

FilledVector

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Chapter 1

FilledVector

1.1 FilledVector.guide

Filled Vector Module for AmigaE 2.5+

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This document describes the usage of a suite of 3d filled vector routines compiled for the AmigaE language.

The following sections are available:

OverView	some of the ideas behind the module
Polygon Context	describing destination memory
Vector Object	vector object creation/manipulation
Rendering	rendering functions
Matrix	coordinate manipulation functions

a few playthings i came up with ...

NOTE: You need to have:

```
MODULE 'tools/filledvector', 'tools/filledvdefs'
```

Somewhere in your MODULE include section

This module should work with all Amiga's

1.2 overview

Filled Vector Module Overview

Whats this module all about?

This module contains some reasonably 'optimised' rendering code to render 3d polygon filled vectors. This includes some a reasonably complex and versatile object format that can be used to create complex iconvex vector objects.

Because it uses the blitter to do rendering, it means you can have very complex objects (ones with holes in them and so on) without slowing it down too much. Unfortunately, performance on accelerated machines isn't so hot ...

BTW, i say "optimised", but its not that fast really ... one reason is because i'm keeping the system intact :) Another reason, is this code is somewhat old by now, and i dont really have the time to update it to the latest kill-os version i have (the kill-os version uses a very interrupt-intensive customblitter queue, and it operates on parameters fixed at compile-time. It is also a LOT faster though ...). It also uses some more efficient data structures and algorithms that i havent had time to put into this one.

One of the "cool" features it DOES have though, is the ability to perform z clipping as its rendering objects. This allows you to smoothly run through objects as you run into them, rather than having them dissapear just as they start to get big. It doesn't use a particularly reliable or fast z clipping algorithm but its still not too bad. (again, my kill-os vector code uses a much more efficient version ...).

Hopefully someone out there will be able to do more with it than just another version of ZedWB :) (although, for full-on vector world creation, you need some more tools ...)

MZ

1.3 author

I'm another one of these poor students, but i live in Australia, not Europe! I've been stuffing about with this vector shit since i had a '64, but never really got to do anything with it ...

Presently, i study 'from time to time' :-)) in order to obtain a Computer Systems Engineering degree from the Univerity Of South Australia. I'm the 'Zed' of FRONTIER in my anti-os hours.

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```

1.4 polygon context

This section describes the functions used for creating and manipulating 'polygon contexts'.

Polygon Context OverView

```
newPolyContext()  create a new one
freePolyContext() free one
setPolyBitMap()   change where it renders
setPolyClipRect() change clipping window
```

All of these functions operate with system libraries starting from V33 (workbench 1.2). However, please note that interleaved bitmaps are only possible when using V39 libraries (WB3.0+).

1.5 polygon context overview

A polygon context is similar to a rastport, but instead of containing all and sundry general purpose drawing variables as a rastport must, it only contains data necessary for polygon rendering.

The following is an example of some of the information that is stored in the polygon context:

```
clipping rectangle
minimum dimensions of current polygon (for blitting)
size of destination bitmap
bytesperrow of bitmap and screen
```

pointer to a bitplane to render polygons into
pointer to bitmap to blit thus rendered polygons
some temporary storage

Because of the context sensitive nature of this data object, when one is allocated it must be attached to a specific screen or bitmap - and MUST NOT be used for another screen or bitmap, unless it is absolutely clear that they are of the same dimensions (the buffered screen routines guarantee this).

All fields of the polygon context are !PRIVATE! and must only be accessed via the provided functions!

1.6 newpolycontext

filledvector.m/newPolyContext

filledvector.m/newPolyContext

SYNTAX

```
polycontext:=newPolyContext( bitmap, workspace )
```

PURPOSE

Allocates memory required for the polygon context and associated memory. A single bitplane the same size as the bitmap is allocated for blitting into along with some work memory.

INPUTS

bitmap a standard 'Amiga bitmap' that is to be the destination for rendering operations. This may be changed during runtime with the setPolyBitMap() function.

workspace a number used to allocate workspace for the polygon rendering functions. Currently make this the maximum number of points in any single object, plus 16.

