

Effects of two-way data binding on better user experience and easier development of Clinical information systems

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Abstract. Today healthcare organizations integrate many types of clinical information systems. These systems are used to collect, manage and report patient-related data, with a goal to increase quality of patient care and clinical research. However, end user experience with these systems, in many cases, is not satisfactory [1]. This paper describes a development method and web technology which ensures more effective manipulation of data, and easier development of applications. This method can be used in developing several web-based clinical information system types; such as EHR or LIMS.

Keywords: Clinical information systems, electronic health record, data search, web-based clinical applications, data quality, user experience

1. Introduction

While designing and developing clinical information systems, either from ontology aspect, database architecture, or development environment, it is crucial to understand all relevant points – define clearly all requirements, and list all possible interactions with other systems. LIMS, for instance, as a software used to manage data and increase control quality in laboratories, should be automated in order to provide maximum efficiency. On the other hand, manual data entry should be minimized, search of data very efficient, ensuring an easy task for a lab worker. Manual or operator work will always be required to some point - that's why we must aim to optimize this process by usage of efficient tools and modern web technologies; such as AngularJS framework, and JavaScript.

When surveyed about what the major challenges were facing in their operations, laboratories shared a short list of common issues [2]. These included: meeting turn around times (TAT) and holding times, missed sampling events, certification audits, unprofitable departments, **lost time searching for or checking data**, and cash flow problems. These issues can be grouped in two main topics, **data quality** and costs. In a laboratory, these two topics are usually linked. The aim of this paper is to show how a process of searching for data in a typical electronic patient record can be improved. We developed a simple demo app using AngularJS Framework – as a proven and powerful environment [5], JavaScript language, and standard HTML.

2. AngularJS and „healthApp“ demo

AngularJS is a full frontend MVC framework for JavaScript web applications. It was built at Google and provides a way to *quickly* **build large, single-page web applications**. Like jQuery, it is included into a page using the <script> tag, and is itself written in JavaScript.

```
<!doctype html>
<html lang="en" ng-app="healthApp">
<head>
  <meta charset="UTF-8">
```

```

<title>HealthCare App Demo for SWAT4LS 2014</title>
<script
src="http://ajax.googleapis.com/ajax/libs/angularjs/1.3.2/angular.min.js"><
</script>
<script
src="http://ajax.googleapis.com/ajax/libs/angularjs/1.3.2/angular-
route.js"></script>

```

Unlike jQuery, it can be used as a framework **upon which an entire healthcare web application is built**. It actually includes a minimal version of jQuery by default. To show this, we developed a healthApp demo – Patient Search module (while the same method can be easily implemented into wide range of clinical information system requirements, where end user is involved).

2.1. Two-way Data binding

Two way data binding occurs when a model variable is bound to a HTML element that can both change and display the value of the variable. In general, we can have more than one HTML element bound to the same variable [6].

We used the `ng-model` directive to bind a model variable to the HTML element that can not only display its value, but also change it. This method can be efficiently used when we need to search data from EHR, LIMS, or wherever there is requirement for efficient filtering of medical data. Figure 1. explains the difference between traditional one-way data binding and new approach in development, two-way data binding model.

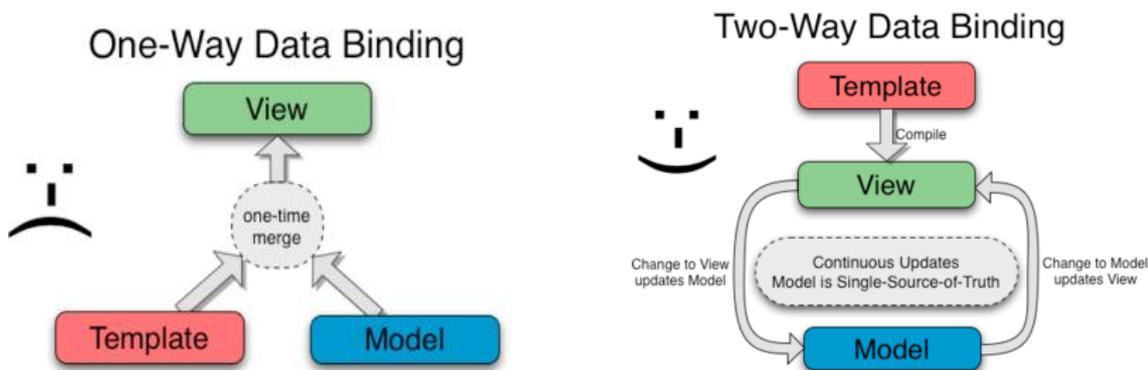


Figure 1. Difference between traditional one-way, and two-way data binding model

In our first example, we bind the `email` and `password` model variables to a couple of HTML elements. When the page is loaded, the value of the `input` elements are initialized to those of the respective model variables and whenever the user types something in an `input`, the value of the model variable is modified as well (two way).

```

<input type="email" class="form-control" id="email" placeholder="Enter your
email" ng-model="email">
  </div>
</div>
<div class="form-group">
  <label class="control-label col-sm-2" for="pwd">Password:</label>
  <div class="col-sm-6">
    <div class="input-group">
      <span class="input-group-addon">
        <i class="fa fa-key fa-fw"></i></span>

