Firefly UI Software Specification

Lukas Gemar, Paul Wells, Graham Dempsey, Kit Werley, Adam Cohen
Q-state Biosciences

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Abstract

This document's purpose is to serve as a meeting place for discussion of the second version of the Firefly's user interface (UI). The specification here should separate itself from the hardware implementation of the microscope and tie itself more closely to the user experience. The user thinks in terms stimulus patterns, cells, and their electrical waveforms, so the initial discussion will involve an abstract specification of the experimental configuration that allows the user to experience the Firefly as a biological oscilloscope and function generator. The second part of the document will include a more in depth exploration of the parameter space and investigate how to abstractly and concretely represent the configuration of a particular experiment. The conclusions drawn here will shape both the user experience and how the front-end interface interacts with the underlying control system.

1 Paradigm: Firefly as a Biological Function Generator and Oscilloscope

1.1 Region Selection

Each region will be contained within the current field of view. There will be three ways to define regions:

- Choose a preset region.
- Define a custom region by clicking on the current field of view.
- Use a segmentation algorithm to generate regions.

1.1.1 Preset Regions and Patterns

Preset regions will include the full field of view and user generated masks.

1.1.2 User-Defined and Algorithmically-Segmented Regions

The user will either click on the field of view to select a region or run a segmentation algorithm. The user will be able to perform the following operations on a region once it has been placed in a field of view:

- Resize
- Reshape
- Drag around the field of view
- Delete

1.1.3 Regions as Sources and Probes

Each region abstractly represents a part of a circuit accessible to a signal generator or oscilloscope probe. A user designates a region as a Stimulus Region, Record Region, or both.

1.2 Stimulus Pattern Generation

For each region designated as a Stimulus Region, the user can specify a pattern of stimulation. The user specifies stimulus patterns by selecting among predefined stimulus waveforms.

1.3 Electrical Waveform Monitor

For each region designated as a Record Region, the user can specify an algorithm for live analysis and monitoring. The user specifies the monitor algorithm by selecting among predefined options.

2 Implementation: Firefly UI Parameter Space and Experimental Configuration

2.1 Sample Selection

A single plate may hold one or more samples. An index i specifies which sample is currently in view and n is the number of samples.

2.1.1 Plate Geometry

The user will select the plate geometry, specifying the number of samples n.

2.1.2 Automation

The user or an automated program can select sample i for viewing.

2.2 Field of View Selection

Once a sample is selected, the position of the field of view within the sample is specified by an (x, y, z) coordinate.

2.3 Spatial Pattern Generation

These spatial patterns are analogous to the "regions" described in the Paradigm section above.

2.3.1 Statically Built Patterns

These are two dimensional masks in the coordinate space of the camera. The simplest such pattern will be the full field of view of the camera. The user will have the option of uploading the masks in camera or DMD coordinates, but the internal representation will be in camera coordinates and the user will visualize these spatial patterns overlaid on the current field of view.

2.3.2 Dynamically Built Patterns

These are patterns specified by clicking around a region or a segmentation algorithm at run-time. Each of these dynamically selected patterns can be manipulated in the following ways:

- Resize
- Reshape
- Drag around the field of view
- Delete

2.4 Temporal Pattern Generation

2.4.1 Static Patterns

Static patterns are created by a user before run-time of the program.

Pattern Upload A user will upload a pattern in a standard format such as a text file. The user will also give the pattern a name at this time for easy reference later.

Pattern Visualization After a user uploads the pattern, there will be an interface for viewing the uploaded waveform to determine that the waveform is correct.

2.4.2 Dynamic Patterns

A user will create some temporal patterns in real time. These patterns are generated by user input: toggling a switch on and off to create a digital waveform in real time or entering a float in a text box to change an analog value.

2.5 Device / Monitor Panel

There will be a panel onto which a user can drag and drop Devices and Monitors. The panel will then show a configuration window for each Device and Monitor.

2.5.1 Devices

Each device will have a name, set of parameters, and input channels. This will allow for the addition of new wavelengths, filters, etc.

2.5.2 Monitors

Each monitor is specified by the algorithm it applies the stream of data that arrives on its input channel. Monitors will implement analysis algorithms for generating real-time data visualizations.

2.6 I/O Configuration

2.6.1 Mapping Output Channels to Devices

The user will create a mapping between control channels to Device input channels.

2.6.2 Mapping Input Channels to Monitors

The user will create a mapping between sampling channels and Monitor input channels.

2.6.3 Mapping Input and Output Channels to Temporal Patterns

The user will have the freedom to create arbitrary mappings between control and sampling channels and temporal waveforms. This will accommodate temporal control of new pieces of hardware and sampling of new kinds of data from detectors.