OUTPUTS

polycontext

pointer to a private polygon context handle that can be passed to the other functions

SEE ALSO

freePolyContext(), Rendering functions

1.7 freepolycontext

filledvector.m/freePolyContext

filledvector.m/freePolyContext

SYNTAX

```
VOID freePolyContext( poly context )
```

PURPOSE

Frees the memory associated with a given polygon context. This function should always be called before a program exits.

INPUTS

polycontext

Pointer to a polygon context handle that was previously allocated with `newPolyContext()`. It MUST have been allocated with this function. This value MUST NOT be NIL.

SEE ALSO

`newPolyContext()`

1.8 setpolybitmap

`filledvector.m/setPolyBitMap`

`filledvector.m/setPolyBitMap`

SYNTAX

```
VOID setPolyBitMap( poly context, bitmap )
```

PURPOSE

Sets the bitmap that the rendering functions will render into. This bitmap must be either the one used to allocate the polygon context, or one with identical structure.

INPUTS

polycontext

Previously allocated (using `newPolyContext()`), valid polygon context. Must not be NIL.

bitmap

Pointer to a standard Amiga bimap that is to become the new destination for rendering.

SEE ALSO

`newPolyContext()`

1.9 setpolycliprect

`filledvector.m/setPolyClipRect`

`filledvector.m/setPolyClipRect`

SYNTAX

```
VOID setPolyClipRect( poly context, [minx, miny, maxx, maxy]:INT )
```

PURPOSE

This function sets the viewport through which all rendering will take place. The values supplied, minx/miny/maxx and maxy must all be within the size of the bitmap being rendered into, with a further restriction that maxx>minx and so on.

INPUTS

polycontext

Previously allocated (using newPolyContext()), valid polygon context. Must not be NIL.

[minx, miny, maxx, maxy]:INT

An array of 4 16 bit numbers that describe the clipping rectangle to be used.

SEE ALSO

newPolyContext(), Rendering functions

1.10 setpolyflags

filledvector.m/setPolyFlags

filledvector.m/setPolyFlags

SYNTAX

VOID setPolyFlags(poly context, newflags, mask)

PURPOSE

This function sets the polygon context flags (see below) for the given polygon context. Not much can be changed just yet. Like several Amiga system functions, the mask value sets which of the bits in the newflags will become set to those values (0 or 1, or whatever).

PCF_ZCLIP

This flag will set zclipping on or off. If this bit is on, zclipping will be performed for all polygons rendered. Turning off zclipping can reduce calculations somewhat, but they can't get too close to the virtual eye-level of the viewer, without stuffing up.

INPUTS

polycontext

Previously allocated (using newPolyContext()), valid polygon context. Must not be NIL.

newflags

State of new flags

mask A 1 in a bit position of the mask indicates that the corresponding bit in the newflags parameter is to be copied to the polygon context flags field. A 0 indicates that that bit is to remain unchanged.

SEE ALSO

newPolyContext()

1.11 vectorobject

This section describes the functions available for creating, destroying, and working with 'vector objects'. These are high level object definitions that can be used to describe quite complex objects, which can then be rendered very efficiently.

Creating new objects can be difficult, designing objects explains more information about how to go about this.

```
newVectorObject()   create a new vector object
freeVectorObject()  free a vector object
copyVectorObject()  make an efficient copy of an object
cloneVectorObject() make a minimal copy of an object

getVObjectPoints()  access the array of vertices

newVList()          create a list header for linking objects
freeVList()         free the list, and optionally all objects in it
addVObject()        add an object to an object list
remVObject()        remove an object from an object list

sortVList()         do a fast sort in descending Z order of the list

drawVObject()       draw a single vector object
drawVList()         draw a list of objects
moveDrawVList()     render a scene of objects
```

All of these functions operate with system libraries starting from V33 (workbench 1.2).

1.12 newvectorobject

filledvector.m/newVectorObject

filledvector.m/newVectorObject

SYNTAX

```
vobject := newVectorObject( type, numpoints, numfaces, points, faces )
```

PURPOSE

Creates a new vector object, and initialises its fields to those supplied.

INPUTS

type type of object, currently only '0' is valid

numpoints

the number of vertices/points in the object

numfaces

the number of faces in the object

points an array of INT's which are the vertices used by the object.

