Utilizing PyQt to create GUIs for Laboratory Use

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Outline

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- What is a GUI?
- Introduction to PyQt
- Widgets
- Threads
- Signals and Slots
- Serial Communication
- QtDesigner
- Two Tanks Experiment
- Two Tanks GUI
- Conclusion

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What is a GUI?

- Graphical user interface (GUI): a user interface that allows users to interact with electronic devices through graphical icons and visual indicators [5]
- Actions are performed through direct manipulation of the graphical elements in the user interface (known as widgets)
- Introduced originally as a way of making computers easier to use
- Used in many devices today: computers, smartphones, gaming devices, etc.

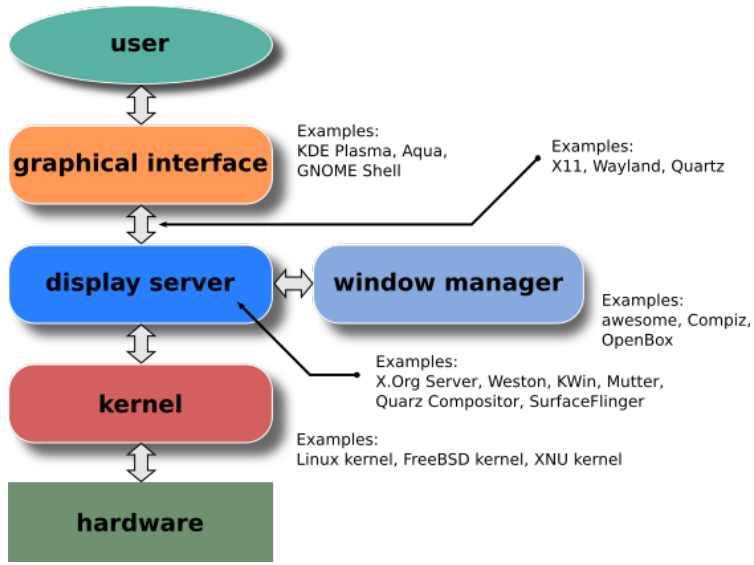


Figure: Components of a GUI [5]

Introduction to PyQt

- PyQt: a Python binding for the Qt Company's Qt application (a cross platform software development kit) [4]
- Supported on all platforms under the GNU GPL v3 and Riverbank commercial license
- GUI toolkit that includes other things such as threads, regular expressions, SQL databases, etc.
- Combines all the advantages of Qt and Python together [4]

Figure: [7]

Widgets

- Widget: an element of interaction in a GUI such as a button or a scroll bar [6]
- Facilitates a specific type of interaction and is a visible part of an application's GUI
- Pre-programmed widgets in PyQt make it easier to create GUIs
- Examples in PyQt: `QPushButton`, `QCheckBox`, `QSlider`, `QMenuBar`, etc.

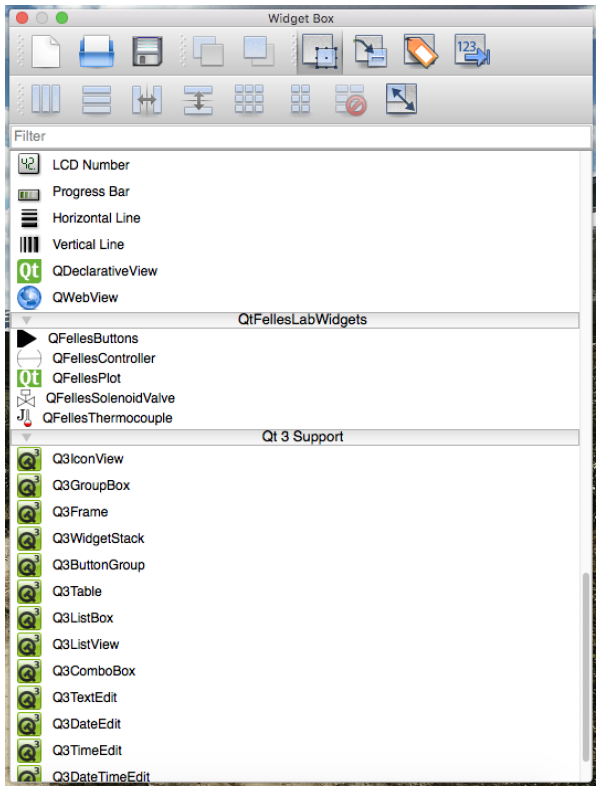
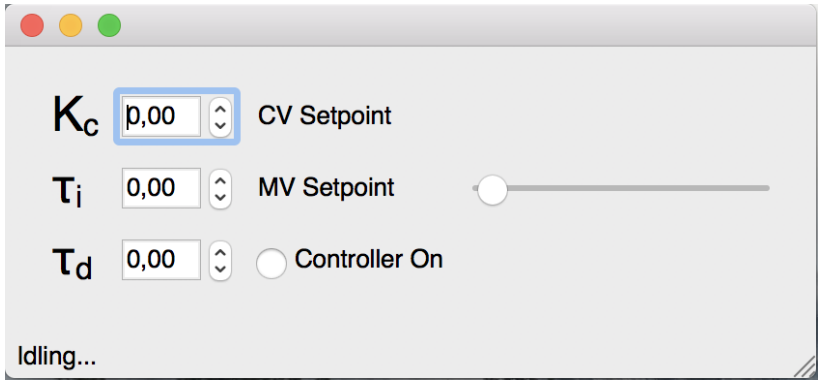


