Dynamically Generating Virtual Reality Scenes Using Molly and A-Frame

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Abstract - Two tag-based authoring systems, A-frame on the client-side, and Molly on the server-side, when used together can dynamically generate web-based Virtual Reality (VR) scenes. A-Frame is a tag-based abstraction layer built on top of WebVR and JavaScript and is used to create virtual reality environments and applications that run in a web browser. Molly is a tag-based abstraction layer on top of PHP and SQL used server-side designed to facilitate construction of web sites and applications. When combined they enable the creation of sophisticated dynamic web-based VR environments without any need for programming.

Keywords: Virtual Reality, VR, A-Frame, Molly, Dynamic VR Environment

1 What is Molly?

Molly is a tag-based abstraction layer on top of PHP and SQL used server-side to build web sites and applications.

The Molly system [28,29] is an ongoing research project at the Rochester Institute Technology, whose goal is to simplify the process of creating dynamic web sites. Hypertext Markup Language (HTML) was designed as a simple, portable means by which web authors could create content quickly and easily. However, with the advent of data-driven dynamic web pages, the task of content creation has become daunting and overwhelming to those with introductory to moderate programming skills. To combat this problem and to return web application development to the content creator, one of the authors of this paper (Vullo) created Molly. The Molly project has been a years-long effort to bring simplicity to dynamic web site development. Molly is an open source system and architecture that allows web site developers to build dynamic web sites using HTML and MAML (Molly Active Markup Language) tags. MAML tags provide the web author with components that can be used to build sophisticated server-side functionality without programming. Molly has been used to build web communities, content management systems, portals, wikis, etc. Molly also serves as a web research platform for faculty, graduate students, and undergraduate students at the Rochester Institute of Technology (RIT).

2 MAML Tag Usage

In order to demonstrate the ease of MAML tag usage, this section presents two case examples. First, this section examines the use of the MAML fetch tag and its associated sub-tags to dynamically generate a user-sortable table of data from a database. Second, this section examines the use of the MAML login tag and how Molly manages user sessions.

<table>
<thead>
<tr>
<th>Name</th>
<th>Eye Color</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfonso</td>
<td>Blue</td>
<td>88</td>
</tr>
<tr>
<td>Genny</td>
<td>Brown</td>
<td>6</td>
</tr>
<tr>
<td>Heather</td>
<td>Blue</td>
<td>28</td>
</tr>
<tr>
<td>Jane</td>
<td>hazel</td>
<td>44</td>
</tr>
<tr>
<td>Jose</td>
<td>purple</td>
<td>128</td>
</tr>
<tr>
<td>Juan</td>
<td>Pink</td>
<td>5</td>
</tr>
<tr>
<td>Meh</td>
<td>grey</td>
<td>666</td>
</tr>
<tr>
<td>Michelle</td>
<td>brown</td>
<td>14</td>
</tr>
<tr>
<td>Paco</td>
<td>Brown</td>
<td>22</td>
</tr>
<tr>
<td>Ron</td>
<td>Brown</td>
<td>48</td>
</tr>
<tr>
<td>Sam</td>
<td>Green</td>
<td>99</td>
</tr>
<tr>
<td>Tim</td>
<td>brown</td>
<td>22</td>
</tr>
<tr>
<td>Zeus</td>
<td>black</td>
<td>3000</td>
</tr>
</tbody>
</table>

Figure 1. Example MAML Database Lookup Output
The above code would be embedded in a full web page, but is separated out here for clarity. Line 1 is the `<maml:fetch>` tag which sets up the database query using simple xml tag attributes. The `table` attribute specifies which database table or tables the query will be performed against. The `criteria` attribute contains what becomes the SQL WHERE clause – in this case, setting it to true fetches all the records in the table. Lines 2 and 3 are the HTML tags to begin a standard table. For each table header cell – lines 4-6 – the header text is enclosed by the `<maml:sort>` tag. This automatically creates a link which will re-render the page with the `sort` attribute of the `<maml:fetch>` tag overridden to resort the table appropriately. Line 8 begins the `<maml:row>` tag, which ends on line 14. Everything between these tags repeats for as many records as the query generated by the `<maml:fetch>` tag finds. As you can see, on lines 10-12 we use the `<maml:field />` tag to output the data from the various columns of the results.

![Figure 3. MAML Generated Login and Logout](image3.png)

Using the simple `<maml:login>` tag on any page creates a widget that will allow users to log in (or log out if they are already logged in) to the web site. Together with the login system, Molly’s permissions system allows the web site author to determine what the user can do and see. Login can use database tables (either locally or remotely) or LDAP for login verification.

![Figure 4. MAML Code for Molly’s Login/Logout System](image4.png)

Line 16 shows the `<maml:login>` tag with the optional `response` attribute. By default, the response page is the page the tag is on. In the `response` attribute you can see the use of one of Molly’s built-in tokens: `*[HTMLRoot]` which will be replaced by the correct path when the page is processed. On line 9 you can see the `<maml:block>` tag which uses the login and permissions system to allow certain users to edit the content of a section of a page via an online WYSIWYG editor. Molly also extends the PHP sessions system to allow web developers to easily generate a list of who is logged in at any moment (using the `<maml:fetch>` tag documented above). This makes creation of various social media sites fairly simple.