Each entry in the list consists of 3 words the X, Y and Z

coordinates of that point. There must be at least

numpoints*3 INT's in this list.
 faces an array of "vface" data structures which describe the faces of the object. There must be at least as many of these as the numfaces argument. See designing objects for more information.

OUTPUTS

vobject Pointer to a vobject type OBJECT that can be used to manipulate the object in some ways.

SEE ALSO

freeVectorObject(), copyVectorObject(), cloneVectorObject(),
 Designing objects

1.13 freevectorobject

filledvector.m/freeVectorObject

filledvector.m/freeVectorObject

SYNTAX

VOID freeVectorObject(vobject)

PURPOSE

Free's a vector object, and any associated memory. This function should be used to free all objects previously created or copied, before the program exits.

INPUTS

vobject previously allocated vector object (either using newVectorObject(), copyVectorObject() or cloneVectorObject()), it may also be NIL, in which case it does nothing.

SEE ALSO

newVectorObject(), copyVectorObject(), cloneVectorObject(),

1.14 copyvectorobject

filledvector.m/copyVectorObject

filledvector.m/copyVectorObject

SYNTAX

vobject := copyVectorObject(vobject)

PURPOSE

Makes an efficient copy of a vector object. The entire object is copied, including the points, the face definitions (colours etc), but the polygon definitions are not copied to save space.

INPUTS

vobject previously allocated vector object (either using

`newVectorObject()`, `copyVectorObject()` or `cloneVectorObject()`,
it may also be `NIL`, in which case it returns `NIL`.

OUTPUTS

`vobject` a copied vector object.

SEE ALSO

`newVectorObject()`, `freeVectorObject()`, `cloneVectorObject()`

1.15 clonevectorobject

`filledvector.m/cloneVectorObject`

`filledvector.m/cloneVectorObject`

SYNTAX

`vobject := copyVectorObject(vobject)`

PURPOSE

Makes a minimal copy of a vector object. The points array, and the face array are NOT copied. This allows an identical object to be created and positioned independently of the original, but any manipulation of either object (colours or points) will affect the other.

INPUTS

`vobject` previously allocated vector object (either using `newVectorObject()`, `copyVectorObject()` or `cloneVectorObject()`, it may also be `NIL`, in which case it returns `NIL`.

OUTPUTS

`vobject` a cloned vector object.

SEE ALSO

`newVectorObject()`, `freeVectorObject()`, `copyVectorObject()`

1.16 getvobjectpoints

`filledvector.m/getVObjectPoints`

`filledvector.m/getVObjectPoints`

SYNTAX

`points := getVObjectPoints(vobject)`

PURPOSE

Allows a pointer to the internal point/vertice array to be obtained. This can be used with the and other manipulation functions (you are free to do what you like) for post-processing the object.

This array will contain as many points as the number of points used

in the argument to the initial `newVectorObject()` call.

INPUTS

vector previously allocated vector object (either using `newVectorObject()`, `copyVectorObject()` or `cloneVectorObject()`), it may also be `NIL`, in which case it returns `NIL`.

OUTPUTS

points A pointer to an array of `INT`'s that are the 3d points of the object. If the object has been cloned, this will point to the same physical array as the parent's point list.

SEE ALSO

`newVectorObject()`

1.17 newvlist

`filledvector.m/newVList`

`filledvector.m/newVList`

SYNTAX

`vlist := newVList()`

PURPOSE

Creates a new list header, and initialises it. This is used for linking several objects into a bigger object, or as a way of efficiently manipulating several objects at a time.

OUTPUTS

`vlist` pointer to a newly allocated `vlist` header, or `NIL` in case of failure.

SEE ALSO

`freeVList()`, , ,
, ,

1.18 freevlist

`filledvector.m/freeVList`

`filledvector.m/freeVList`

SYNTAX

`VOID freeVList(vlist, freenodes)`

PURPOSE

Free's a vector object list header, and optionally, all of the vector objects connected to the list.

INPUTS

`vlist` pointer to a previously allocated `vlist` header, allocated with

, this must not be NIL!

freenodes
 Boolean value which indicates whether all of the objects in the vlist are also to be free'd.

