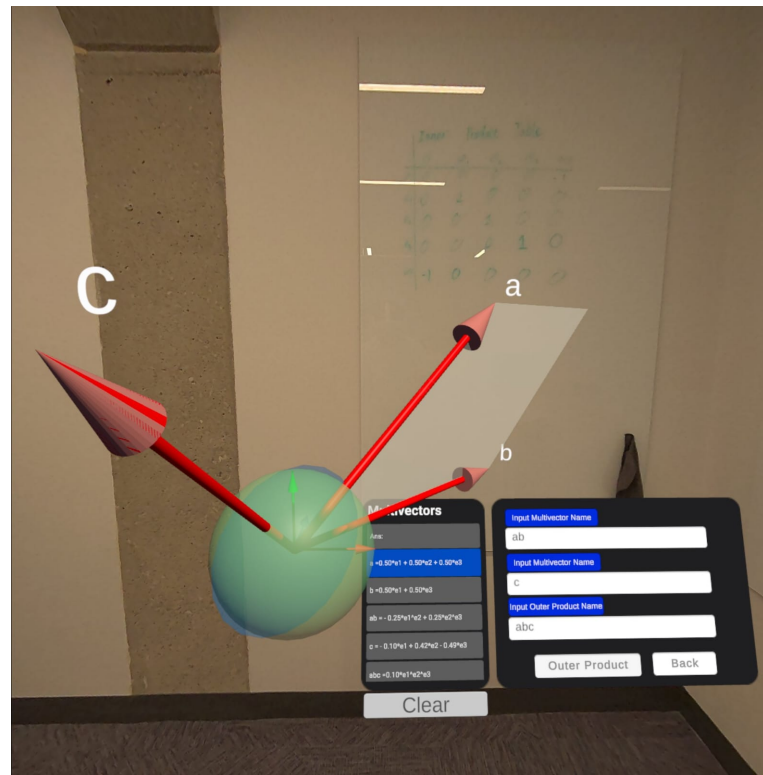


A Virtual Reality System For Visualizing Geometric Algebras

Stephen Mann

Jessica Ding and HongFei Huang



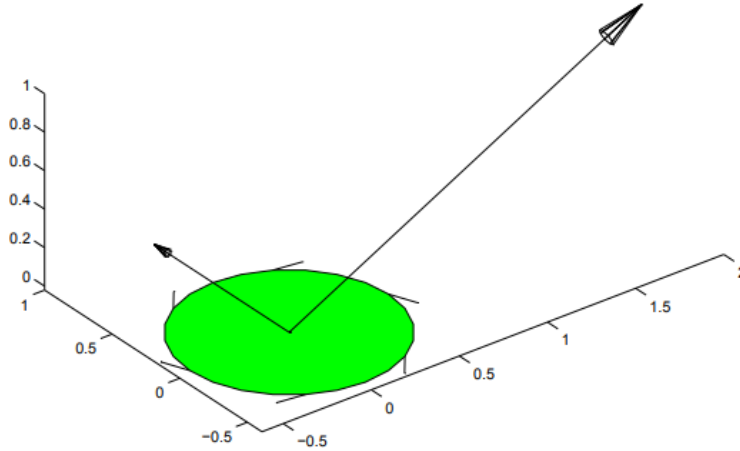
Visualizing and Interacting with Objects in Geometric Algebra

- Want software to visualize and interact with objects in geometric algebras
- Numerous systems for such visualizations

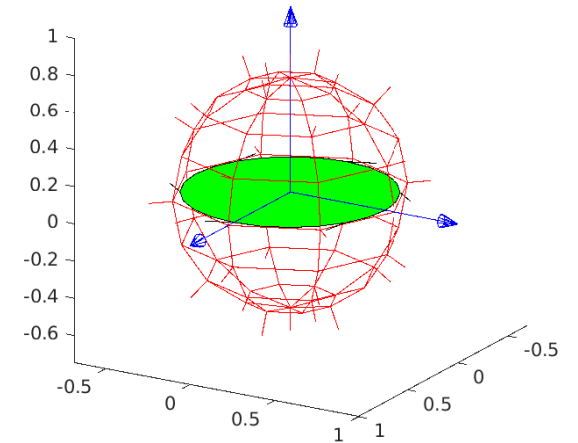
Will focus on ones I'm familiar with, but other systems exist

