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WebGL

545

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// ..

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// ..
“ ” . ..-.., . ..
, //

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Mathematics & Mechanics Faculty

Software Engineering Chair

Development and implementation of geometry algorithms based on WebGL for 3D human anatomy deformations

by

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Graduate paper

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reviewer	.	graduate student A.G. Petrov
"Approved by" Head of Department	.	Professor A.N. Terekhov

Saint Petersburg

2012

1

. , , . , , , , . , “Software as a Service” - .

Software-as-a-Service (“SAAS”) - , Web-, . , , , .

, , . , . , .

, , , . , *.OBJ. SAAS, , . ,

. .

2

2.1

- . web-, , OBJ-. AJAX , JSON . API, , .

2.1.1

web-, HTML5.0 Javascript. WebGL.

WebGL[?] - , JavaScript, 3D web-. WebGL . Khronos Group, . Apple Safari, Google Chrome, Mozilla Firefox, Opera, AMD NVidia. Safari, Mozilla, Opera Chrome, Internet Explorer IEWebGL. Nokia N900, Safari Mobile iOS 4.2.

WebGL - . - .[1]

2.1.2

C “Node.js”. JavaScript , JavaScript- “V8”, Google Google Chrome.

“Node.js”[?] - , I/O JavaScript. , , I/O “EventMachine” Ruby. “EventMachine” EcmaScript 5.0, JavaScript, “Node.js” . I/O (web-), I/O , “Node.js”-.

. , . , , - .

“Node.js”, , . . , web-, , , “Node.js” . “Node.js” , , proxy . , , .

“Node.js” . Connect, - , . , , .

, - - , .

[1] , WebGL Mobile Safari iAd

2.2

. . . , , .

2.2.1 Flash

web- Flash, . , . , .

, Flash . Adobe, Flash , . - , . , .

2.2.2 3D- Unity

Unity OS X Windows. - , , , . , SAAS, .

web-, Unity

- , Unity-. .
- Flash. , Flash.

, . , , .

2.2.3 Ruby on Rails

. , . html-. : “Ruby on Rails”, “Django” “Node.js” “Express.js”[?]. “Ruby on Rails” “Django” Ruby on Rails “Node.js”.

“Ruby on Rails” , “Express.js”. open-source , . “Ruby on Rails” - , , . , “Node.js” .

“Node.js”.

3

3.1

3.1.1 “Three.js”

WebGL , . - , , [?]. , , , . - WebGL. “Three.js”.

“Three.js”[?] , JavaScript, . “Three.js” [2] . JavaScript-, WebGL. , (,) JavaScript JavaScript , .

3.1.2 Strategy

, .

1. "".
2. "".

, , . Strategy[?], .

Strategy .

```
1  function FooTool(context) {
2      this.context = context;
3  }
4
5  FooTool.prototype.setUp = function() {
6      // set up event listeners for context
7  }
8
9  FooTool.prototype.tearDown = function() {
10     // remove all set event listeners
11 }
```

Foo, applyMouseStrategy(FooTool),

[2]

```
ManagedObject.prototype.applyMouseStrategy = function(Strategy) {
    if (this.mouseStrategy != null) {
        this.mouseStrategy.tearDown();
    }
    this.mouseStrategy = new Strategy(this);
    this.mouseStrategy.setUp();
}
```

1. , - , , tearDown().
2. - ,
3. setUp(),

, , .

3.1.3 Observer

, , , . , .

EventBus, , Observer[?].

```
// jQuery based implementation of event bus

var EventBus = {
    subscribe: function(event, fun) {
        $(this).bind(event, fun);
    },
    publish: function(event, arg) {
        $(this).trigger(event, arg);
    }
}
```

- , :

1. subscribe(event, callback) - event callback
2. publish(event, arg) - event arg

, , jQuery[?]. , “< >:< >”. , , . , .

. , , , , .

3.1.4 AJAX

, , , obj- . , .

- AJAX (Asynchronous Javascript And XML). AJAX

1.

2. DHTML

AJAX JavaScript- XMLHttpRequest. . , Microsoft Internet Explorer XMLHttpRequest , .

```
function getXmlHttp(){
  var xmlhttp;
  try {
    xmlhttp = new ActiveXObject("Msxml2.XMLHTTP");
  } catch (e) {
    try {
      xmlhttp = new ActiveXObject("Microsoft.XMLHTTP");
    } catch (E) {
      xmlhttp = false;
    }
  }
  if (!xmlhttp && typeof XMLHttpRequest!='undefined') {
    xmlhttp = new XMLHttpRequest();
  }
  return xmlhttp;
}
```

, , , XMLHttpRequest, , , . abort(), , Internet Explorer . , XMLHttpRequest - , . jQuery, , “” XMLHttpRequest , “XPath”[?], .

