INTRODUCTION TO DESIGN AUTOMATION

Lecture 3.
GUI Programming with Qt4

Prof. Guoyong Shi
shiguoyong@ic.sjtu.edu.cn
School of Microelectronics
Shanghai Jiao Tong University
2013 - 2015

Outline

- Qt4 programming basics
- Beginner’s tutorial
- Qwt

- Qt programming excercise

Another open source GUI toolbkt is “Gtk”. You may find the references on the Internet.

About Qt

- Qt is a language for developing cross-platform GUI applications.

- Qt is C++.
- Qt is successful because programmers like it
- The latest release is “Qt4”
- Qt is publicly available

About Qt

- Qt was made publicly available in 1995

- Qt was initially developed by two graduate students
  - Haavard Nord (Trolltech CEO) and
  - Eirik Chambe-Eng (Trolltech President),
- both graduated from Norwegian Institute of Technology in Computer Science

A Brief History of Qt

- In 1988 Haavard was commissioned by a Swedish company to develop a C++ GUI framework.
- In the summer of 1990, Haavard and Eirik were working together on a C++ database application for ultrasound images.
  - The GUI system was required to run on Unix, Macintosh, and Windows.

- They decided to develop an object-oriented cross-platform GUI framework..

History of Qt (cont'd)

- In 1991, Haavard and Eirik started writing the classes that eventually became Qt.
- In 1992, Eirik came up with the idea for "signals and slots", a simple but powerful GUI programming paradigm that has now been embraced by several other toolkits.
- By 1993, Haavard and Eirik had developed Qt's first graphics kernel and implemented their own widgets.
- At the end of the year, Haavard suggested that they start business together to build "the world's best C++ GUI framework".

-- From "A Brief Histroy of Qt"
Jasmin Blanchetter and Mark Summerfield, C++ GUI Programming with Qt 4, Prentice Hall, 2006.

About Qt

- The name of “Qt” was inspired by Xt, the X Toolkit, with 't‘ standing for "toolkit",.
- All Qt classes are prefixed by the letter “Q”, because the letter looked beautiful in Haavard's Emacs font.
- The company was incorporated on March 4, 1994, originally as Quasar Technologies, then as Troll Tech, and later as Trolltech.
- On June 6, 2008, Nokia acquired Trolltech by paying about $150 millions.

Qt Licenses

- Qt provides two licenses from day one:
  - A commercial license for commercial development, and
  - a free software edition for open source development.

- Qt 3.0 was released in 2001.

- Qtopia Core won the LinuxWorld "Best Embedded Linux Solution" award in both 2001 and 2002,
- and Qtopia Phone achieved the same distinction in 2004.

Qt4

- Qt 4.0 was released in the summer of 2005.
- With about 500 classes and more than 9000 functions
  - efficient and easy-to-use template containers,
  - advanced model/view functionality,
  - a fast and flexible 2D painting framework, and
  - powerful Unicode text viewing and editing classes.

- Qt 4 is the first Qt edition for both commercial and open source development on all the platforms it supports.

Qt is popular today

- Qt is very popular today.
- This success is a reflection both of the quality of Qt and of how enjoyable it is to use.
- In the last decade, Qt has gone from a product being used by only a few to one that is used daily by thousands of customers and tens of thousands of open source developers all around the world.

Qt4 in CYGWIN

- Qt4 currently has been included in the latest CYGWIN release.

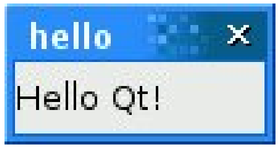
- To run the qtdemo:
  - Start X-server
  - run in CYGWIN at any directory: $ qtdemo &

Install Qt4-Win

- Download Qt4-Win release from http://trolltech.com/downloads
- Unpack the archive (this release has <qt_windows.h>)
- Type the following in a Windows console
  - configure
  - nmake
- The Qt4-Win release was installed on my XP machine successfully (after compiling the source code for about 4-5 hours).

Hello Qt !

```
#include <QApplication>
#include <QLabel>
int main(int argc, char *argv[])
{
    QApplication app(argc, argv);
    QLabel *label = new QLabel("Hello Qt!");
     label->show();
     return app.exec();
}
```



```
Hello Qt!
```

- Save the source code to “hello.cpp” in a directory called “hello”.
- Type the following:
- cd hello
- qmake －project (generates “hello.pro”)
- qmake hello.pro (generates “Makefile”)
- make (use nmake if running on Windows)

Qt is easy to learn

- Qt is consistent and fully object-oriented in the construction and use of widgets.
- Qt carefully chooses names for functions, parameters, enums, and so on.
- Qt signal/slot connections and layouts are easy to learn.
- Qt new widgets are easy to learn and use.