SEE ALSO
 newVList()

1.19 addvlist

filledvector.m/addVList

filledvector.m/addVList

SYNTAX

VOID addVList(vlist, vobject)

PURPOSE

Adds a vector object to the vlist.

INPUTS

vlist pointer to a previously allocated vlist header, allocated with
 , this must not be NIL!
 vobject previously allocated vector object (either using
 newVectorObject(), copyVectorObject() or cloneVectorObject()),
 it may also be NIL, in which case it returns NIL.

SEE ALSO
 newVList(),

1.20 remvlist

filledvector.m/remVList

filledvector.m/remVList

SYNTAX

VOID addVList(vlist, vobject)

PURPOSE

Removes the vector object from the vlist.

INPUTS

vlist pointer to a previously allocated vlist header, allocated with
 , this must not be NIL!
 (currently, this field is unused, since the list uses a doubly
 linked list. If in the future, this changes, then this
 will become important)
 vobject a vobject that has previously been added to the vlist using
 .

SEE ALSO

```
newVList(),
```

1.21 sortvlist

filledvector.m/sortVList

filledvector.m/sortVList

SYNTAX

```
VOID sortVList( vlist )
```

PURPOSE

Takes the vlist argument, and scans all of the vector objects on the list. It looks at the vobject.pz value, and uses this to sort the list indescending Z order.

The algorithm used by this sort is a modified mergesort, which uses a prescan stage to break the list into already-sorted sublists, which it then takes pairs of, and merges to create larger sublists, until sorted. This will mean that a nearly sorted list can be sorted VERY quickly. Even with a completely reversed list, the properties of the mergesort algorithm guarantee a very fast worst case performance.

INPUTS

vlist pointer to a previously allocated vlist header, allocated with
 , this must not be NIL!
 vobject a vobject that has previously been added to the vlist using
 .

SEE ALSO

newVList(),

1.22 drawvobject

filledvector.m/drawVObject

filledvector.m/drawVObject

SYNTAX

```
VOID drawVObject( polygon context, vobject )
```

PURPOSE

Draws a single vector object into the polygon context described. The object's position and angles are taken into account, resulting in a positioned and rotated object being rendered into the destination bitmap.

INPUTS

poly context
 Pointer to a polygon context handle that was previously allocated with newPolyContext(). It MUST have

been allocated with this function. This value MUST NOT be NIL.
 vobject previously allocated vector object (either using newVectorObject(), copyVectorObject() or cloneVectorObject()), it must NOT be NIL.

SEE ALSO
 Polygon Context, Vector Objects

1.23 drawvlist

filledvector.m/drawVList

filledvector.m/drawVList

SYNTAX

VOID drawVList(polygon context, vlist)

PURPOSE

Scans the vector object list, and draws all of the items contained within it. No sorting of the objects is done whatsoever, so if you wish to have correctly depth sorted (i.e. painters algorithm) objects, must be called first.

Each object is rendered using its position and angles as specified in the vobject OBJECT.

INPUTS

poly context

Pointer to a polygon context handle that was previously allocated with newPolyContext(). It MUST have been allocated with this function. This value MUST NOT be NIL.

vlist pointer to a previously allocated vlist header, allocated with , this must not be NIL!

SEE ALSO
 newVList(), Polygon Context, Vector Objects

1.24 movedrawvlist

filledvector.m/moveDrawVList

filledvector.m/moveDrawVList

SYNTAX

VOID moveDrawVList(polygon context, vlist, position)

PURPOSE

This is a high level function which performs a lot of processing in one step. Initially, it scans the list of objects, and uses the supplied position OBJECT to rotate and position all

of the objects into an internal list. Once this has taken place, this list is depth sorted, and all objects in the list are rendered, starting from the back.

The positions within each vobject now become relative to the position supplied as an argument above. The angles should be relative too, but currently the angles stored in each vobject are ignored when this function is called.

INPUTS

poly context

Pointer to a polygon context handle that was previously allocated with `newPolyContext()`. It MUST have been allocated with this function. This value MUST NOT be NIL.

vlist pointer to a previously allocated vlist header, allocated with , this must not be NIL!

position

an OBJECT position object, which describes the position and angle at which the object list is to be drawn.

