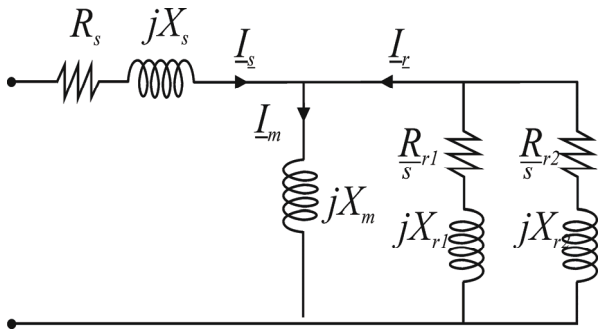

Fig.5. Equivalent circuit of deep-bar induction motor for steady-state analysis, s – rotor slip, I_s –stator current,I_r –rotor current, I_m – magnetising current

Web application for estimation of parameters

Proposed web application for parameters estimation of induction motor's mathematical model at first shows selected parameters of the considered motor. This stage is presented on Fig. 6.

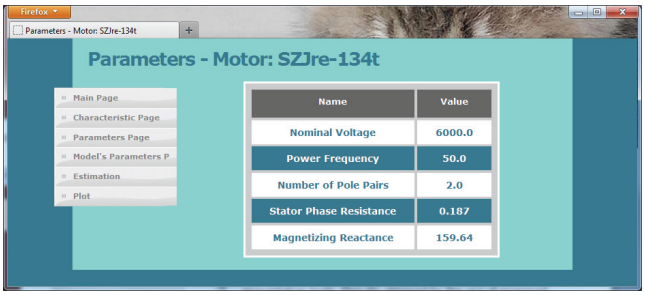

Fig. 6. Sub-page of the web application with parameters of selected motor

For each motor it is possible to store in database as many measured static characteristics, as desired. Fig 7. presents a web page with measured static characteristic current vs. slip.

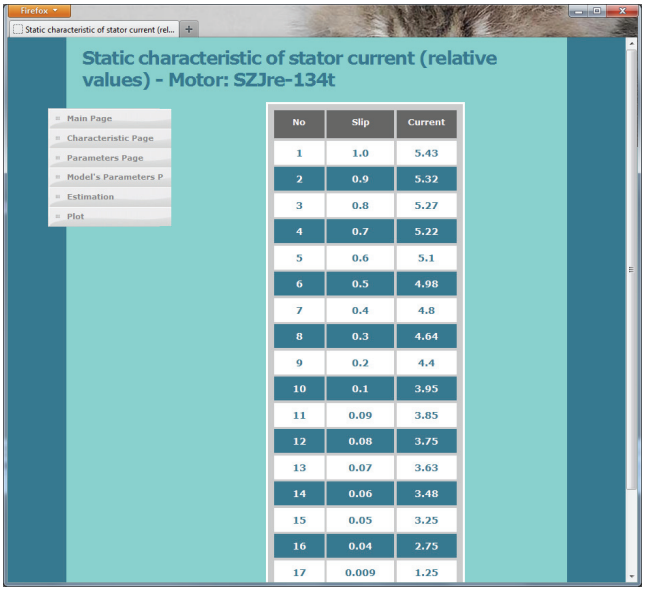

Fig. 7. Sub-page with measured static characteristic current vs. slip

Fig. 8. presents the results of algorithm – estimated values of five parameters.

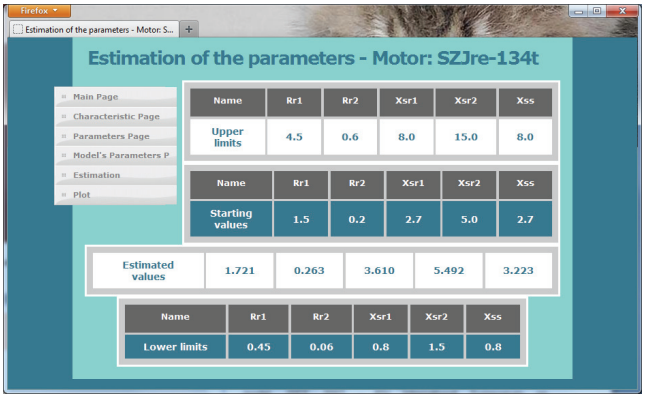

Fig. 8 Sub-page with results of the estimation algorithm

Data from figures 6, 7 are inserted into database by the use of proper forms.

By the use of Matplotlib library it is possible to prepare on-fly a plot as a file in .png format, in which the measured data and the characteristics calculated for the starting values and characteristics calculated for estimated values of the parameters are presented. This sub-page is shown in Figure 9.

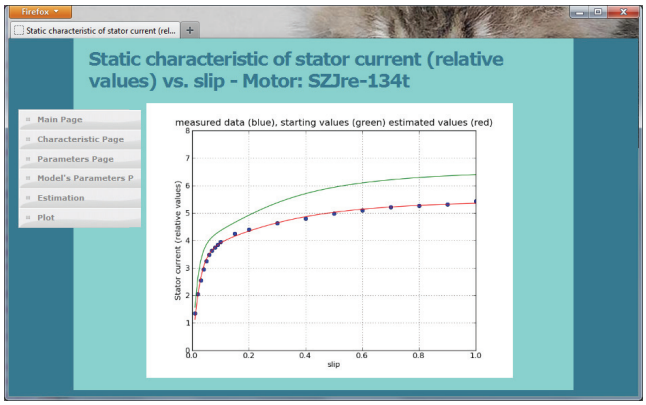

Fig. 9. Sub-page with plots: measured data (blue dots), characteristic calculated for the starting values of parameters (green line), characteristic calculated for the estimated values of parameters (red line)

Conclusions

Presented in this article an example of web-application confirms, that there is possible to combine in one application both the calculation algorithm and data presentation tools. Results obtained by the use of proposed application are available through WWW to all. The advantage of Django framework manifests in fact, that all the elements of this application are programmed in one programming language.

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