VAGC_grad_scalar.wxm

A development document for Geometric Algebra using wxMaxima

Exercise 5.13, VAGC page 66 for the gradient of a scalar function in 3D

Initialization

```
(%i1) ext:["wxm"]$
      file_type_maxima:append(ext,file_type_maxima)$
      batchload("initialize_fns")$
```

the pseudoscalar and its inverse
the lowest useable dimension pseudoscalar should be {e1,e2} i.e. Plen = 2
e.g. for four dimensions edit Pseudos:{e1,e2,e3}$ to Pseudos:{e1,e2,e3,e4}$

```
(%i1) Pseudos:{e1,e2,e3}$
      Pvar:listofvars(Pseudos)$
      Plen:length(Pvar)$
      I:Pseudos$
      ni:(Plen-1)*Plen/2$
      Ii:(-1)^ni*I$
      kill(ni)$
      ldisplay(Pvar)$

 (%t8) Pvar=[e1,e2,e3]

(%i9) batchload("initialize_lsts")$

 (%t9) lstblds=[[{e1},{e2},{e3}],[{e1,e2},{e1,e3},{e2,e3}],[{e1,e2,e3}]]
(%t10) allblds=[{e1},{e2},{e3},{e1,e2},{e1,e3},{e2,e3},{e1,e2,e3}]
(%t11) invblds=[{e1},{e2},{e3},-{e1,e2},-{e1,e3},-{e2,e3},-{e1,e2,e3}]
```

end of Initialization

set derivabbrev:false$

```
(%i12) derivabbrev:false$
```

Exercise 5.13
VAGC page 66

form the coordinate vector, x from the lists of coefficients

```
(%i13) xstr:"x"$
       xlst:lstvector(xstr)$
       ldisplay(xlst)$

 (%t15) xlst=[x1,x2,x3,0,0,0,0]

(%i16) x:makevector(xlst)$
       ldisplay(x)$

 (%t17) x={e3}*x3+{e2}*x2+{e1}*x1
```

form the scalar valued function, f(x,y,z)=x^2+y^2+z^2

```
(%i18) f(x):=normod(x)^2$
       fxyz:ev(f(x))$
       ldisplay(fxyz)$

 (%t20) fxyz=x3^2+x2^2+x1^2
```

part a) the level surfaces of f are the spheres

part b) the normals would be the in the direction of the radial vectors, x

```
(%i21) Fstr:"fxyz"$
       gradF:mvgrad(Fstr,xlst)$
       ldisplay(gradF)$
```

$$(\%t23)\quad gradF={e3}\,\&*\left(\frac{d}{d*x3}*fxyz\right)+{e2}\,\&*\left(\frac{d}{d*x2}*fxyz\right)+{e1}\,\&*\left(\frac{d}{d*x1}*fxyz\right)$$

part c) grad(f) = 2x

```
(%i24) gradf:ev(gradF,diff)$
       ldisplay(gradf)$

 (%t25)/R/ gradf=2*x1*{e1}+2*x2*{e2}+2*x3*{e3}
```

N.B. the gradient gives non-unit normals to level surfaces of scalar functions

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