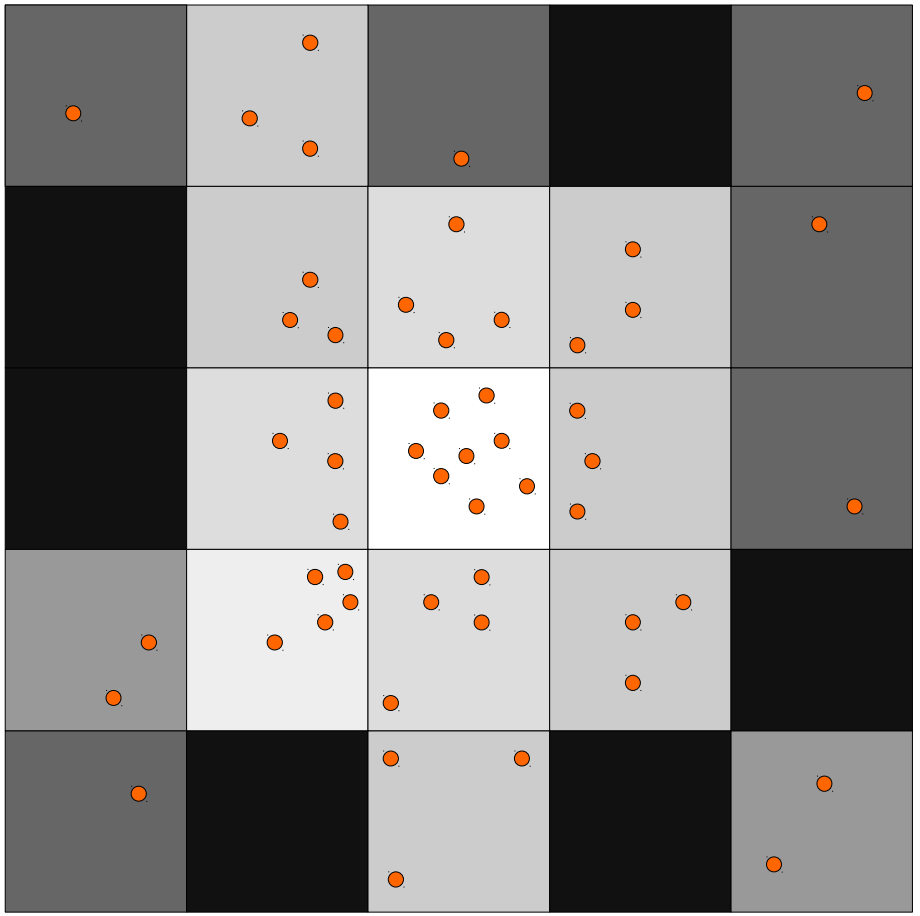
Лекция 14

Текстуры.

- Использование текстур в компьютерном моделировании.
- uniform переменные.
- Атомарные функции.

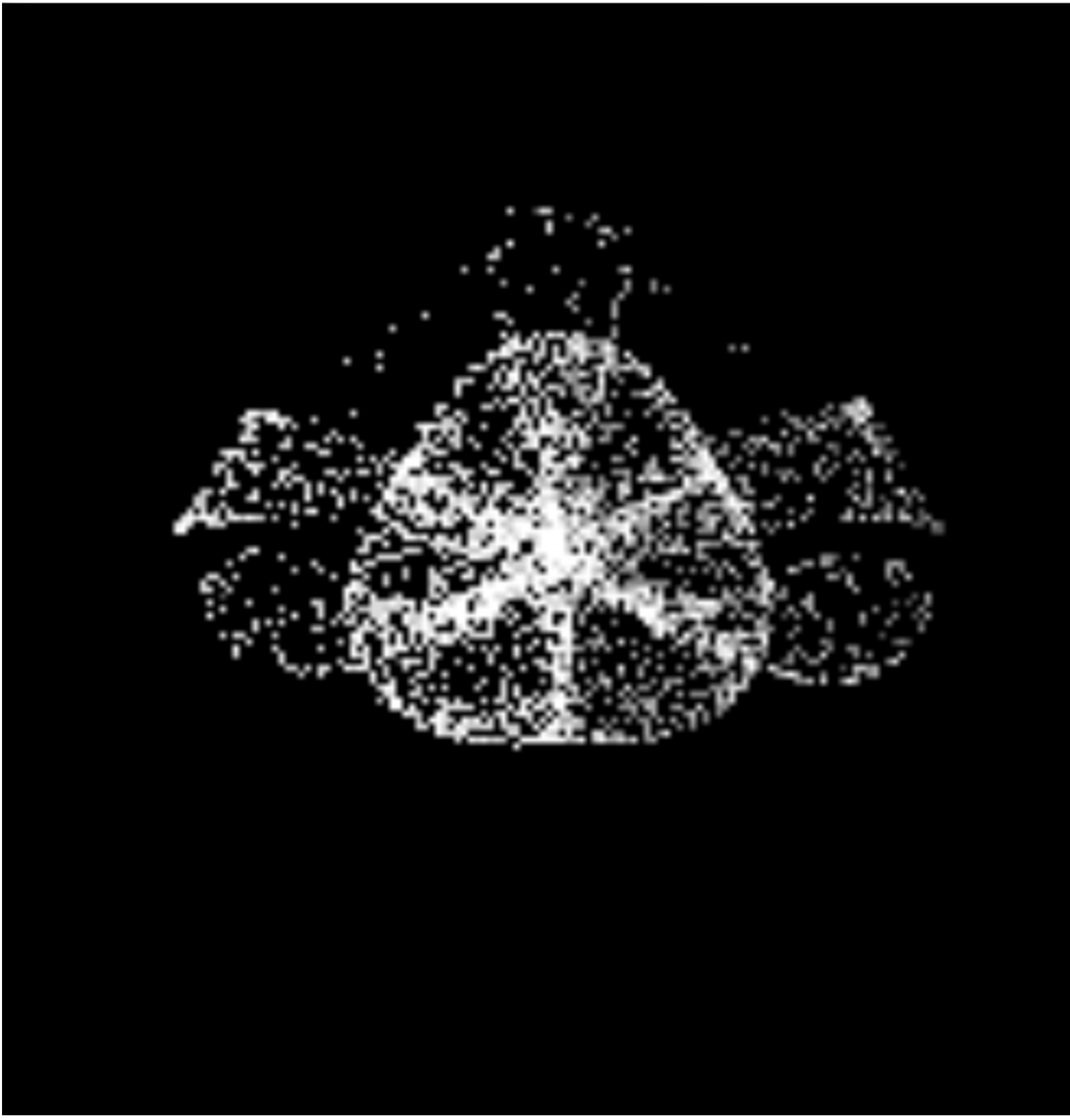


GLuint genInitProg();
GLuint genMoveProg();

```
……
i=int((Pos[index*6]-xmin)/hx);\
j=int((Pos[index*6+1]-xmin)/hy);\
atomicAdd(Grid[j+i*M],1);\
……
```

GLint GenGrid2TexProg();

```
……
color=log2(1.0+float(Grid[index]))/3.0;\
Tex[index*4]=color;\
Tex[index*4+1]=color;\
Tex[index*4+2]=color;\
Tex[index*4+3]=1.0;\
……
```



```
int main(){
  initGL();
  initBuffers();
……..

  do{
……..
      display();
      hMove();
      glfwSwapBuffers(window);
……..
