Project: Visualizing Complex Functions
Date(s): October 1 2012
Prepared by: Branden Dundey

Document status: __ Draft __ Proposed __ Validated _x_ Approved

1. Introduction

This document contains the system requirements for the project *Visualizing Complex Functions*. These requirements have been derived from *the website Plotting Functions on a Complex Variable.*

1.1 Purpose of This Document

This document is intended to guide development of the project *Visualizing Complex Functions*. It will go through several stages during the course of the project:

1. **Draft:** The first version, or draft version, is compiled after requirements have been discovered, recorded, classified, and prioritized.
2. **Proposed:** The draft document is then proposed as a potential requirements specification for the project. The proposed document should be reviewed by several parties, who may comment on any requirements and any priorities, either to agree, to disagree, or to identify missing requirements. Readers include end-users, developers, project managers, and any other stakeholders. The document may be amended and reproposed several times before moving to the next stage.
3. **Validated:** Once the various stakeholders have agreed to the requirements in the document, it is considered validated.
4. **Approved:** The validated document is accepted by representatives of each party of stakeholders as an appropriate statement of requirements for the project. The developers then use the requirements document as a guide to implementation and to check the progress of the project as it develops.

1.2 How to Use This Document

We expect that this document will be used by people with different skill sets. This section explains which parts of this document should be reviewed by various types of readers.

Types of Reader

This document's intended readers are the project manager, the designers/programmers, and the evaluators. The most important sections for the project manager are the Product Functions (2.2), General Constraints (2.4) and every section in Specific Requirements (3). The most important section for the designers are the System and Integration Requirements (3.3) and the User Interface Requirements (3.5). For the evaluators, every section should be read.

Technical Background Required
The technical background needed for this document is an understanding of the Java Programming Language, an understanding of Java Applets, and an understanding of website creation.

Overview Sections
Readers who only wish to have an overall understanding of the project should refer to Product Functions (2.2).

Reader-Specific Sections
The System and Integration Requirements (3.3) and the User Interface Requirements (3.5) sections are intended only for the project managers, designers, and the evaluators. This section may therefore be skipped by other readers.

Section Order Dependencies
The sections of this document may be read in any order.

1.3 Scope of the Product
This product will help mathematicians and other programmers use and graph complex functions. By using a web based java applet, users will have no need to download any software as long as they have java installed on their computer. The user will be able to input a function in a text field and by using button based methods. The user will then be able to select patterns, shadings, and other parameters from a list , as well as choose what type of graph they want to draw.

1.4 Business Case for the Product
This product is required for a development project course. This product will help mathematicians and other programmers have an easier understanding of how complex functions work and how they are graphed.

1.5 Overview of the Requirements Document
The most important requirements in this document are to:

- Provide multiple visual representations of user-provided complex functions.
- Web interface that is easy to use.

2. General Description
This section will give the reader an overview of the project, including why it was conceived, what it will do when complete, and the types of people we expect will use it. We also list constraints that were faced during development and assumptions we made about how we would proceed.

This project will be a WWW based application which accepts complex functions and then the user chooses the pattern or shading and other parameters like time and then builds a graphic representation.

2.1 Product Perspective
This project is being developed to aid people who have an interest in mathematics. The main goal is to help visualize complex functions that are difficult to imagine without the aid of technology. The primary stakeholders for this product are people with math majors who will rely on this tool, and professors who may use this tool in assistance with teaching. A team of three senior level undergraduate students are developing this product who hope that students with math majors will find it easier to visualize complex functions by using this product.

2.2 Product Functions
Our product will be able to provide multiple visual representations of user-provided complex functions. The main functions of our product will be to:
- Provide a 2D visualization of a function
- Provide a sample function list for the user to select predetermined functions
- Have the ability to have user input
- Be able to draw the complex function with a color map
- Have the ability to save any pictures generated
- Host the project on a website

If time and resources permit, these additional features will be included:
- Providing a 3D visualization of a function
- Including a time parameter to make animations
- Saving the animation in a GIF format

2.3 User Characteristics
We expect users that are in the field of mathematics or programming to use this product. By being able to simulate and visualize a complex function, this topic will become easier to understand and easier to use in a real world scenario. The product will be aimed for a target audience that has an understanding of higher level calculus and the desire to educate themselves or others in this field.