SEE ALSO

`newVList()`, `Polygon Context`, `Vector Objects`

1.25 rendering

Currently, the only available rendering functions are those in the vector object section.

Sometime in the future, some more low-level, but simple to use polygon rendering functions will be provided.

1.26 matrix

This section describes the range of general purpose matrix-based functions that are available for manipulating sets of points in 2d and 3d.

Have a look at matrix information on just how to use these functions.

<code>setMatIdent()</code>	setup a matrix to do nothing (identity matrix)
<code>setMatRotate()</code>	setup a matrix to perform a rotation
<code>setMatScale()</code>	setup a matrix to perform a scaling operation

<code>matSize()</code>	scale the rows of a matrix
<code>matMult()</code>	multiply two matrices

<code>matApply3()</code>	apply a matrix to a set of 3d points
--------------------------	--------------------------------------

All functions here work with all machines.

1.27 matrixinfo

So, there's all of these matrix functions - just what the hell do you do with them? Well, matrices are an efficient way to manipulate things like points in 3d. You can do things like scaling, rotation, shearing, and so on all using a single matrix. You can also combine operations, like doing several rotations at once, or a rotation and a scale, by combining the individual transformations into one matrix, and then applying this matrix in one go to the points.

Ok, how about an example. Say we wish to rotate several points, and then scale them up by 100%, in the X direction.

```
DEF matrotate:matrix, matscale:matrix

setMatRotate(matrotate, anglex, angley, anglez); -> rotate angles
setMatScale(matscale, 2048, 1024, 1024);      -> scale 2x in x
matMult(matscale, matrotate)                  -> create new transform

matApply3(matrotate, 10, points, buffer); -> apply the matrix
```

Because the scaling matrix is left-multiplied with the rotation matrix (the matMult call above), then the new matrix will act as if two separate transformations had occurred, the first being a rotate, and the second a scaling.

If the order of multiplication of the matrices was reversed, then the matrix would represent first a scaling operation, and THEN a rotation. These two different matrices result in quite different outputs.

This operation (multiplying the two matrices) is known as concatenation, and is mentioned throughout the function descriptions.

Another way to perform scaling is to use the matSize() function. This modifies the rows of the matrix directly, and will produce similar results (and is actually more efficient), but it always acts as if it is the last operation.

See the various functions for more information about what is available. A textbook on 3d graphics, or simply one on linear algebra which talks about affine transformations may also be handy.

1.28 setmatident

filledvector.m/setMatIdent

filledvector.m/setMatIdent

SYNTAX

```
VOID setMatIdent( matrix )
```

PURPOSE

Sets up the contents of the matrix pointed to by matrix to

the internal identity matrix value.

OUTPUTS

matrix Matrix setup to do nothing.

SEE ALSO

,

1.29 setmatrotate

filledvector.m/setMatRotate

filledvector.m/setMatRotate

SYNTAX

VOID setMatRotate(matrix, anglex, angley, anglez)

PURPOSE

Sets up the contents of the matrix pointed to by matrix to a rotation matrix which represents the rotations provided in the arguments. This matrix is itself a concatenated matrix (but calculated much more efficiently than taking 3 2d rotations and multiplying them together), and as such has certain properties. For example, the order of rotations becomes important - i think the order is anglez, angly then anglex.

If you wish to rotate with other angle ordering, then you can make 2d rotation matrices using this function, and setting two of the angles to 0, then concatenating the resultant matrices yourself (using).

INPUTS

anglex, angley, anglez

The angles to use as the basis of the rotations.

0 = 0 degrees, and 512 = 360 degrees.

OUTPUTS

matrix Matrix setup with a rotation matrix

SEE ALSO

,

1.30 setmatscale

filledvector.m/setMatScale

filledvector.m/setMatScale

SYNTAX

VOID setMatScale(matrix, scalex, scaley, scalez)

PURPOSE

Sets up the contents of the matrix pointed to by matrix to a scaling matrix which represents the scaling provided in the arguments.

This provides a true mathematical accurate scaling operation, that can be concatenated and ordered correctly. For a simpler version, see .