3.2

3.2.1 “Express.js”

web- :

1. ,

2. html- ,

REST- “Node.js” “Express.js”. :

1.

2. ( )

3. [3]

REST-: REST, POST, PUT, DELETE. , HTTP 1.0 [?]: HEAD, GET, POST, HTML 4.0 PUT DELETE .

, “Express.js” PUT DELETE, method , .

3.2.2 web-

, , . HTML-, . , , “Ruby on Rails” erb- [4], “Java EE” Java Server Pages. - “Express.js” Jade.

Jade[?] - HTML-, JavaScript. Jade , DSL[5] (- Jade), HTML-. Jade , , HTML .

Jade . Jade

```
1  !!!
2  html(lang="en")
3    head
4      title= pageTitle
5      script(type='text/javascript')
6        if (foo) {
7           bar()
8        }
9    body
10     h1 Jade - node template engine
```

[3] HTML- web-,

[4] embedded ruby file

[5] Domain Specific Language

```
11      #container
12        if youAreUsingJade
13          p You are amazing
14        else
15          p Get on it!
```

, pageTitle = "Hello, Jade", HTML-

```
1  <!DOCTYPE html>
2  <html lang="en">
3    <head>
4      <title>Jade</title>
5      <script type="text/javascript">
6        if (foo) {
7          bar()
8        }
9      </script>
10   </head>
11   <body>
12     <h1>Jade - node template engine</h1>
13     <div id="container">
14       <p>You are amazing</p>
15     </div>
16   </body>
17 </html>
```

.

3.2.3 *.obj-

, OBJ. , “Three.js” OBJ- JSON-. convert_obj_three.py, Python, . , , 48 , .

, , . , .

1. OBJ-,
2. , “Three.js”
3. .

, , (). ./objects,

- ADD. . , , , ,
- LIST. . , ./objects
- REMOVE. . .

“Node.js” exec “child_process”. , , JavaScript.

4

4.1

“”. .

1.

2. , , , .

3. , ,

Strategy. , , , , . .

( ) , .

```
function ModifyingStrategy(mobject) {
    this.managedObject = mobject;
    this.formerRender = mobject.render;
}
```

, , “this”,

```
ModifyingStrategy.prototype.setUp = function() {
    var gthis = this;
    this.managedObject.render = function() {
        // Adding sphere is needed
        ....
        // Calling original rendering method
        gthis.formerRender.call(this);
    }
}
```

- , - .

, , , . , “Three.js” . Ray, , , . , , , . , .

, . $matrixWorld$, , . , , , $matrixWorld^{-1}$.

```
1 var v = intersection.point.clone();
2 var m = new THREE.Matrix4().getInverse(mesh.matrixWorld);
3 m.multiplyVector3(v);
```

. , - , , , .

: R, K.

1. p , .

2. $\vec{n}$.

3. $\vec{v} = -R \cdot \vec{n}$, R. S $= p + K \cdot \vec{v}$ R

4. u , S, , . -

$$(\vec{u} - \vec{c}) \cdot \vec{n} = |\vec{u} - \vec{c}| \cdot |\vec{n}| \cdot cos(\vec{u} \wedge \vec{n})$$

, , . .

5. , , , $\vec{n}$

.

, - $\vec{s}$, , , $\vec{d}$.

$$\vec{p}_{line} = \vec{s} + k \cdot \vec{d}$$

, (x_c, y_c, z_c)

$$(x - x_c)^2 + (y - y_c)^2 + (z - z_c)^2 = R^2$$

, . .

k_1, k_2 , $\vec{s}$, . , , .

4.2

, , . . .

. 1. a ( )

- , . , [6], . : “Three.js”, WebGL, , . WebGL , , , . , , , . , . , “Three.js”. .

-
- *.OBJ-

, . . , , , .

[6] ,

. 2.

5

, web-, . :

1. FPS (Frames per second) - . , 30FPS .

2. . .

.

	couch1	Jane_solid_obj	ladybird	Woman-head	Mini-cooper
	3098	12334	23496	114344	254714

1.

