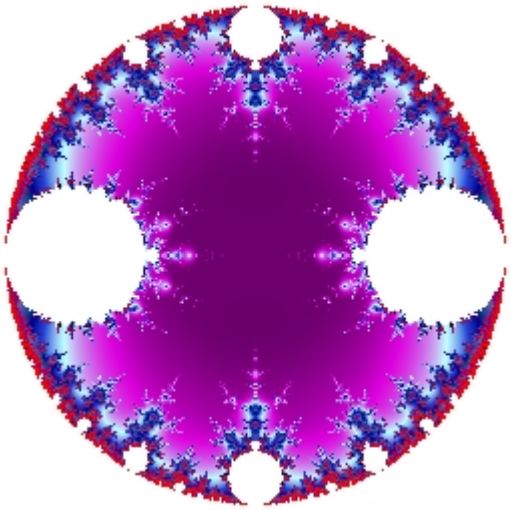
# Mini-Fractals

# Introduction





## Welcome

Greeting !

Have Fun playing with this Toy !

Show it to the Kids !

It just might get them interested in algebra.

The program is a beta, as I am not an OpenGL expert, just an intermediate.
However, I have been developing software for 3 decades now, so the application is fairly robust.

The source code, if in the installer version you used, has been put in your personal folder, might be the User Folder on Windows 7 and Vista, and/or the My Documents Folder.



## What's new

What's New? Everything about this application.

It has many added features from the original OpenCL sample it came from.

And many more features than any one sample used in it's creation.

So I guess it is a good contribution to the community.

And it's just too much fun to play with ...



## About

This Code sample application was originally a R+D project to explore GPU programming, with Fractals in

mind. The code will eventually find it's way into the 'real' project: Many-Fractals. The application was originally written with glut using OpenCL, and there is a binary executable for that included with some distros.
Email: author@manyfractals.org if you would like the code for the OpenCL sample. I'll try to post that too.

The new, and big item with this OpenGL sample is the GLSL complex (function) library. I hope this will be very helpful to other programmers.
The GLSL language does not allow C++ struct to have operators so as a result only functions for these operators can be written. To handle this, I allow Users of the executable to use operators in a text edit box, and then 'translate' them into these functions. Right now only + , - , * , / are translated. The Boolean functions aren't done yet, but the code is down to just rote repetition for these operators. However, all complex functions are fully available as valid entry in the User Enter Equations/Function, just use [] instead of () ... sorry, cheap translator.



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# Getting Started

Click Make Fractal Button.
Try the different Orbit Functions, clicking Make-Fractals button after each selection.
Try the Julia Check Box with Z^F+C Orbit equation. Click Zoom.
Zoom will put the App in animation mode.
After Clicking Zoom, move the mouse pointer over the image window and move it around.
Click the left mouse button to Zoom in.
Click the right mouse button to zoom out.
Double Click toggles Zoom Function.

The App uses 8 decimal digit float point numbers, so one can't magnify in very deep, but the App can make the images fast, especially User Entered Equations, as the code is fully compiled and optimized by the GLSL compiler.

The app is designed to be the most bang for the byte, and show off lot of good code examples.



## System requirements

It's hard to say the exact requirements.
The App works on ati 4670, but with strange graphic glitches, your mileage may vary.
I think it will work fine on ati 4700 series and above just fine.
It does work fine on ati 5450, and likely will on all ati 5000 series GPUs.
I think the same era nVidia's will show the same results, other than weird bugs.
The App was developed on AMD A10-5700 with ati 7660D GPU (384 shaders).
I would say, if the machine is a single core CPU, don't bother trying it.



## GLSL shader Language

See the included GLSL PDFs included with the code.

Basically, it codes just like C code, but with reduced function set.
Remember to end each statement with a semi-colon !!

Here are the links to them at OpenGL.org, if you don't have them :

http://www.opengl.org/documentation/glsl/



## User Equations

The User Entered Equation/Functions are entered in a two line high Edit Box just above the debug/info output box on the bottom of the main window.

The Code entered there is almost pure GLSL, but which version can vary. I've written it for #version 330 , 3.30
The big difference is with parenthesis '(' and ')' ... which in the language (and C/C++) has more than one use. For our User Equations, they only mean the algebraic use. Use Square brackets for all other use. Therefore to call the sine of a number use: sin[...]
The shader file has quite a few coding helpers built into it. The most helpful for our Fractal context is the Complex Functions and variables.
The Complex type is a C struct. It's members are r for real and i for imaginary.
The editor allows for addition, subtraction, multiplication and division to be written algebraically, although the GLSL language has no operators. This is done by translating the edit box code into Complex Number Functions: ADD, SUB, MUL and DIV. The last thing the translator does is translate all square brackets to parenthesis. In the translation the original parenthesis are removed. However, any original square bracket are retained and replaced with () ... so it all works out, if you simply just use [] for all non-algebraic () use.