Figure: Illustration of some built in and custom widgets in PyQt

Widget Example

- PID Controller Settings Widget: custom widget designed using PyQt



Threads

- Thread (GUI/main thread): handles users requests and serves as an event loop
- Can have multiple threads; one is a main thread and all others are worker threads
- Main thread should always be available to handle user requests
- Main thread passes off time consuming actions to worker threads
- Worker threads perform behind the scene tasks: data collection, communication, calculations, etc.

Signals and Slots

- Signal: emitted whenever a particular event is triggered
- Slot: a function that is called in response to a specific signal
- Signals and slots are used for communication between objects [2]
- Unique mechanism to Qt and one of its central features

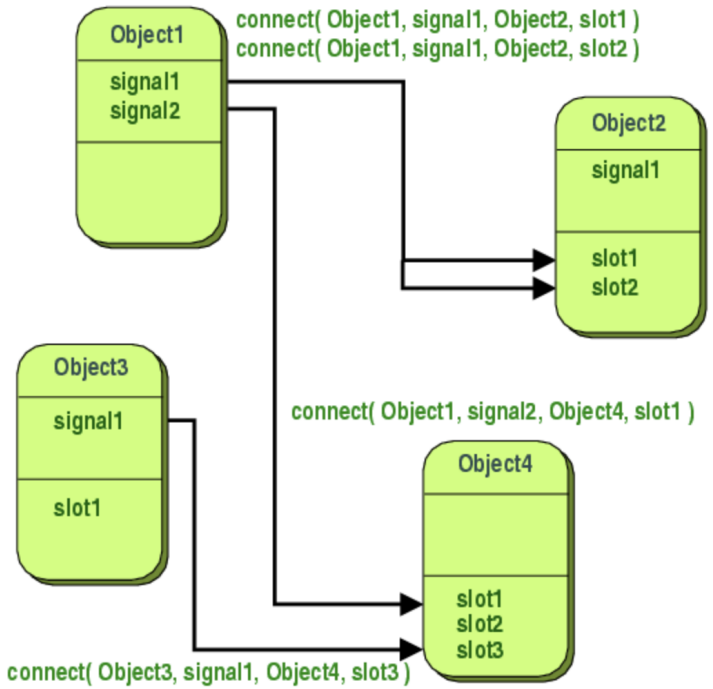


Figure: Illustration of slot and signals [2]

Communication

- PyQt does NOT offer built in hardware communication utilities; gaps can be covered by Python modules though
- Communication with sensors can be done: `pyserial` and `minimalmodbus`
- `pySerial` [3]: provides backends for Python running most platforms allowing for serial port communication
- `minimalmodbus` [1]: Modbus implementation for Python (supports Modbus RTU and ASCII)
  - Modbus is a communication protocol that works for many different instrument types; the instrument is typically connected via a serial port
  - Several types of Modbus protocols: Modbus RTU (binary representation of data), Modbus ASCII (ASCII representation of the data), and Modbus TCP (communication over TCP/IP networks)

QtDesigner

- QtDesigner: Qt tool for designing graphical user interfaces using drag and drop widgets
- Connect signals and slots visually
- Good for users who are less familiar with coding
- Custom widgets can be loaded into QtDesigner and utilized like any other pre-programmed widget
- Integrates with programmed code
- Can convert QtDesigner files to Python code