:

- : Google Chrome v.19.0
- : Intel Core i5, 1.7, - 3
- : 4 DDR3 1333
- : Intel HD Graphics 3000 384

5.1 :

WebGL “Three.js”. , :

1. web- *.OBJ

2.

3. FPS,

??. , WebGL “Three.js” .

	3098	12334	23496	114344	254714
FPS	60	60	60	60	59

2. FPS

5.2 :

. , , :

1. web- *.OBJ
2.
3. FPS,

	3098	12334	23496	114344	254714
FPS	60	41	22	6	2

3. FPS “”

??.

. , (,).

, , JavaScript $O(N)$, N - . FPS .

,

1.
2. , . , $O(N)$, .

5.3

, - “”. $O(N)$, ,

1. , , JavaScript

2. , ,

, , .

6

6.1

, , . JavaScript .

. - (). , .

- .

1. , ,
2. -
3.
4. ,
5.

( ), , - .

, , , , (, - JavaScript, ++).

, JavaScript . .

6.2 Protocol Buffers Apache Thrift

. , . .

, . :

- Google Protocol Buffers
- Apache Thrift

Apache Thrift Google Protocol Buffers . (. ??).

, , , , Apache Thrift .

	Apache Thrift	Google Protocol Buffers
	Binary, JSON	Binary
“Node.js”		

4. Apache Thrift Google Protocol Buffers

6.3 Apache Thrift

Apache Thrift[?] - , . , , , , , , . , Thrift .

Thrift : , , , . , . Apache Thrift , , , . “MainService_server.skeleton.cpp”, .

```
1 struct Point {
2     1: double x,
3     2: double y
4 }
5
6 service ScaleService {
7     Point scalePoint(1:Point point, 2:int scalar)
8 }
```

1. Thrift

, . , thrift, . “server.cpp”, “include” . , , , Thrift, , .

, , “generate.sh” “bash”, . ,

1. *.cpp *.h ./thrift/algo. , .

2. “bash generate.sh” ./thrift, Thrift

“./thrift/server” . , “Node.js” , , . “generate.sh”

1. gen-nodejs gen-cpp, , .

2. , , , “*.h” , , Thrift

3. Thrift , JavaScript “Node.js”

4. “remoteComputing.js”, , . “Node.js”

5. Thrift , C++.

6. “server.cpp”, Thrift,

7. , js-

8. “server.cpp”, .

2, “*.h” . “ctags”. , ,

```
1    ctags -x --c-kinds=p *.h | cut -f1 -d' '
```

6.4 Node-Thrift

Apache Thrift “Node-Thrift” “Node.js”, , .

, , . echo-, “Node.js” C++.

```
1 service EchoService {
2     double echo(1:double msg);
3 }
```

, 0 . , double. , Ruby . , “Node-Thrift” “Node.js”. .

, Node-Thrift . , 8- . , [?], , .

7

, , . , , .

```
#include "scale_x2.h"
using namespace std;
using namespace threejs;

void scale_x2(Geometry& _return, const Geometry& geom) {
    vector<Vertex> vv = geom.vertices;
    for(vector<Vertex>::iterator it = vv.begin(); it != vv.end(); ++it) {
        Vertex v = *it;
        v.x *= 2;
        v.y *= 2;
        v.z *= 2;

        _return.vertices.push_back(v);
    }
}
```

- , , . WiFi, 3G, .

, , ,

- : 3073
- : 500
- : 2 / ,

, ??

	3098	12334	23496	114344	254714
LAN ,	397	826	2394	4103	17956
3G ,	3344	8402	34018	-	-
node-thrift	43.5	148.5	672	1278.5	5448.5

5.

, LAN, 3G .

8

, . :

- , , .
- , Thrift.js

: , -, . .

, , .

8.1

, Three.js. , . Three.js , .

```
var fs = require('fs');
var vm = require('vm');

var t = fs.readFileSync('./public/js-libs/Three.js', 'utf8');

self = {};
window = {};
vm.runInThisContext(t);
```

```
function loadModel(path, callback) {

    var l = new THREE.JSONLoader();

    fs.readFile(path, 'utf8', function(err, j) {
        var jj = JSON.parse(j);

        l.createModel(jj, callback);
    });
}
```

8.2

, , . , : SessionID. SessionID, -, , .

Connect.js

9

, , , .

, ??

	3098	12334	23496	114344	254714
LAN ,	213	513.5	1941.5	3718.5	12572
3G ,	603	1571	3871	6003	-
node-thrift	33.5	143	654	1230	-

6.

, LAN, .

