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Calculation of electrical parameter of solar cell using java framework

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ABSTRACT

The present manuscript deals with the development of JAVA based framework for calculation of electrical parameters of the solar cells. For the development of graphical user interface we have used eclipse IDE (Integrated Development Environment). Eclipse is a open source Integrated Development Environment and offers superior java development environment For Backend we use SQL (Structural Query Language) database. SQL is a standard language for managing, storing data in Relational Database Management System (RDBMS). For the present investigation we have used three input values i.e fill factor (FF), short circuit current (Jsc), and open circuit voltage (Voc) and calculated the unknown Vmp (V) and Imp (mA/cm^2) values using random number generation and java programming. The calculated values are closely matches with the existing results reported in the literature. The results suggested that the java programming will be useful for the solar cell research.

Keywords: Java Programming; Solar cell; Simulation; Random Numbers.

I. INTRODUCTION

The fossil fuels are responsible for the pollutions and they will be exhausted over the next few years, hence it is necessary to find out alternative solutions to fulfil the increasing energy demand. The solar energy can fulfil the ever growing energy demand of the world and on other hand it is eco-friendly, cost effective and abundant source of energy [1]. It can reduce greenhouse gas emissions and does not polluted nature which great help to the environment. Furthermore, solar cells requires low maintenance which results in a less cost of the end product i.e. solar electricity.

To develop a efficient solar cell, it is required to synthesis and characterize the various materials. Various experimental techniques takes very enormous time to market time hence modeling of solar cell will be one of the solution to reduce time to market period. To deal with such issues modeling is a better choice. A model represent a system which is simple and enables the analyst to predict the effect of the changes to the system. Model validity is very important in modelling. The techniques of model validation is to prepare the model or simulate the model under known input conditions and compare model output with system outputs [2-6].

IJARSE
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Recently, Sista et al have reported a review of general approaches, challenges, solutions and recent research in the field of polymer tandem solar cell [7]. You et al have explored the progression in polymer tandem solar cell by focusing active layer materials [8]. Hafezi et al have reported present performances and future perspectives for a high efficiency 'micromorph' (mc-Si:Hya-Si:H) tandem solar cells [9]. King et al have explored a progression of multijunction cell architectures and solar cell materials [10]. Siyu et al reported AIGaAs/GaAS tunnel junctions in a 4-J tandem solar cell which results in a ultra-high efficiency. The AIGaS or GaAS selected as a tunnel junction for simulation of entire characteristics by PC1D current densities with Voc [11]. Mahfound Adberrezek et al have been investigated the effect of temperature on GaInp/GaAS tandem solar cells [12]. White et al have reported low cost & high efficiency solar cell using novel thin film solar cell combined with c-Si [13]. Dongale et al have successfully simulate and developed various solar cells [14-20].

Considering the literature trends and our past experience in the solar cell research, the present manuscript deals with the development of JAVA based framework for calculation of electrical parameters of the solar cells. The rest of paper is as follows, after brief introduction in the first section, second section deals with the background details of JAVA framework and pseudo code. Section third deals with the discussion of graphical user interface and at the end results are presented.

II. FINDING SOLAR CELL ELECTRICAL PARAMETER USING JAVA FRAMEWORK

Java is most popular programming language released by Sun Microsystems in 1995. Java is a simple language as well as open source language. It is a high-level, third generation programming language. It is object oriented programming language. Java works on concept which is "Write once and run everywhere" means it is platform independent. It solves a problem of platform independence by using a byte code. Java runs on java virtual machine(JVM). Java has a built-in support for multithreading. Java has a pre-defined set of run-time libraries. Java has automatic garbage collector which is helpful for improving memory management. Java provides a platform for application development. It also provides a TCP/IP networking facilities. The typical architecture of JAVA language is shown in fig. 1.

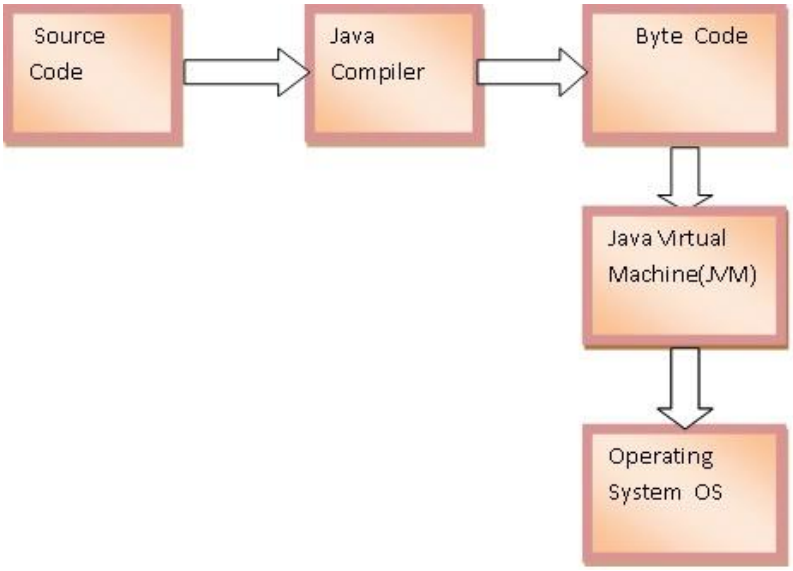

Fig. 1: The architecture of java language.