GABLE

- Matlab graphics, UI



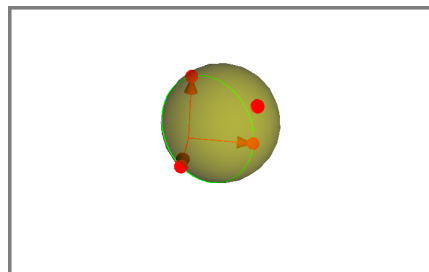
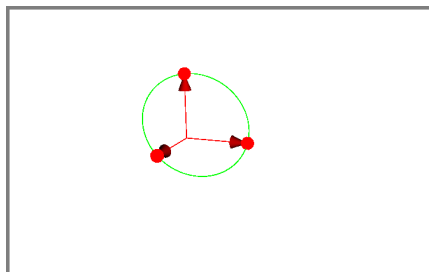
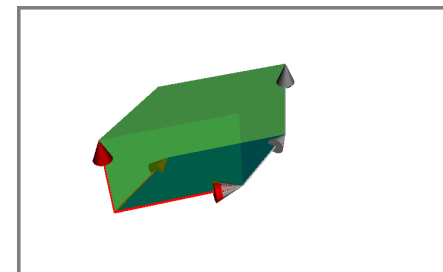
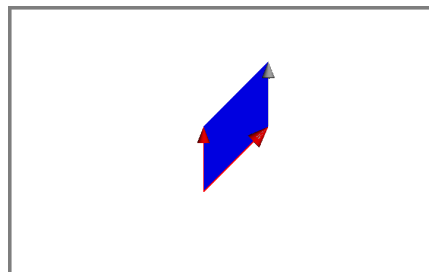
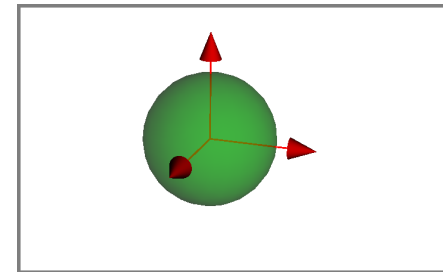
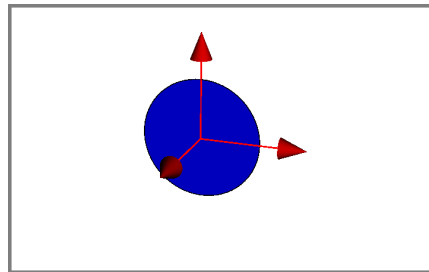
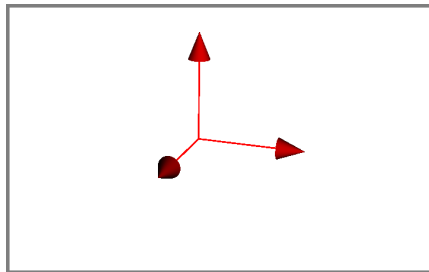
```
draw(2*e1+e3); draw(e2); draw(e1^e2)
```



- Limited geometries

GAViewer

- GAViewer had better graphics, better interaction
- Support for more geometries

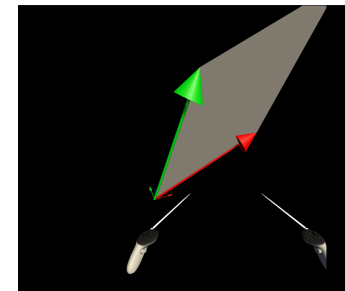
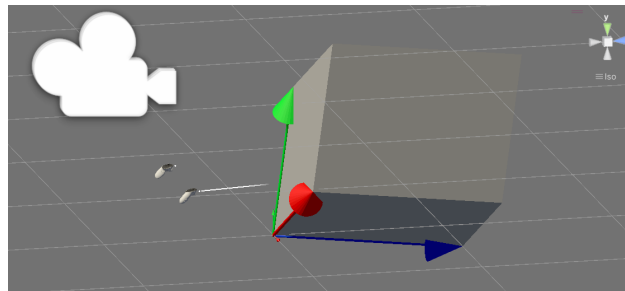