```

```
void initBuffers(){
  genBuffers();
  genTexture();
  initMapBuffer();
  initTexBuffer();
}
```

```
enum bufferNames{POSITIONS, VELOCITIES, GRID,TEXTURE, MAP,
                                                    NUM_OF_BUFFERS};
const int L=128,M=128;
const int num_of_verticies=L*M;
```

```
void genBuffers(){
  glGenBuffers(NUM_OF_BUFFERS, bufferID);
  glBindBuffer( GL_ARRAY_BUFFER, bufferID[POSITIONS]);
  glBufferData( GL_ARRAY_BUFFER, 6*num_of_verticies*sizeof(float),
                                                    0, GL_DYNAMIC_DRAW );
  glBindBuffer( GL_ARRAY_BUFFER, bufferID[VELOCITIES]);
  glBufferData( GL_ARRAY_BUFFER, 3*num_of_verticies*sizeof(float),
                                                    0, GL_DYNAMIC_DRAW );
  glBindBuffer(GL_PIXEL_UNPACK_BUFFER, bufferID[TEXTURE]);
  glBufferData(GL_PIXEL_UNPACK_BUFFER , 4*L*M*sizeof(float),
                                                     0, GL_DYNAMIC_DRAW);
  glBindBuffer(GL_ARRAY_BUFFER, bufferID[GRID]);
  glBufferData(GL_ARRAY_BUFFER, L*M*sizeof(uint),
                                                      0,GL_DYNAMIC_DRAW);
}
```

```
GLuint genTexture(){
  GLuint texHandle;

  glGenTextures(1, &texHandle);

  glBindTexture(GL_TEXTURE_2D, texHandle);
  glTexStorage2D(GL_TEXTURE_2D, 1, GL_RGBA8, L, M);

  glBindBuffer(GL_PIXEL_UNPACK_BUFFER, bufferID[TEXTURE]);

  glTexSubImage2D(GL_TEXTURE_2D,
                  0,
                  0, 0,
                  L, M,
                  GL_RGBA, GL_FLOAT,
                  (Glvoid*)NULL
          );
```

```
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER,
                                                  GL_LINEAR);//GL_NEAREST);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER,
                                                  GL_LINEAR);//GL_NEAREST);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_S,
                                                      GL_CLAMP_TO_EDGE);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_T,
                                                      GL_CLAMP_TO_EDGE);

  glGenerateMipmap(GL_TEXTURE_2D);

  checkErrors("Gen texture");

  return texHandle;
};
```

```
void initMapBuffer(){
  static const GLfloat tex_map[] = {
         0.75f, -0.75f,
        -0.75f, -0.75f,
        -0.75f,  0.75f,
         0.75f,  0.75f,

         0.0f, 0.0f,
         1.0f, 0.0f,
         1.0f, 1.0f,
         0.0f, 1.0f
  };
  glBindBuffer(GL_ARRAY_BUFFER, bufferID[MAP]);
  glBufferData(GL_ARRAY_BUFFER,
            sizeof(tex_map),
            tex_map, GL_STATIC_DRAW);
}
```

```
void initTexBuffer(){
  csDataInit(bufferID, L*M);    //запускают вычислительные шейдеры для
  csGrid2Tex(bufferID, L*M);  //инициализации буфера текстуры
}
```

```
void csDataInit(GLuint* inBuf,int N){
  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 0,
                                                    inBuf[POSITIONS]);
  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 1,
                                                  inBuf[VELOCITIES]);
  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 2, inBuf[GRID]);

  GLuint computeShaderID=genInitProg();
  glUseProgram(computeShaderID); // Связывание вычислительного
                                                  // шейдера
  GLuint loc = glGetUniformLocation(computeShaderID,"L");
  glUniform1i(loc, L);
  loc = glGetUniformLocation(computeShaderID,"M");
  glUniform1i(loc, M);
  glDispatchCompute(N/128, 1, 1); // Выполнение вычислительного
                        //шейдера со 128 рабочими группами (workgroups)
  glMemoryBarrier( GL_SHADER_STORAGE_BARRIER_BIT);
}
```

```
"#version 430\n",
