IIIT Vadodara
Autumn 2018-19
TE3 Computer Vision
Lab-5: Shape from Shading (SFS)

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Problem 1. Given different source positions, find resulting images of a given sphere. Use the corresponding class notes. Hint: Assume different source positions and find the resulting image of a given sphere. Assume different source positions as (ps, qs) = (0,0), (0.5,0.5), and more in the image coordinate system.

Solution Code :-

In this solution I have made different functions in the code.

The main function

```
clc;
clear all;
I = uint8(zeros(128,128));
r = 40;
center_x = round(size(I,1)/2);
center_y = round(size(I,2)/2);
ps = 0;
qs = 1;
for i = 1:size(I,1)
    for j = 1:size(I,2)
        x_adjusted = i - center_x;
        y_adjusted = j - center_y;
        p = (-x_adjusted)/(sqrt(power(r,2) - power(x_adjusted,2) -
            power(y_adjusted,2)));
        q = (-y_adjusted)/(sqrt(power(r,2) - power(x_adjusted,2) -
            power(y_adjusted,2)));
        num = (p*ps) + (q*qs) + 1;
        den = (sqrt(1 + power(p,2) + power(q,2))*sqrt(1 + power(ps,2) +
            power(qs,2)));
        irradiance = num/den;
        if ((power(x_adjusted,2))+(power(y_adjusted,2)) < power(r,2))
            I(x_adjusted+center_x,y_adjusted+center_y) = 500*irradiance;
```

```
        endif
    endfor
endfor
```

---

tElapsed = 28.786

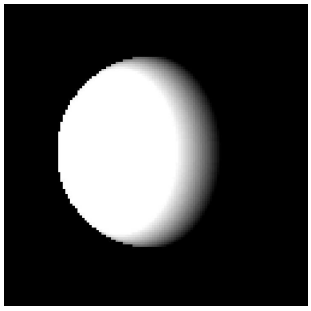

Figure 1: ps = 0, qs = 1

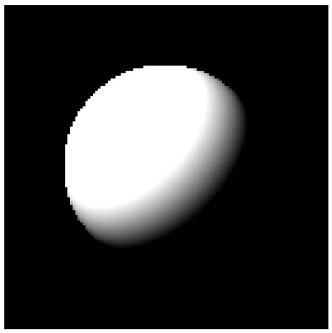

Figure 2: ps = 1, qs = 1

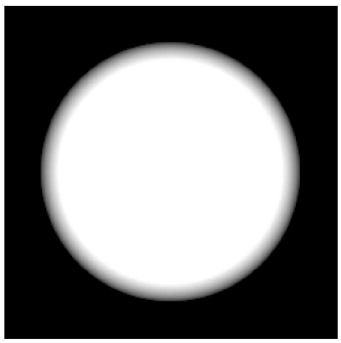

Figure 3: ps = 0, qs = 0

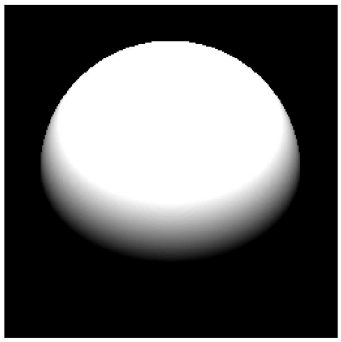

Figure 4: ps = 1, qs = 0

Problem 2. SFS: Estimate reflectance map R(p, q), i.e., surface gradient matrices p and q, for the images generated in Q.1.

Solution Code :-

```
E = I;
i1 = size(E,1);
j1= size(E,2);
p = rand(i1, j1);
q = rand(i1, j1);
ps = 0.5;
qs = 0.5;
lambda = 0.8;
for count = 1 : 100
  i1 = size(p,1);
  j1= size(p,2);
  for i = 3 : (i1 - 3)
    for j = 3 : (j1 - 3)
      p_n1(i, j) = p_bar(p, i , j) + (lambda / 4) * (E(i , j) - reflectance(p(i,
          j), q(i, j), ps, qs)) * del_p(p(i, j), q(i, j), ps, qs);
```

```
      q_nl(i, j) = q_bar(q, i , j) + (lambda / 4) * (E(i , j) - reflectance(p(i,
         j), q(i, j), ps ,qs)) * del_q(p(i, j), q(i, j), ps, qs);
    endfor
  endfor
  p = p_n1;
  q = q_nl;
endfor

save p.mat p
save q.mat q
```

$\mathrm{del}_p.m$

```
function delp = del_p( p, q , ps, qs )
delp = (ps * (power(q,2) + 1) - p * (q * qs + 1)) / ((power((power(qs, 2) + 1 +
    power(ps, 2)), 0.5)) * (power((power(q, 2) + 1 + power(p, 2)), 1.5)));
endfunction
```

$\mathrm{del}_q.m$

```
function delq = del_q( p, q , ps, qs )
delq = (qs * (power(p,2) + 1) - q * (p * ps + 1)) / ((power((power(qs, 2) + 1 +
    power(ps, 2)), 0.5)) * (power((power(q, 2) + 1 + power(p, 2)), 1.5)));
endfunction
```

$\mathrm{p}_b ar.m$

```
function pbar = p_bar( p, i , j )
  pbar = (p(i + 1,j) + p(i - 1,j) + p(i ,j + 1) + p(i ,j - 1))/4;
endfunction
```

$\mathrm{q}_b ar.m$

```
function qbar = q_bar( q, i , j )
  qbar = (q(i + 1,j) + q(i - 1,j) + q(i ,j + 1) + q(i ,j - 1))/4;
endfunction
```

reflectance.m

```
function ref = reflactance( p, q , ps, qs )
  ref = (p * ps + q * qs + 1)/(power(power(p,2) + power(q,2) + 1 ,0.5 ) *
     (power(power(ps,2) + power(qs,2) + 1 , 0.5)));
endfunction
```

tElapsed = 568.93