INPUTS

scalex, scaley, scalez

The scaling values (fixed point) to be used to setup the matrix. These fixed point values are normalised to 1024. This means a value of 512 will mean a halving along that axis, and a value of 2048 a doubling etc.

OUTPUTS

matrix Matrix setup with a scaling operation

NOTES

Dont try to scale above 32 times larger! (32767), negative values are also acceptable, and will tend to flip the object inside out along that axis (odd results).

SEE ALSO

, ,

1.31 matSize

filledvector.m/matSize

filledvector.m/matSize

SYNTAX

VOID matSize(matrix, scalex, scaley, scalez)

PURPOSE

Modifies the matrix, by scaling each of its rows by the 3 values provided. This provides a more efficient way to add a scaling operation to a matrix, but it always acts as if it was the last operation performed on the matrix.

INPUTS

scalex, scaley, scalez

The scaling values (fixed point) to be used to setup the matrix. These fixed point values are normalised to 1024. This means a value of 512 will mean a halving along that axis, and a value of 2048 a doubling etc.

OUTPUTS

matrix Matrix modified with the scaling factors above

SEE ALSO

1.32 matmult

filledvector.m/matMult

filledvector.m/matMult

SYNTAX

VOID matMult(source matrix, dest matrix)

PURPOSE

Concatenates the two matrix operations, by left multiplying (go look in a maths book!) the destination matrix by the source matrix, and storing the result in the dest matrix. The net result is that the two transformation matrices are combined, with the effect being that the resultant matrix will represent the operation originally performed by the dest matrix, followed by the operation performed by the source matrix.

Maybe an would help!

INPUTS

source matrix

operation to be performed by the concatenated result last. This matrix is left-multiplied with the dest matrix.

dest matrix

operation to be performed by the concatenated result first. The result of the entire operation is also stored in here

OUTPUTS

dest matrix

the result of the operation is stored in the dest matrix

NOTES

The result of any concatenation must fit within the size of the numbers used to prevent any errors. This means that the net result of any operation must not result in a scaling up of more than 32x.

SEE ALSO

, ,

1.33 matapply3

filledvector.m/matApply3

filledvector.m/matApply3

SYNTAX

```
VOID matApply3( matrix, number, source points, dest points )
```

PURPOSE

Multiplies each 3d point in the points list by the matrix, and stores the result somewhere else.

The matrix can be setup to perform any affine transformation that it has been setup to (currently functions exist for setting up scaling and rotation matrices only).

INPUTS

matrix matrix containing transformation to apply.

number the number of points to apply the operation to.

Currently, must be >0.

source points

An array of INT's which contains the 3d coordinates to process

OUTPUTS

dest points

An array, at least as big as number*3 INT's in which to store the result. This value may be the same as the source points parameter, if you just wish to process an existing list of points.

SEE ALSO

, , ,

1.34 Example code

I've had this module floating around on my hdd for 6-12 months actually ... i just needed to gt my finger out and write all this damn documentation :)

(i was going to recode it using some ideas i've had since then, but i never got around to it ..!)

Anyway, it means i've had time to come up with some decent (if still trivial) examples.

The Vxx+ below shows which versions of the OS the examples work with. Since some use the ScrBuffer module, they require Workbench 3.0+ (V39+).

V33+

A very simple example which demonstrates the basics required to get a vector object spinning on the screen. It uses the cube designed in the , and also some simple Workbench 1.2 functions to do the page flipping.

V39+

Another simple demo of the module. This one also uses the

Workbench 3.0+ double buffering routines to make it run smoother, and allow you to drag the screen.

V39+

One of the first examples i coded :) Its a spinning Zed logo, and uses WB3.0 double buffering, and demonstrates the use of that, the vector module, multiple part objects, and some of the matrix routines. Use the left mousebutton to make it go away, and right to make it come closer. (you can still drag its screen BTW). Both to exit.

V37+

An animated workbench backdrop! Uses an offscreen render bitmap to draw a picture, which is then blitted to the workbench screen. This has been tested and works on machines with custom graphics cards! (if slowly ...)

V37+

Identical to wbl200, but uses a different object. The object in this one was created in imagine, and converted using a longwinded and labourious process ...