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There are many devices where java is currently used like desktop applications (media player, Antivirus), Enterprise application i.e banking application, mobile, embedded system, smart Card, robotics, games etc. Using java we can create distributed applications for this Remote method invocation (RMI), Enterprise Java Bean (EJB) are used. Java succeeded to a large extent in creating balance between portability, speed and security [17]. The present paper focuses on the calculations of voltage at maximum power point (Vmp) and current at maximum power point (Imp) values by using java framework. The Vmp and Imp calculated by generating random numbers and solving the solar cell equations. The pseudo code for the present tool is given in table 1 and entity relationship diagram (ERD) is shown in fig. 2. Here we consider min. range and max. range 16 values and these values are as follows,

minrang[]={1.3800,1.3800,1.3800,1.3800,1.3800,1.3700,1.3600,1.3800,1.3800,1.3800,1.3900,1.3900,1.3900,1.3900,1.3900,1.3900};

maxrang[]={1.3944,1.3946,1.3954,1.3953,1.3954,1.3887,1.3820,1.3757,1.3954,1.3986,1.4008,1.4024,1.4024,1.4023,1.4023,1.4023};

Table 1: pseudo code of the JAVA framework

Pseudo code	
Step 1: Declare as double variable FF	//FF is Fill Factor value
Step 2: Declare as double variable Voc	//Voc is Open Circuit Voltage
Step 3: Declare as double variable Jsc	//Jsc is Short Circuit Current
Step 4: Declare as double variable Vmp	//Vmp is Voltage at Maximum point
Step 5: Declare as double variable Imp	//Imp is Current at Maximum point
Step 6: Declare an integer variable index	//index is for storing index value
Step 7: Initialise index to zero	//Assigning zero to index
Step 8: Declare as double array variable minrange	//minrange is array of size 16 which is // used for storing minimum values within a range
Step9: Declare as double array variable maxrange	//maxrange is array of size 16 which is used for storing maximum values within a range
Step 10:Random rno=new Random( )	//Creation of Random class object i.e. rno
Step 11: For loop_counter = 0 to 16 step 1	//Increment the counter by 1
Read value FF	//Read value of Fill Factor
Read value Voc	//Read value of Open Circuit Voltage
Read value Jsc	//Read value of Short Circuit Current
Step 12 : Declare as double variable rang	//rang is for storing the Minimum and //Maximum range values
Step 13: Declare as double variable scale	//scale is for storing randomly generated // value within a range

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Step 14: Declare as double variable rvmp //rvmp is Random value for vmp

Step 15 : Set range maxrange[index] to minrange[index] //Minimum range values are stored in minrange array and

// Maximum Range values are stored in maxrang array

Set scale=rno.nextDouble( )*rang // scale stores randomly generated value

// within a range of minrange to maxrange

Set rvmp=scaled +minrange[index] //Calculation of random number for Vmp

Assign Vmp=rvmp value //Assigning randomly generated value

//to Vmp

Print Vmp value

Imp=(FF*Voc*Jsc)/Vmp //Calculation of Imp value by using

//ramdomly generated Vmp value.For

//this we use formula of Fill Factor is

//FF=Vmp*Imp/Jsc*Voc

Print Imp value

Step 16: Increment index=index + 1 //increment index by 1

Step 11: End For

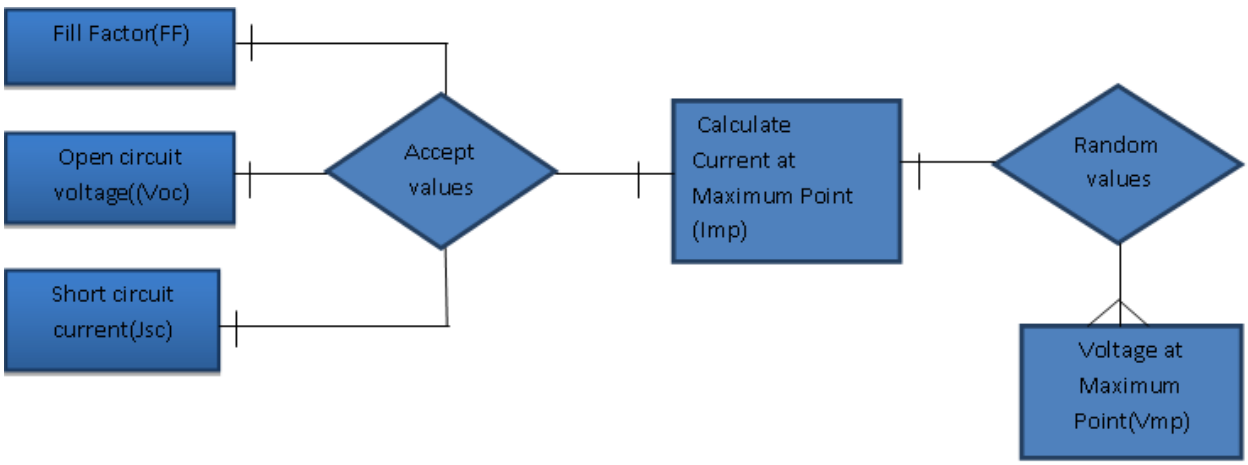

Fig. 2: Entity relationship diagram (ERD)