10

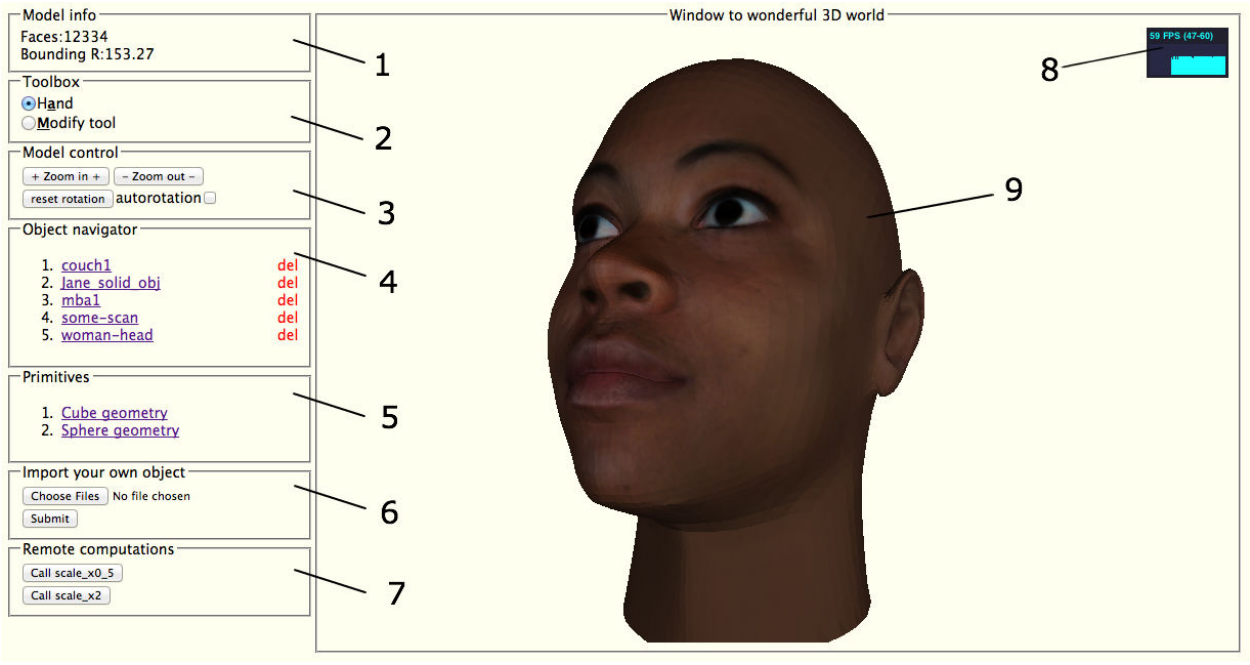
. , :

- *.OBJ
- ,
-
- , ++

:

1.

2. ++


Model info
Faces:12334
Bounding R:153.27
Toolbox
Hand
Modify tool
Model control
+ Zoom in +
- Zoom out -
reset rotation
autorotation
Object navigator
1. couch1 del
2. Jane_solid_obj del
3. mba1 del
4. some-scan del
5. woman-head del
Primitives
1. Cube geometry
2. Sphere geometry
Import your own object
Choose Files
No file chosen
Submit
Remote computations
Call scale_x0_5
Call scale_x2
Window to wonderful 3D world
59 FPS (47-60)
1
2
3
4
5
6
7
8
9

. 3.

?? -

1 .

2 .

3 : , ,

4 OBJ-, . “del” .

5

6 OBJ- OBJ- .

7 ,

8 FPS FPS

9 3D

[1] WebGL
http://www.khronos.org/webgl.

[2] Node.js
http://nodejs.org/

[3] Express.js
http://expressjs.com/

[4] Three.js
https://github.com/mrdoob/three.js/

[5] Apache Thrift
http://thrift.apache.org/

[6] node-thrift
https://github.com/aslushnikov/node-thrift

[7] Jade
http://jade-lang.com/

[8] JQuery
http://jquery.com/

[9] JQuery Form
http://jquery.malsup.com/form/

[10] Underscore
http://documentcloud.github.com/underscore/

[11] WebGL. .
http://learningwebgl.com/blog/?p=28

[12] Observer

http://en.wikipedia.org/wiki/Observer_pattern

[13] Strategy

http://en.wikipedia.org/wiki/Strategy_pattern

[14] HTTP 1.0

http://www.w3.org/Protocols/HTTP/1.0/draft-ietf-http-spec.html#Methods