Command Line Compile

- qmake −project (generates "hello.pro", platform-independent)
- qmake hello.pro (or simply "qmake" to generate "Makefile")
- make

- You may type all in one line:

- qmake −project && qmake && make (on CYGWIN/LINUX)
- qmake −project && qmake && nmake (on Windows)
- .\debug\hello.exe (to run)

In case ...

- In case your system has “qt3” installed as well, you must use the following “qmake”:
- /lib/qt4/bin/qmake

- You can create a Visual Studio project file from hello.pro by typing:
- qmake –tp vc hello.pro

Hello Qt !

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#include <QApplication>
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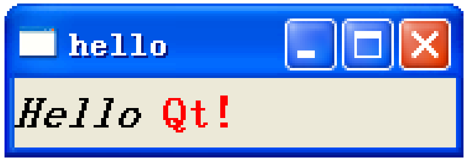


Hello Qt!

Replace

```
QLabel *label = new QLabel("<h2><i>Hello</i> " "<font color=red>Qt!</font></h2>");
```

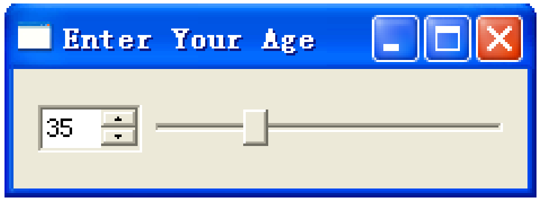
- You may use Marking Language (like in HTML) to set the label fonts.

Qt Designer

- Qt Designer is Qt's visual design tool (just like Microsoft Visual Studio.)
- Using *Qt Designer* is a lot faster than hand-coding
- The Qt Designer comes with the installation of Qt4.

Example of Signal & Slot

```
10      QSpinBox *spinBox = new QSpinBox;
11      QSlider *slider = new QSlider(Qt::Horizontal);
12      spinBox->setRange(0, 130);
13      slider->setRange(0, 130);
14      QObject::connect(spinBox, SIGNAL(valueChanged(int)),
15                       slider, SLOT(setValue(int)));
16      QObject::connect(slider, SIGNAL(valueChanged(int)),
17                       spinBox, SLOT(setValue(int)));
18      spinBox->setValue(35);
```



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- **The two QObject::connect() calls shown in lines 14 to 17 ensure that the spin box and the slider are synchronized (i.e., always showing the same value).**
- **Whenever the value of one widget changes, its valueChanged(int) signal is emitted, and the setValue(int) slot of the other widget is called with the new value.**

Signals and Slots

- You should learn the signals and slots mechanism for Qt programming.
- Signals and slots *bind objects together*.
- Slots are like ordinary C++ member functions.
  - They can be virtual; they can be overloaded; they can be public; protected, or private, they can be directly invoked like any other C++ member functions; and their parameters can be of any types.
- "By *connecting* a signal to a slot" it means that whenever the signal is emitted, the slot is called automatically.

connect( )

- The connect() statement looks like this:
  - connect(sender, SIGNAL(signal), receiver, SLOT(slot));

- sender and receiver are pointers to QObjects,
- signal and slot are function signatures without parameter names.
- The SIGNAL() and SLOT() macros essentially convert their argument to a string.

Connecting signals and slots

- One signal can be connected to many slots.
- Many signals can be connected to the same slot.
- A signal can be connected to another signal.
- Connections can be removed.

- (See Qt4 documentation for more details.)

Qt 2D Graphics

- Qt’s 2D graphics engine is based on the QPainter class.
- QPainter can draw geometric shapes (points, lines, rectangles, ellipses, arcs, chords, pie segments, polygons, and Bezier curves), as well as pixmaps, images, and text.

Qt Modules

- Qt consists of several modules, each lives in its own library.
- Some most important modules are:
  - QtCore
  - QtGui
  - QtNetwork
  - QtOpenGL
  - QtScript
  - QtSql (database)
  - QtSvg (Scalable Vector Graphics)
  - QtXml (XML parser)

QtOpenGL Module

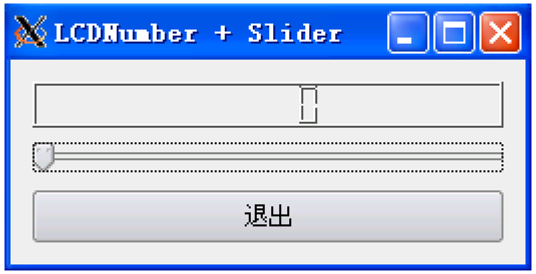
- An alternative to QPainter is to use OpenGL commands.
- OpenGL is a standard library for drawing 3D graphics.
- QtOpenGL module makes it easy to integrate OpenGL code into Qt applications.