III. GRAPHICAL USER INTERFACE

For the development of graphical user interface we have used eclipse IDE (Integrated Development Environment). Eclipse is a open source Integrated Development Environment. It offers superior java development environment as well as it provides a different types of facilities like error highlighting with no need to recompile project, code assist, Refactoring etc. It runs on different operating system platforms like windows, Linux, MAC OSX etc. For Backend we use SQL (Structural Query Language) database. SQL is a standard

IJARSE
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language for managing, storing data in Relational Database Management System (RDBMS). Figure 3 represents the graphical user interface of proposed solution.

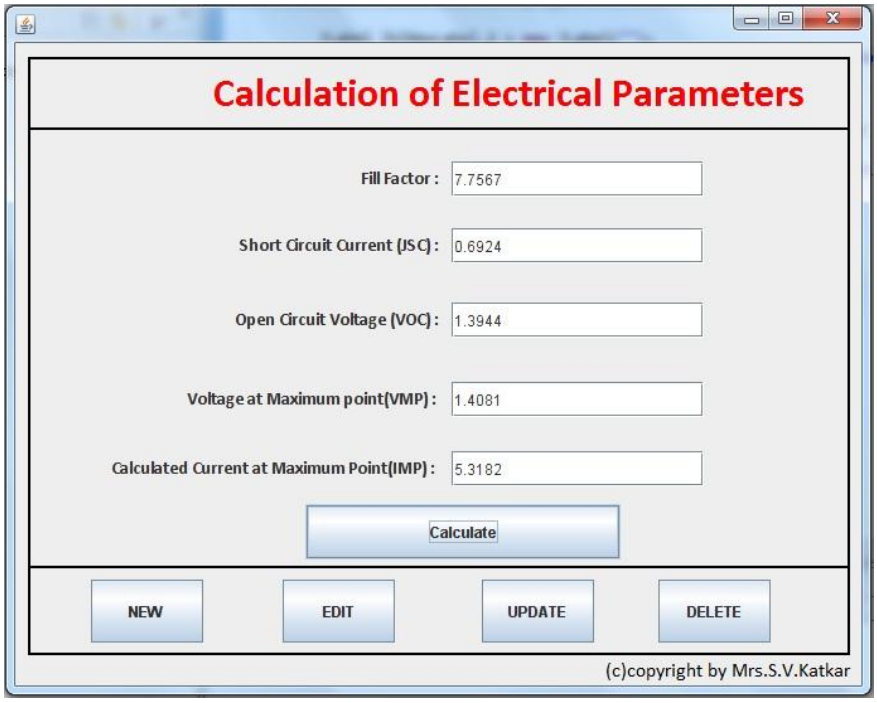

Fig. 3: Graphical User Interface of proposed system

IV. RESULTS AND DISCUSSIONS

The output generated by program is shown in table 2. For the present investigation we have used three input values i.e fill factor (FF), short circuit current (Jsc), and open circuit voltage (Voc) and calculated the unknown Vmp (V) and Imp (mA/cm^2) values using random number generation and java programming. The calculated values are closely matches with the results reported in the reference [14]. The results suggested that the java programming will be useful for the solar cell research.

Table 2: Results obtained from the developed JAVA framework

Short Circuit Current (mA/cm^2) [14]	Open Circuit Voltage (V) [14]	Fill Factor (FF) [14]	Vmp (V)	Imp (mA/cm^2)
7.7567	1.3944	0.6924	1.3943	5.3708
7.9065	1.3946	0.6924	1.3896	5.4937
8.0540	1.3954	0.6925	1.3930	5.5866
8.0445	1.3953	0.6925	1.3939	5.5760
8.0540	1.3954	0.6925	1.3873	5.9483
4.9121	1.3887	0.6920	1.3793	3.4225
3.4676	1.3820	0.6916	1.3614	2.4343
2.6244	1.3757	0.6912	1.3784	1.8103

IJARSE
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8.0540	1.3954	0.6925	1.3812	5.6345
9.2982	1.3986	0.6925	1.3839	6.5072
10.1857	1.4008	0.6928	1.3923	7.0993
10.8707	1.4024	0.6929	1.3931	7.5823
10.8707	1.4024	0.6929	1.3994	7.5483
10.8627	1.4023	0.6929	1.4013	7.5317
10.8624	1.4023	0.6929	1.4013	7.5318
10.8626	1.4023	0.6929	1.3943	7.5698

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