"layout (local_size_x = 128, local_size_y = 1, local_size_z = 1) in; \
 layout(std430, binding = 0) buffer PositionBuffer{float Pos[];};\
 layout(std430, binding = 1) buffer VelocityBuffer{float Vel[];};\
 layout(std430, binding = 2) buffer GridBuffer{int Grid[];};\
 uniform int L,M;\
 float lmap(in uint i){\
  uint count;\
  float x=0.78;\
  for(count=0;count<i;count++)\
    x=3.99*x*(1-x);\
  return x;\
 }\
```

```
    void main() {\
     uint index = gl_GlobalInvocationID.x;\
     float hx=1.5/L;\
     float hy=1.5/M;\
     int i,j;\
     Pos[index*6]=-0.5+1.0*lmap(index);\
     Pos[index*6+1]=-0.5+1.0*lmap(index*10);\
     Pos[index*6+2]=0.0;\
     Pos[index*6+3]=0.0;\
     Pos[index*6+4]=0.0;\
     Pos[index*6+5]=0.0;\
     Vel[3*index]=-0.5+1.0*lmap(index);\
     Vel[3*index+1]=-0.5+1.0*lmap(index*10);\
     Vel[3*index+2]=0.0;\
     Grid[index]=0;\
     barrier();\
     i=int((Pos[index*6]+0.75)/hx);\
     j=int((Pos[index*6+1]+0.75)/hy);\
     atomicAdd(Grid[j+i*M],1);\
  }"
```

```
void csGrid2Tex(GLuint* inBuf,int N){

  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 0, inBuf[GRID]);
  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 1,
                                                  inBuf[TEXTURE]);

  GLuint computeShaderID=genGrid2TexProg();
  glUseProgram(computeShaderID);

  glDispatchCompute(N/128, 1, 1);

  glMemoryBarrier( GL_SHADER_STORAGE_BARRIER_BIT);
}
```

```
"#version 430\n",
"layout (local_size_x = 128, local_size_y = 1, local_size_z = 1) in;\
 layout(std430, binding = 0) buffer GridBuffer{uint Grid[];};\
 layout(std430, binding = 1) buffer TexBuffer{float Tex[];};\
 void main() {\
  float color;\
  uint index = gl_GlobalInvocationID.x;\
  color=log2(1.0+float(Grid[index]))/5.0;\
  Tex[index*4]=color;\
  Tex[index*4+1]=color;\
  Tex[index*4+2]=color;\
  Tex[index*4+3]=1.0;\
  }"
```

```
void hMove(){
  csMove(bufferID, num_of_verticies);
  csGrid2Tex(bufferID, num_of_verticies);
  genTexture();
}
```

```
void csMove(GLuint* inBuf,int N){
  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 0,
                                                inBuf[POSITIONS]);
  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 1,
                                                inBuf[VELOCITIES]);
  glBindBufferBase(GL_SHADER_STORAGE_BUFFER, 2, inBuf[GRID]);

  GLuint computeShaderID=genMoveProg();
  glUseProgram(computeShaderID);

  GLuint loc = glGetUniformLocation(computeShaderID,"L");
  glUniform1i(loc, L);
  loc = glGetUniformLocation(computeShaderID,"M");
  glUniform1i(loc, M);

  glDispatchCompute(N/128, 1, 1);
  glMemoryBarrier( GL_SHADER_STORAGE_BARRIER_BIT);
}
```

```
"#version 430\n",
"layout (local_size_x = 128, local_size_y = 1, local_size_z = 1) in; \
 layout(std430, binding = 0) buffer PositionBuffer{float Pos[];};\
 layout(std430, binding = 1) buffer VelocityBuffer{float Vel[];};\
 layout(std430, binding = 2) buffer GridBuffer{int Grid[];};\
 uniform int L,M;\
 void main() {\
  float x,y,vx,vy;\
  float tau=0.01;\
  float eps=0.5;\
  float hx=1.5/L;\
  float hy=1.5/M;\
  int i,j;\
  uint index = gl_GlobalInvocationID.x;\
```

```
        x=Pos[index*6];\
        y=Pos[index*6+1];\
        vx=Vel[3*index];\
        vy=Vel[3*index+1];\
        \
        vx=vx+tau*10.0*(-x-eps*(2*x*y));\
        vy=vy+tau*10.0*(-y-eps*(x*x-y*y));\
        \
        x=x+tau*vx;\
        y=y+tau*vy;\
        \
        Pos[index*6]=x;\
        Pos[index*6+1]=y;\
        Vel[index*3]=vx;\
        Vel[index*3+1]=vy;\
        Grid[index]=0;\
        barrier();\
        i=int((Pos[index*6]+0.75)/hx);\
        j=int((Pos[index*6+1]+0.75)/hy);\
        atomicAdd(Grid[j+i*M],1);\
}"
```

Спасибо за внимание!