Chapter 22
Data Visualization Strategies for Computer Simulation in Bioelectromagnetics

Akram Gasmelseed
Qassim University, Saudi Arabia

Ali H. Alharbi
Qassim University, Saudi Arabia

ABSTRACT

Bioelectromagnetics is a branch of science that examines how living organisms interact with electromagnetic fields. In a broader sense, it is a discipline that spans the fields of signal processing, electromagnetics, medical imaging, physiology, medical physics, anatomy, occupational and environmental health, behavioral, and computer sciences. Due to its provision of interactive and flexible programming environment, this chapter describes a LabVIEW-based data visualization system that has been implemented and used in bioelectromagnetics simulations. The graphical nature of the LabVIEW programming environment makes it very easy to create a sophisticated application in a minimum amount of time, especially when compared to designing graphical user interfaces in a low-level programming language.

INTRODUCTION

Bioelectromagnetics is a branch of science that examines how living organisms interact with electromagnetic fields. In a broader sense, it is a discipline that spans the fields of signal processing, electromagnetics, medical imaging, physiology, medical physics, anatomy, occupational and environmental health, behavioral, and computer sciences.

Due to its provision of interactive and flexible programming environment, this chapter describes a LabVIEW based data visualization system that has been implemented and used in bioelectromagnetics simulations (Gasmelseed, 2013). The graphical nature of the LabVIEW programming environment makes it very easy to create a sophisticated application in a minimum amount of time, especially when compared to designing graphical user interfaces in a low-level programming language.

DOI: 10.4018/978-1-5225-7368-5.ch022

BACKGROUND

Bioelectromagnetics

Bioelectromagnetics is the field that depicts the interaction of electromagnetic (EMW) waves with biological systems (Furse et al., 2009). The Common core area of study in bioelectromagnetics includes the study of the interactions between electromagnetic waves and human tissue. Recent advances in computational techniques have made it easier to assess the EMW behavior within the exposed biological tissue model numerically.

Computational techniques are extremely powerful for solving bioelectromagnetic problems and have been successfully employed in the modelling of microwave applicators used in hyperthermia (Polk & Postow, 1995; Maruyama et al., 2006), calculating electromagnetic signal absorption in human body models (Reyhani & Ludwig, 2006), and for dosimetry of mobile handhelds (Lin, 2006).

Laboratory Virtual Instrument Engineering Workbench (LabVIEW)

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a National Instruments program development application (http://www.ni.com/labview/) with computational capabilities (e.g. analysis, visualization) similar to those found in C, Fortran or Matlab development systems (Samsi et al., 2010). LabVIEW is different from those applications in one important respect: other programming systems use text-based languages to create lines of code, while LabVIEW uses a graphical programming language called 'G' to create programs in block diagram form (Kalkman, 1995; Olansen & Rosow, 2001). LabVIEW also has extensive libraries of functions and subroutines for most programming tasks such as data analysis, data presentation, and data storage. LabVIEW includes conventional program development tools, allowing the user to set breakpoints, animate program execution to see how data passes through the program and single-step through the program to make debugging and program development easier. Graphical programming is based on the concept of data flow, in contrast to the sequential logic of most text-based programming languages. This means that execution of a block or graphical component is dependent on the flow of data, or, more specifically, a block executes when data are made available at all of the block's input and output data are sent to all other connected blocks.

LabVIEW is a multithreaded programming language, so that specific operations within a single application can be subdivided into individual threads, each of which can theoratically run in parallel. For example, the block diagrams in LabVIEW are parallel programs. The LabVIEW compiler automatically breaks up these parallel programs into multiple threads for the user and passes these threads to the operating system for assignment to multiple processing cores. In comparison, text-based languages are sequential, that is, the code is basically run line by line.

Moreover, researchers in the field of bioelectromagnetics prefer to integrate C subroutines into MATLAB or Simulink code in order to speed-up their execution (Laakso & Hirata, 2012; Quinto et al., 2011). Integrating C subroutines with MATLAB or with Simulink is a difficult task and demands knowledge of the MATLAB MEX interface or the Simnulink S-function interface. On the other hand, in LabVIEW, C subroutine can be integrated using the code interface nodes (CINs) (Johnson, 1998). LabVIEW will create the prototype function headers and linking references, easing the insertion of the required C subroutine.