Virtual Reality

- Stereo view



- Superimpose objects on world



- Direct interaction with objects

Controller



- Press and hold Meta button (∞) to reset view
- Press Meta button (∞) to...?
- Point and pull trigger to “select”
- Interact with hand gestures

Hand Gestures

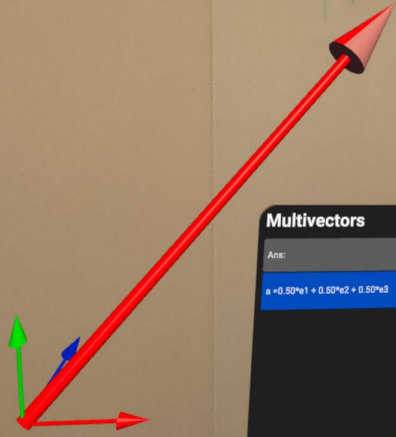
- Virtual hand drawn on top of hand
- Pinch gesture commonly used to select
- Grab gesture

Vector

Inner Product Table

	e_1	e_2	e_3	a
e_1	0	0	0	-1
e_2	0	1	0	0
e_3	0	0	1	0
a	0	0	0	1

a



Multivectors

Ans:

$a = 0.50e_1 + 0.50e_2 + 0.50e_3$

e_1 0.5

e_2 0.5

e_3 0.5

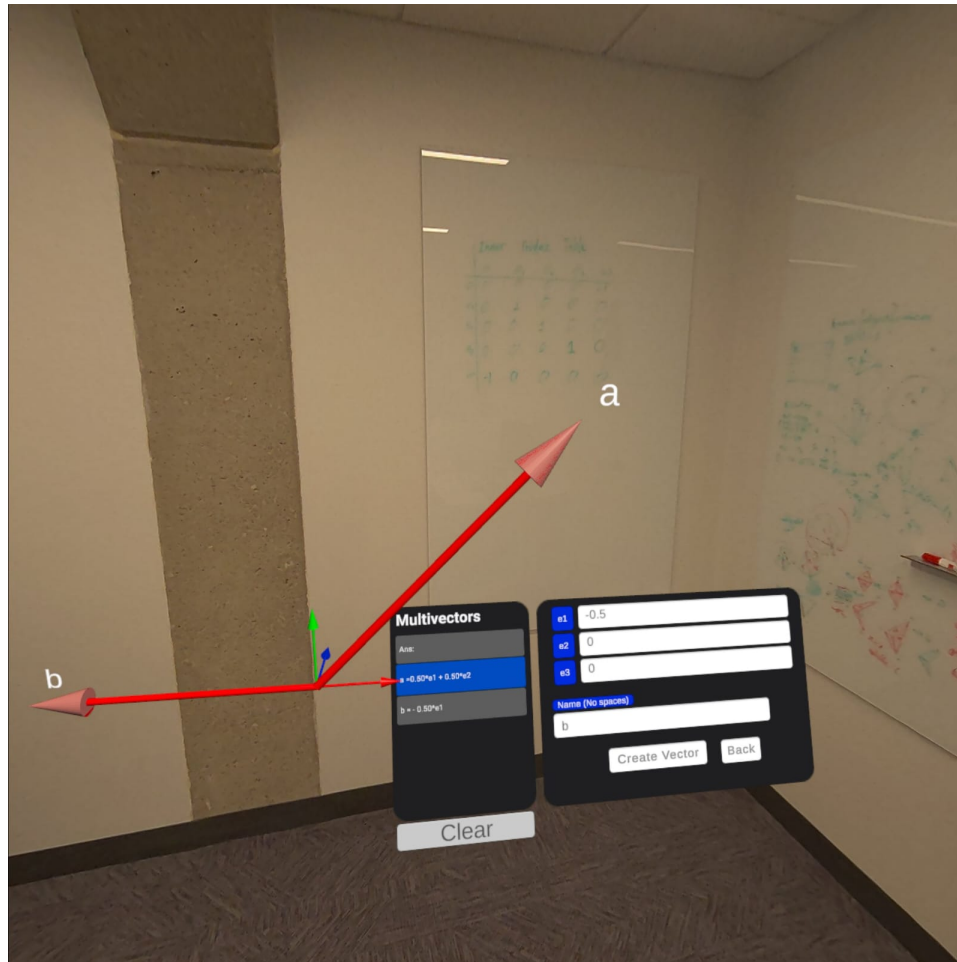
Name (No spaces)