Chinese Language

- Qt4 can display Chinese Language.

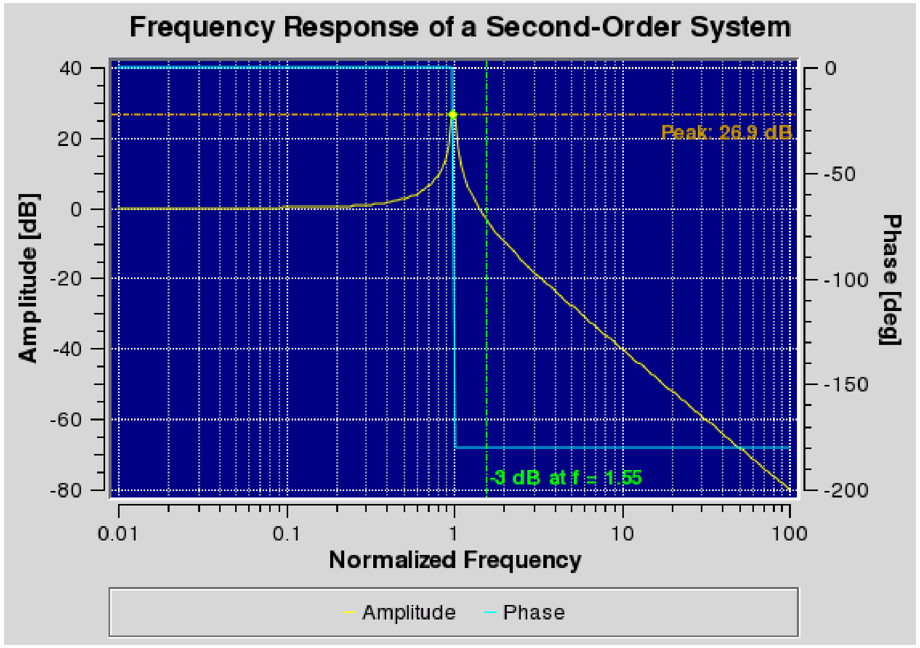
```
#include <QTextCodec.h>
...
int main (...)
{
        QApplication app(argc, argv);
        QTextCodec::setCodecForTr(QTextCodec::codecForName("GB18030"));

        QPushButton *button = new QPushButton(QWidget::tr("退出"));
}
```



Qwt

- Qwt – Qt Widgets for Technical Applications
- The Qwt library provides GUI components for technical plotting.
- Authors: Uwe Rathmann, Josef Wilgen



http://sourceforge.net/projects/qwt

Linking to Qwt

- Qwt is not included in the official Qt package
- Suppose you have your own installation
- Depending on your Qwt installation, add the following lines in the “.pro” file:

- INCLUDEPATH += . /usr/local/qwt-5.2.1/include
- LIBS += -L/usr/local/qwt-5.2.1/lib   -lqwt.dll

- When “Makefile” is generated, the correct paths will be included in the Makefile.

Programming Kick-Off

- How to write professional programs?
  - Divide your project into modules
  - Learn multiple-file programming
  - Learn compile using a "makefile"

  - Start from writing GUI programs ...

Qt Programming Exercise

Use the Qt toolkit, write the following programs:

- Run some Qt examples given in the Qt installation.
- Write a simple GUI window containing
  1. a menu system;
  2. a text editor;
  3. a drawing popup window;
  4. a simple command window.
  5. Learn to use Qwt

  (see the menu example next ...)

Menu Example

In the menu system:

- Use following menu system for your reference.
- Write your program in a way that the menu system is easily modifiable.
- Your menu system will change as your simulator project proceeds.

File	Edit	Tools	Simulate	Window	Help
Open Netlist ...	Delete	Floorplan	Spice	New Window	Help & Support
Save	Undelete	Placement	Digital	Arrange All	About ...
Save As ...	Copy	Route	Mixed-Signal	Cascade	Contact Developer
Exit		Extraction			

More Exercises

- Write Qt program using following widgets:
  1. A text file editor
  2. A pop-up window for drawing geometrical shapes

- Try to put together the Qt GUI examples in a single GUI program, and compile and run.

- Run some Qwt demo programs.

- Show to the class if you have written something exciting ...

Suggestions

- Write code with good habits:
  - Indention;
  - Comments;
  - Modular code;
  - Multiple files

- Learn to write “makefile”
  - Avoid using any automatically generated makefile