### 3 What is A-Frame?

A-Frame is a tag-based abstraction layer on top of WebVR and JavaScript used to create client-side virtual reality environments and applications that run in a web browser.

The A-Frame project was started by the Mozilla Virtual Reality (VR) group to facilitate WebVR content creation. It is a framework for building virtual reality environments based on a tag-based abstraction layer over WebVR and JavaScript.

A-Frame allows developers to build VR scenes using just HTML and some additional A-Frame HTML-like tags. Developers also have unlimited access to the underlying JavaScript (specifically three.js) and all existing Web APIs. A-Frame uses an entity-component-system that promotes composition and extensibility. It is a free and open source product with a community of developers building tools and components.

Because A-Frame is based on the W3C HTML Document-Object Model (DOM), most existing libraries and frameworks (i.e. React, Vue.js, d3.js, jQuery, and Angular) can be used in creating A-Frame environments. Since most existing web development tools were built on the basis of manipulating plain HTML, they are compatible with A-Frame.

A-Frame was built to make virtual reality development more accessible to web developers than traditional game-engine VR development systems. It is easy to get started with A-
Frame and leverage existing web development experience to learn and develop VR environments. A-Frame is a fairly light-weight system, therefore these environments lend themselves to use in smart phone web browsers with inexpensive headsets such as Google Cardboard or Vullo’s DIY VR headset kits.

4 A-Frame Tag Usage

Here we present a simple example of creating a basic VR scene using A-Frame and HTML tags.

Figure 5. Simple A-Frame VR Environment

Above is a screen capture from a web browser displaying a simple 3D environment created in A-Frame. Dragging the mouse around the browser window changes the perspective. If the browser is on a smart phone or Oculus/Vive compatible browser, then clicking on the headset icon puts the rendering into VR mode with two images for 3D viewing and motion tracking for looking around the environment.

Figure 6. “Hello VR” Code

As you can see, A-Frame works similarly to Molly, in that you embed A-Frame tags, like the `<a-sphere>` tag, which allows you to create and place objects within the scene. The `<a-entity>` and `<a-camera>` tags allow you to place the user into the scene.

5 Why Use Them Together?

Since Molly is designed to simplify the development of dynamic web sites, and A-Frame is designed for developers to build 360-degree VR scenes using HTML, using them together could streamline VR development. In other words, it would help users that are not web developers to more easily develop VR environments.

Using Molly, developers can create a dynamically generated environment and perform database lookups easily. Using A-Frame, a VR author can create an immersive 360-degree environment. When combined together, developers can make a 360-degree immersive environment that can pull information from databases using Molly and easily change the objects in the environment.

Because A-Frame is a client-based text/tag system – built in JavaScript – and Molly is a server-based text/tag generation system, the two work extremely well together. For example, the `<maml-fetch>` tag suite can easily use data from a table to dynamically generate `<a-sphere>` (or any other A-Frame) tags complete with their own positioning and other attributes. Combined with Molly’s login and sessions systems, A-Frame objects could be generated and associated with logged in users as avatars, for example. Using AJAX to update the scene with fresh queries via Molly allows relatively easy creation of multi-user VR spaces.

Figure 7. A Dynamically Generated “Map Room” of shared virtual spaces.

We have used Molly and A-Frame together to prototype virtual shared spaces, such as the “map room” in figure 7 and continue to explore the possibilities. Figure 8 shows the combination of MAML and A-Frame used to generate and locate the spheres in the map room from a database table.

Figure 8. Map Room Spheres Code
As you can see, we use the previously described <maml:fetch> and <maml:row> tags to query the database for the information needed to create the various spheres in the map room. Instead of the <maml:field> tags used in the previous HTML table example, the alternative token syntax is used here for database values such as *[position_x]*, *[position_y]*, and *[position_z]* which allows these values to be inserted into the <a-sphere> tag’s position attribute in a syntactically correct manner.

By combining MAML and A-Frame, we now have a VR space which can be modified simply by changing the data in the database table(s) used to generate the scene. Adding, deleting, moving, or renaming the spheres requires no modification of the code.

6 Summary

A-Frame is a tag-based abstraction layer on top of WebVR and JavaScript used to create client-side virtual reality environments and applications that run in a web browser. Molly is a tag-based abstraction layer on top of PHP and SQL and employed server-side to build web sites and applications. Used together they enable the creation of sophisticated dynamic web-based VR environments without any need for programming.

7 References

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8 About the Authors

Dr. Vullo is Associate Professor, Department of Information Sciences and Technologies, creator and director of the Minor in Web Design and Development for non-computing Majors, and MAGIC Center faculty affiliate.

Miss Catalfamo is an Alumna of the Rochester Institute of Technology’s Motion Picture Science program and a member of the Society of Motion Picture & Television Engineers (SMPTE). She also earned a Minor in Web Design and Development during which she was first exposed to the DIY VR project.