The Complex number functions available are as follows:

re[] returns the real component
im[] returns the imaginary component
ir[] returns Complex(i,r)
abs[] absolute of complex
norm[]
arg[]
sgn[]
rec[]
pol[]
NEG[] - operator
COMPLIMENT[] ~ operator
ADD[] + operator translated for you
SUB[a,b] a - b operator translated for you
MUL[] * operator translated for you
DIV[a,b] a / b operator translated for you
pow[a,b] a^b
sqrt[]
ISEQU[a,b] is equal == operator
ISNOTEQU[a,b] != operator
ISLESS[a,b] a < b operator
ISMORE[a,b] a > b operator
ISLESSEQU[a,b] a <= b operator
ISMOREEQU[a,b] a >= b operator
exp[]
ln[]
log[] same as ln[]
log10[]
sin[]
cos[]
tan[]
sinh[]
cosh[]
asin[]
acos[]
atan[]
tanh[]
asinh[]
acosh[]
atanh[]

There are helper functions for other variables, like float, but not Complex :
MUL_ADD[a,b,c] which is ( ((a) * (b)) + (c) )
ATAN2[a,b]

hypot[r,i]
fabs[x]

Constants:

| | |
|---|---|
| HALFPI | 1.5707963f |
| LOG10 | 2.3025851f |
| LOG2 | 0.6931472f |
| e | 2.7182818f |
| pi | 3.1415927f |
| DBL_EPSILON | 2.2204460e-8 |

I, J, _I, _J
defined as :

```
I.r =  0.0 ;  I.i = 1.0 ;                  // root of z^2+1 = 0
J.r = -0.5 ;  J.i =0.5*sqrt(3.0) ;         // root of z^2+z+1 = 0
_I = DIV(1.0 , I);
_J = DIV(1.0 , J);
//     J = -0.5 , 0.8660254037844386
//    _J = -0.5 , -0.8660254037844386
//    _i = 0 , -1
//     i = 0 , 1
```

// ToDo: these need Complex-Function counter-parts to have them work with Complex ...

```
#define SWAP(a,b,t) ((t)=(a),(a)=(b),(b)=(t))
#define SIGN(a)  ((a)<0 ? -1 : 1)
#define ABS(a)   ((a)<0 ? -(a) : (a))
#define SQR(a)   ((a)*(a))
#define MIN(a,b) ((a)<(b) ? (a) : (b))
#define MAX(a,b) ((a)<(b) ? (b) : (a))
#define MIN3(a,b,c) ((a)<(b) ? ((a)<(c) ? (a) : (c)) : ((b)<(c) ? (b) : (c)))
#define MAX3(a,b,c) ((a)>(b) ? ((a)>(c) ? (a) : (c)) : ((b)>(c) ? (b) : (c)))
```

// These are Read-Only 'Input' values to the shaders.

```
uniform vec2 param;
uniform int iters;
uniform int ipow_f;    // integer power F for the edit-spin box on control-panel dialog
uniform int OrbitFunc;
uniform bool UseEsmooth;
uniform float floatG;    // our user input floating point value
uniform float fBailout;   // the float of the compare value. Note: norm(ZZ) not ABS(ZZ)
uniform vec2 viewPos;
uniform float viewZoom;
uniform float viewRatio;
uniform float anim;
uniform bool juliaMode;
uniform bool blinkMode;
```

The actual code of the User Equation in the shader file :

```
////////////////////////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////////////////////////
//    USER ENTERED EQUATION HERE !!
//
```

```
                case 3:
                                // UseEsmooth  floatG  fBailout
                                i=0;
                                while( i < iters )
                                {
                                        dNorm = norm(ZZ);
                                        if( dNorm >= _Type1_(fBailout) ) break;
                                        if( UseEsmooth ) fMU.x += Fast_eSmooth(dNorm);
                                        i++ ;

                                        /////////////// DO NOT EDIT FOLLOWING  /////////////////

                                          // FGZ_USER_FUNCTION_INSERTION_POINT

                                        ///////////////// END /////////////////
                                        // ZZ = ADD( MUL(ZZ, ZZ), DIV( CC, ADD(_Type1_(1.0), MUL
(floatG, ZZ) ))) ;
                                        // /////
                                }
                                if( !UseEsmooth ) {
                                   fMU.x = ZZ.r ;
                                   fMU.y = ZZ.i ;
                                }

                                break;


                ////////////////////////////////////////////////////////////////////////////////
                ////////////////////////////////////////////////////////////////////////////////
```



## User Equ/Func tips

Another slight glitch in the translator :

sin[ ZZ * ipow_f ]  will cause compiler error

use:

sin[ (ZZ * ipow_f) ]  this will compile fine ... sorry

///////////////

If you get a compile error about a '}' , it's because of something else you entered or the translator botched.

//////

if you get link errors, it's all over with, the application will not work with the GL on your system.

//////

there in a known major graphics glitch on ati 4670 and ati 5450 both with 512 MB VRAM.
The issue may be too little VRAM. The author doesn't know.

The application does produce perfect graphic on ati 7660D.
A yellow square means your GPU doesn't have the right shaders for the application.

//////



## Julia Set tips

Try magnifying in first on the Mandelbrot (or Mandel like) Set, first, just a little ways, not too far. Then switch to Julia mode on the same Orbit function, and Keep on Zooming !

Enjoy !

... on some functions Julia mode doesn't work well. Keep experimenting.