2.4 General Constraints
No budget
Project needs to be finished by the Design Showcase in April

2.5 Assumptions and Dependencies
No known assumptions were made.

3. Specific Requirements

This section of the document lists specific requirements for the project Visualizing Complex Functions. Requirements are divided into the following sections:
1. User requirements. These are requirements written from the point of view of end users, usually expressed in narrative form.
2. Reporting requirements.
3. System and Integration requirements. These are detailed specifications describing the functions the system must be capable of doing.
4. Security Requirements
5. User Interface requirements. These are requirements about the user interface, which may be expressed as a list, as a narrative, or as images of screen mock-ups.

3.1 User Requirements
- Easily accessible and easy to understand
- Intuitive Interface
- Help Menu
- Tutorial
- Visualizations should be correct
- Clear Instructions
- Normalized color mappings
- Errors will be handled correctly

3.2 Reporting Requirements
- 6 Milestones will be met throughout a year.
- Each Milestone will have a small presentation explaining what was accomplished.
- The project will be finished in May 2013
- The project will represent our knowledge of software engineering and computer science

3.3 System and Integration Requirements
The program shall have these features:
- Input field
  - Handles errors effectively
  - Reads string as a series of tokens
  - Buttons will add to the string
- Sample functions
  - List of small, medium and large functions. Functions will not be specifically labeled as small, medium, or large, but this will be an estimate for our sample functions.
    - $w = 1/z$ qualifies as a small length function
    - $w = \log (\sin(z) / \cos (z))$ qualifies as a medium length function
    - $w = 2(z+1)^{(1/2)}+ \log \{[(z+1)^{(1/2)}-1] / [(z+1)^{(1/2)}+1]\}$ qualifies as a long length function
- Color schemes and mappings

- ○ Every function should have the same options for color schemes
- Menu
- Tutorial
  - ○ Explains how to enter functions and what to expect as a result
  - ○ Will be under help menu at the top of the page
  - ○ Will have a small paragraph explaining the program. Extra help will be located under the help menu
- Intuitive interface
  - ○ All buttons will be easily identified with a name
- Working program that handles complex functions
  - ○ Handles imaginary numbers
  - ○ Correctly uses the z variable
    - ■ Uses real part of Z
    - ■ Uses imaginary part of Z
    - ■ Modulus of Z
    - ■ Utilizes the complex conjugate of Z
  - ○ Cartesian Plane that represents the real and imaginary axis
- The programming language will be Java
- Deploy-able on a website
  - ○ The Java applet will be embedded within the website. No external windows will open.
- Compatible with all major browsers.
  - ○ Internet Explorer, Google Chrome, Mozilla Firefox, Safari
- Animations with a time parameter if time and resources allow.
- 3D imaging if time and resources allow.

3.4 Security Requirements

The project will not introduce any new security flaws that are not already present in Java or HTML5

3.5 User Interface Requirements

The interface shall have these features:
- Windows
  - ○ Sample Functions
  - ○ Graphs
  - ○ Shadings/Color Schemes

4. High-Level Technology Architecture

This product will be a web-based java applet.

5. Customer Support

A User Manual and a demonstration video will be included for assistance. No other customer support will be provided.

6. Appendices

This project originated from Part 1 of:
http://cs.fit.edu/~pkc/classes/seniorProjects/opportunities/
TwoMathEducationProjects.pdf

A sample project that was the inspiration of our project was from:
http://my.fit.edu/~gabdo/function.html

7. Glossary

Imaginary number
    The real multiple of i.

Complex number
    A number of the form $a + bi$, where a and b are real numbers

Complex plane
    A Cartesian representation of complex numbers

z
    A representation of a complex number as a vector on the complex plane.

Real part of z (Re(z))
    x coordinate of z

Imaginary part of z (Im(z))
    y coordinate of z

Real axis
    Set of real numbers (usually horizontal axis on the complex plane)

Imaginary axis
    Set of imaginary numbers (usually vertical axis on the complex plane)

Modulus of z (|z|)
    Length r of z.

Argument of z (arg(z))
    Angle θ of z

Complex conjugate of z (z bar)
    Reflection of z in the real axis

Complex function
>A function involving complex numbers instead of real numbers

8. References

Java Application *Bombelli*
http://www.dmat.ufpe.br/~ssc/bombelli/

Website - Plotting Functions of a Complex Variable
http://my.fit.edu/~gabdo/function.html

Book - *Visual Complex Analysis*
Tristan Needhm, *Visual Complex Analysis.* Oxford University Press, 1999

Various sample applets that help map complex functions
http://www.math.ucla.edu/~tao/java/index2.html