a

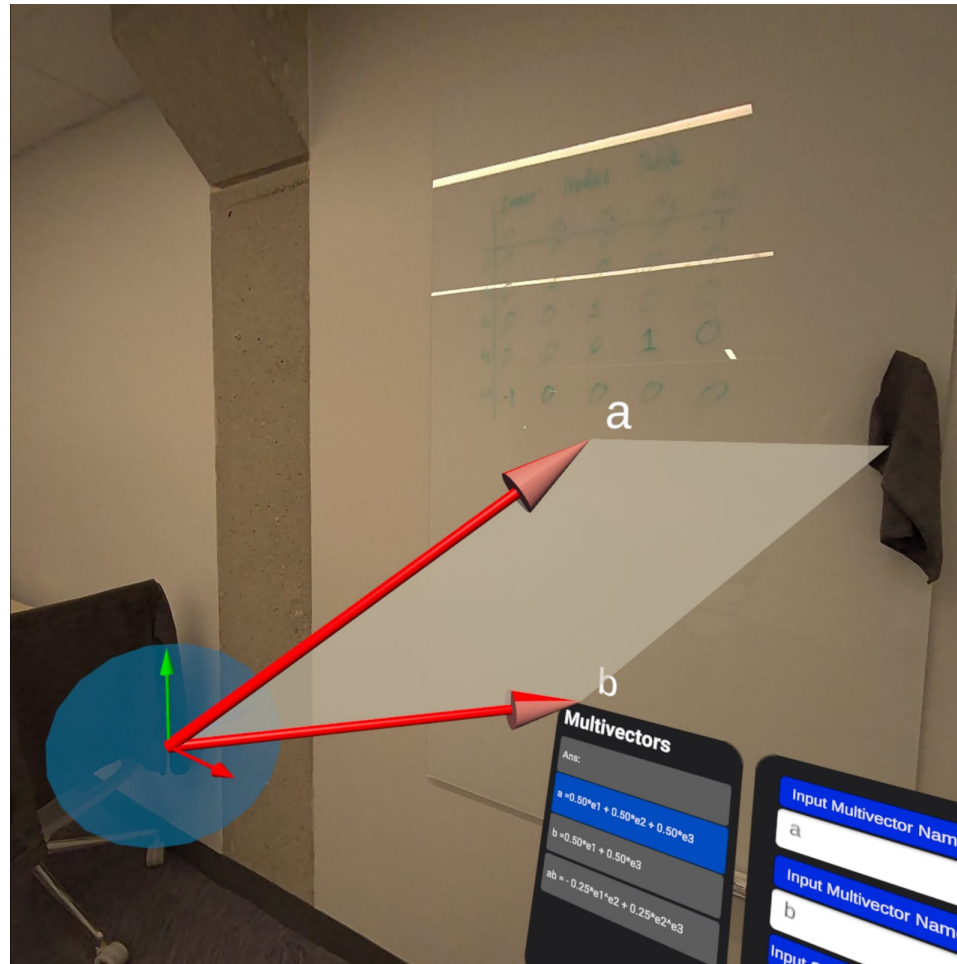
Create Vector Back

Clear

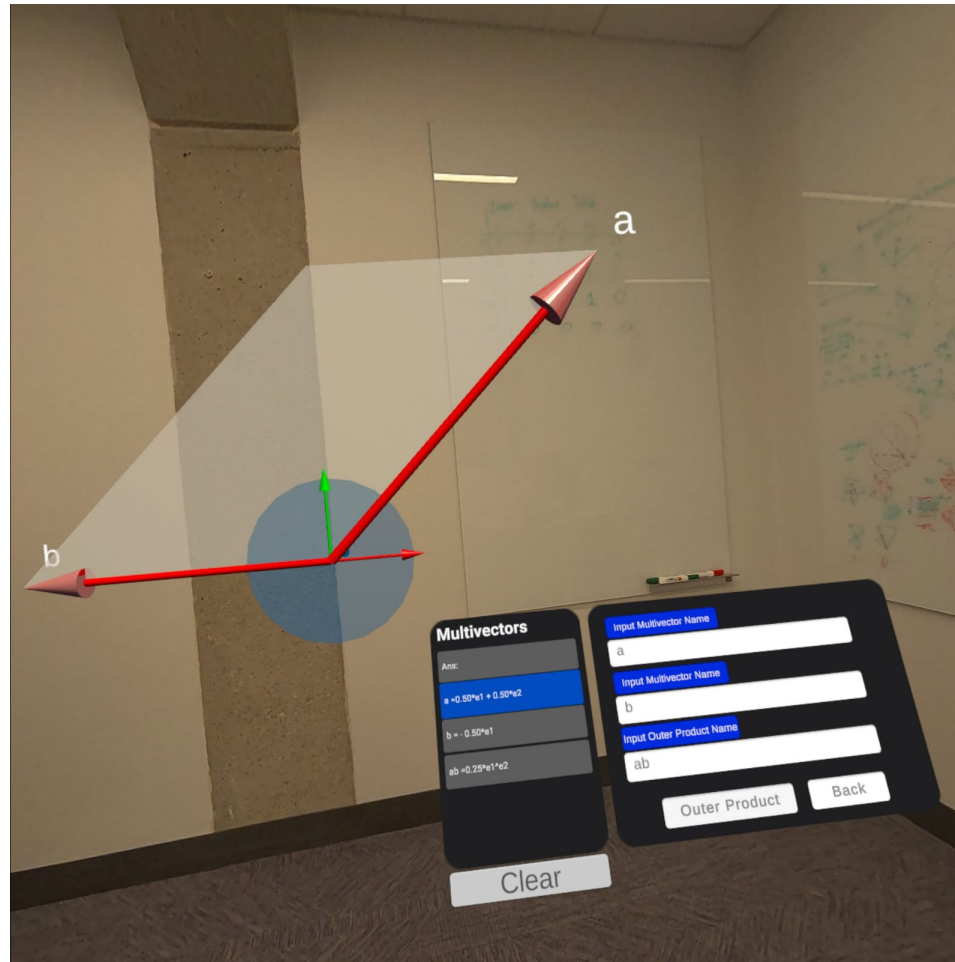
Vector



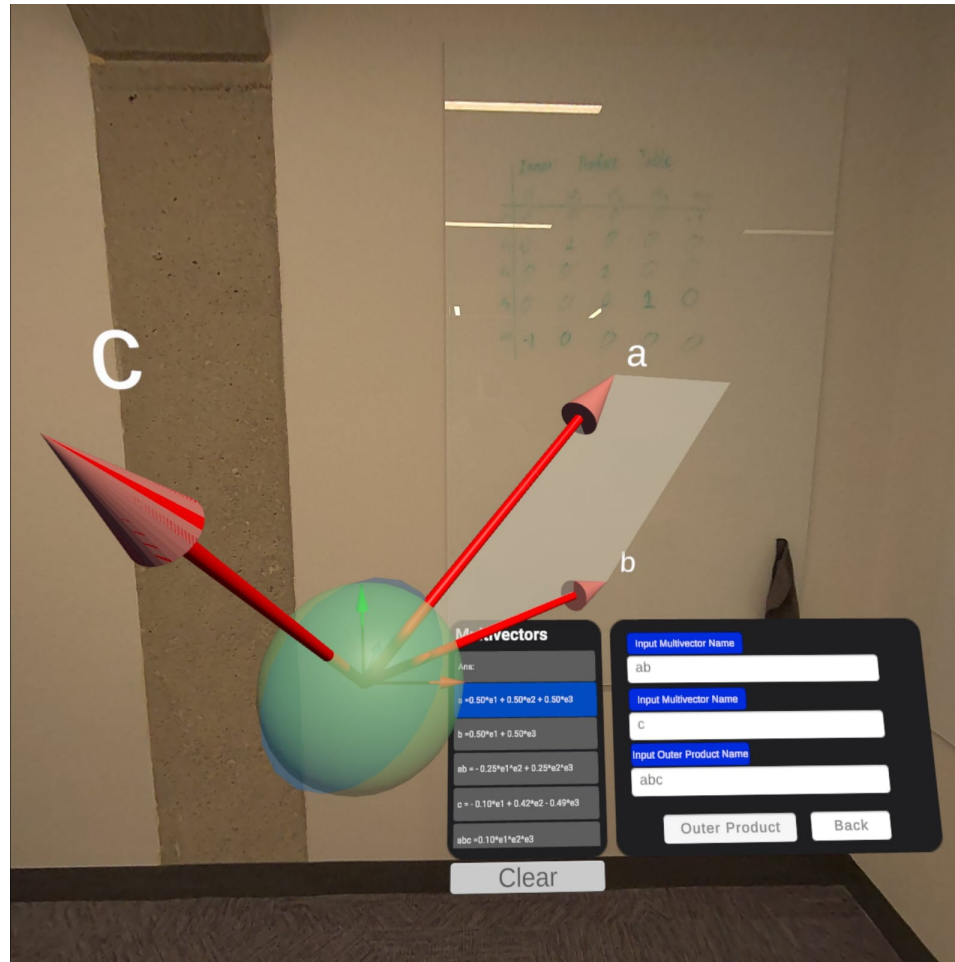
Bivector



Bivector



Trivector



Still To Come

- Snap to grid

Allows for more precise positioning by hand

- UI for products; construction and application of operators

- C3GA support

- Keyboard (virtual? bluetooth?)

```
pt=no+v+0.5*inner(v,v)*ni
```

- Gallery of interesting objects

UI For Products

- How to specify outer, inner, and geometric products of objects?
 - Text
 - Menu/Form
 - Gesture?
- How to graphically represent result of product
Outer product “easy” ...
- How to apply rotors etc to objects?

CGA, PGA

CGA

- Create points
- Outer product to get circles, spheres