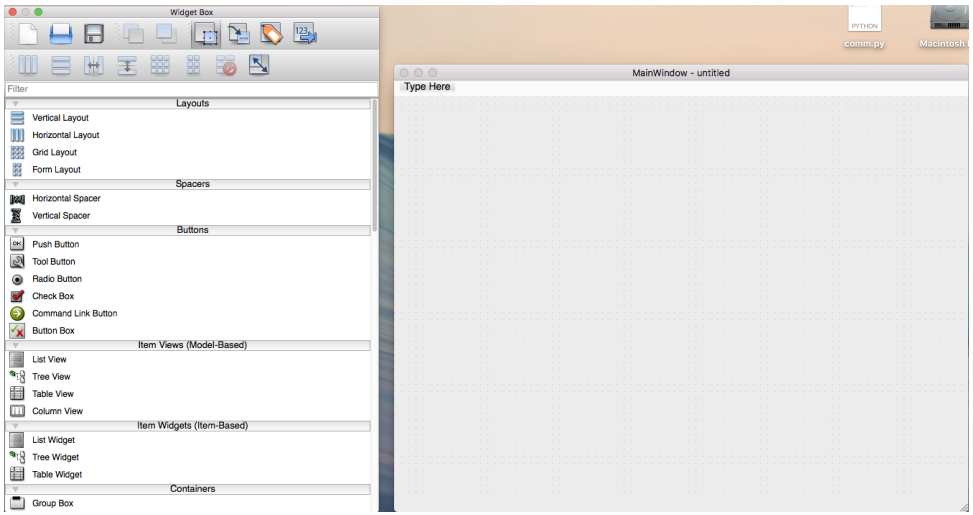


Figure: QtDesigner Interface

Two Tanks Experiment

- Fill tanks with room temperature water and heat each tank
- Outlet streams combine to formed one mixed stream
- Control the outlet flow rate of each tank using the solenoid valves to get the mixed stream to reach a desired temperature