- How to represent o , ∞ ?
- Flats?

PGA

Keyboard, Expressions

- Keyboard for more complex things
- Idea: two types of “equal sign”
 - One for creation and assignment
$$a = b \wedge c$$
Changes to b or c leave a unchanged
 - One for specifying expressions
$$a := b \wedge c$$
Update a when b or c change

Keyboard: Virtual vs Bluetooth

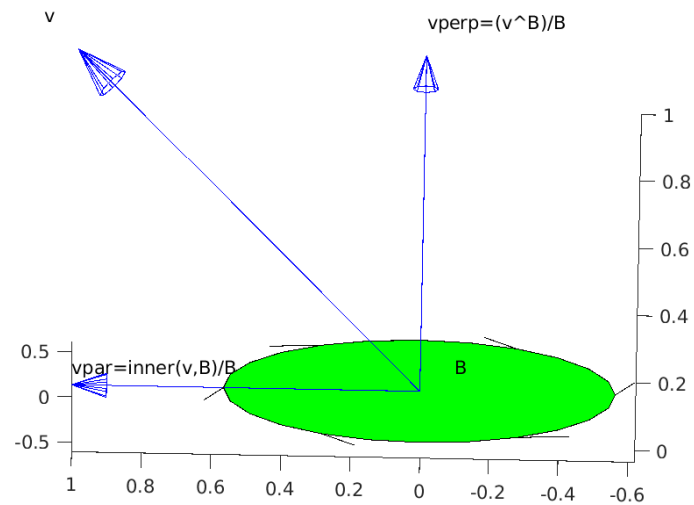
- Virtual keyboard



- Bluetooth easier to use (touch typing)
- Virtual keyboard:
Potentially customizable (e.g., e1,e2,e3 keys, etc.)

Gallery/Tutorial

- Gallery of interesting objects/constructions
Can interact with them
- Tutorial sequence of objects to interact with, create



Software

- C#
- Meta/Unity
- Blender
- Antlr
- Gaigen (c3ga library)

Starting the Program



Find “Quest 3 Test” on bottom and select it (either with hand, via pinch, or with controller)

The Controller



Your Hand

Position hand with palm down

- Pinch item to select
- To type, push through the key on the keyboard
Remember to press enter
- To scroll through menus, click (pinch) and drag

Form Entry

Multivectors

Ans:

This is the origin that will display all multivectors

These three entries are input fields for the value of e1, e2 and e3

e1 0.5

e2 0.5

e3 0.5

The input field of the vector name

Name (No spaces)

a

Create Vector **Back**

Back to main page

If all the above input fields have been properly filled, click this button to generate the vector

This button clears all multivectors

Clear