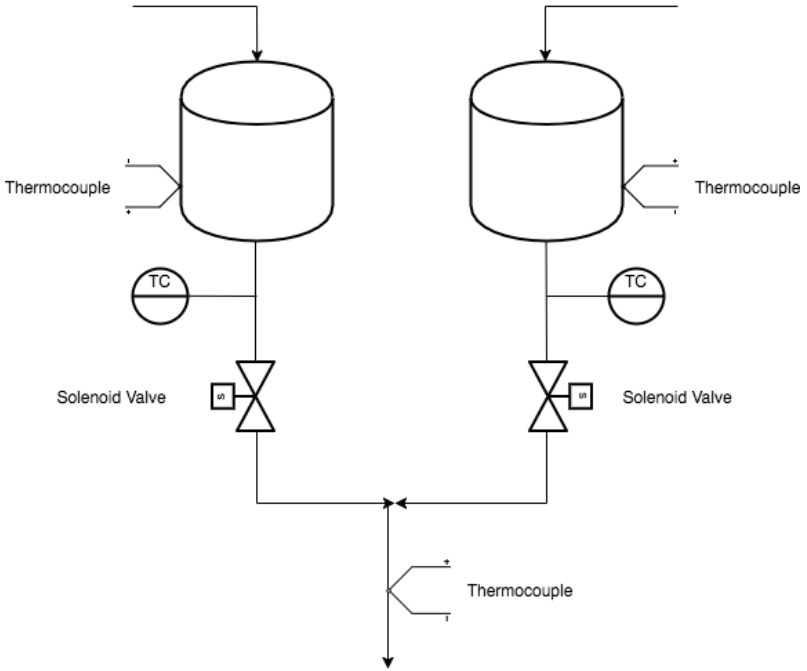


Figure: Sketch of the experiment

Two Tanks GUI

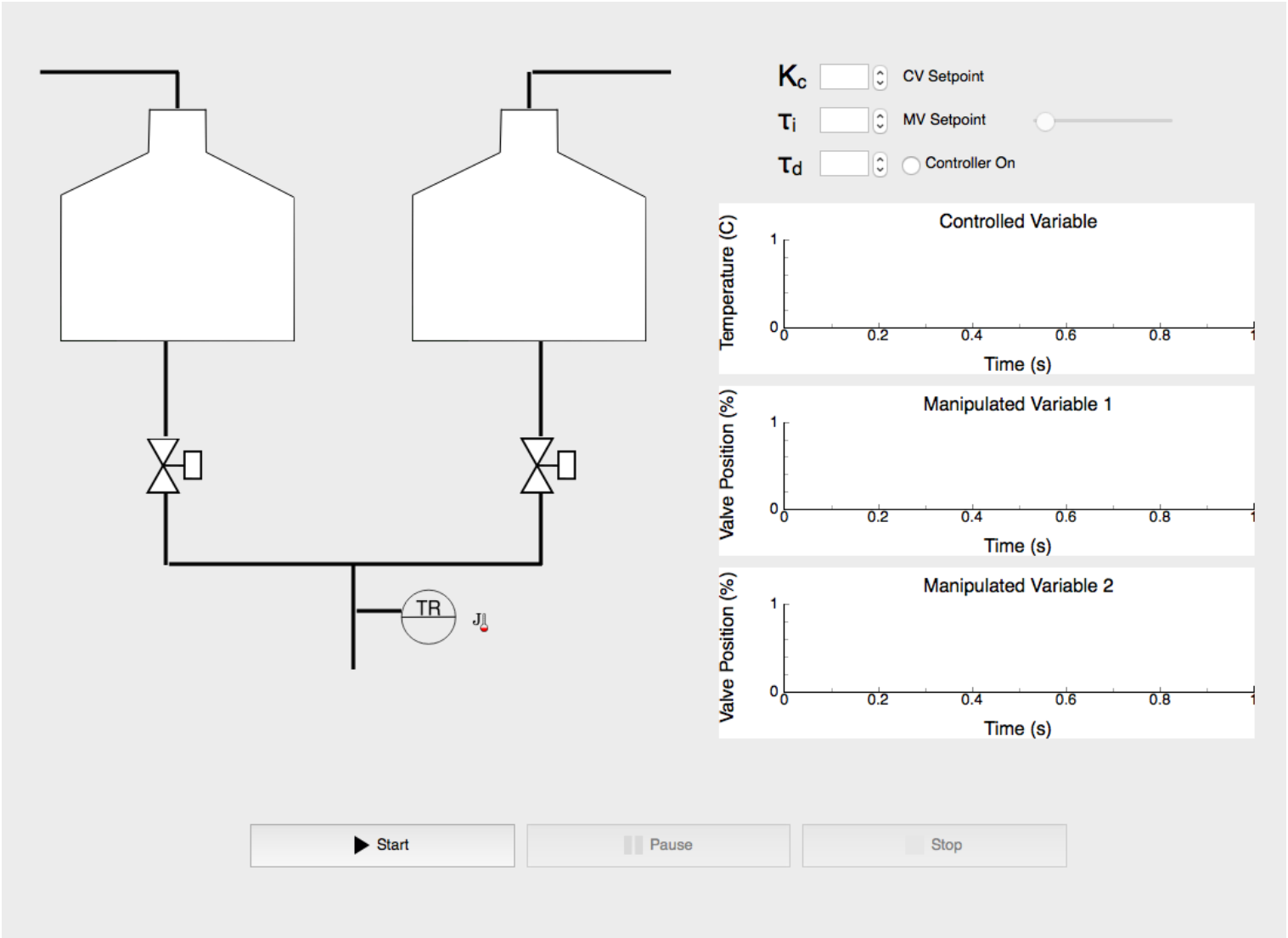


Figure: Two tanks GUI Mockup

QtDesigner + Two Tanks Example

- Load custom widgets

```
1  export PYTHONPATH=``\${HOME}/lib/python2.7/site-packages"
2  export PYQTDESIGNERPATH=``\${PYTHONPATH}/felleslab/qt_plugins"
3  open -a designer
```

- Drag and drop pre-programmed widgets
- Connect signals and slots

Conclusion

- PyQt was not designed to replace LabView but can be made to work as a replacement
- Requires coding experience
- Can create custom widgets to be used in other GUIs
- Lots of examples available online

References

- Jonas Berg. *MinimalModbus*. URL: https://minimalmodbus.readthedocs.io/en/master/ (visited on 12/04/2017).
- The Qt Company. *Signals and Slots*. URL: http://doc.qt.io/qt-4.8/signalsandslots.html (visited on 12/04/2017).
- Chris Liechti. *pySerial*. URL: https://pythonhosted.org/pyserial/ (visited on 12/04/2017).
- Riverbank Computing Limited. *What is PyQt?*. URL: https://riverbankcomputing.com/software/pyqt/intro (visited on 12/04/2017).
- Wikipedia. *Graphical user interface*. URL: https://en.wikipedia.org/wiki/Graphical_user_interface (visited on 12/04/2017).
- Wikipedia. *Widgets*. URL: https://en.wikipedia.org/wiki/Widget_(GUI) (visited on 12/04/2017).