```

```

        <input type="password" class="form-control" id="pwd"
placeholder="Enter your password" ng-model="pass">

```

2.2. Data Filtering

Filtering of data is very simplified: We use `| filter` command to define which variable will be used as a filter parameter, while sorting is enabled by `orderBy` command. healthApp Demo is an example of a SPA (single page application), where we are using Template feature – meaning that only necessary part of HTML is rendered. Complete coding of our `patient_list.html` page is provided below:

```

<div class="container" ng-controller = "listaController">
    <form class="form-horizontal" role="form">
        <div class="form-group">
            <div class="col-sm-6">
                <label>Filter:</label>
                <input type="text" class="form-control" placeholder="Filter"
ng-model="query">
            </div>
        </div>
        <div class="form-group">
            <div class="col-sm-6">
                <label>Sorting:</label>
                <select class="form-control" id="sell" ng-model="orderPatient">
                    <option value="name">Name</option>
                    <option value="adress">Adress</option>
                    <option value="age">Age</option>
                </select>
            </div>
        </div></form><br/>
        <br/>
        <label>Patient list:</label>
        <hr/>
        <table class="table table-striped table-bordered">
            <thead>
                <tr>
                    <th>Profile</th>
                    <th>Patient Name</th>
                    <th>Diagnosis</th>
                    <th>Therapy</th>
                    <th>Adress</th>
                    <th>Age</th>
                </tr>
            </thead>
            <tbody>
                <tr ng-repeat="p in patients | filter:query | orderBy:
orderPatient">
                    <td><a href="#/index/{{p.id}}" class="thumb"></a></td>
                    <td><a href="#/index/{{p.id}}">{{p.name}}</a></td>
                    <td>{{p.disease}}</td>
                    <td>{{p.therapy}}</td>
                    <td>{{p.adress}}</td>
                    <td>{{p.age}}</td>
                </tr>
            </tbody>
        </table>

```

Output of the Patient Search or Filter command is shown on the next figure.

Profile	Name and Surname	Diagnosis	Therapy	City/Municipality	Age
	Adis Ahmić	Mužnina u abdomenu. Iscrpljenost i povišena temperatura.	Antibiotik i Voltaren čepići.	Zeničko dobojski kanton	44
	Anela Hasić	Bol u glavi. Iscrpljenost	Brufen jedanput dnevno	Tuzlanski kanton	24
	Nihad Omerbegović	Upala grla	Paracetamol jedanput dnevno. Med i čaj	Sarajevski kanton	32
	Sead Medić	Upala lednog žvca	Odmor u banji Ilikaža 7 dana.	Sarajevski kanton	56

Figure 2. GUI/ Screen of the Patient record and power of data filtering

Figure 2. shows the output of the Patient record search and Filtering of data, based on any criteria. As soon as user starts typing specific term or a word (for ex: disease), results are instantly displayed on the screen.

3. Usage in practise

Two-way data binding method can be efficiently used in developing Sample Tracking or Patient Search modules of a web-based LIMS [3]. This method could be also implemented to reduce paper work in a laboratory.

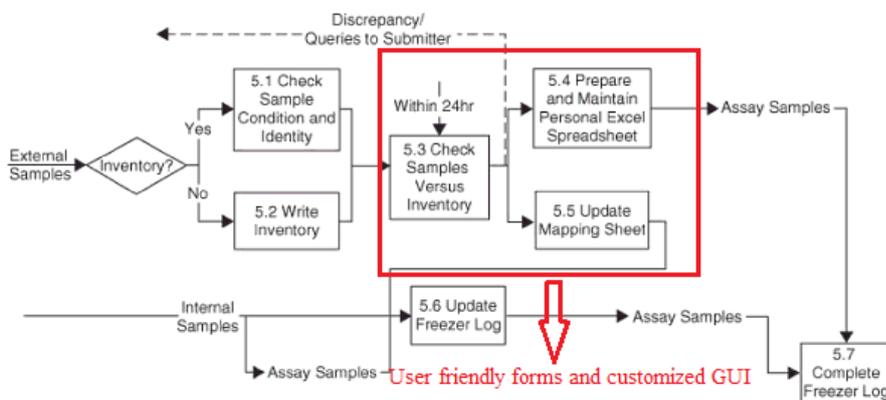


Figure 3. Standard Sample management process in a LIMS

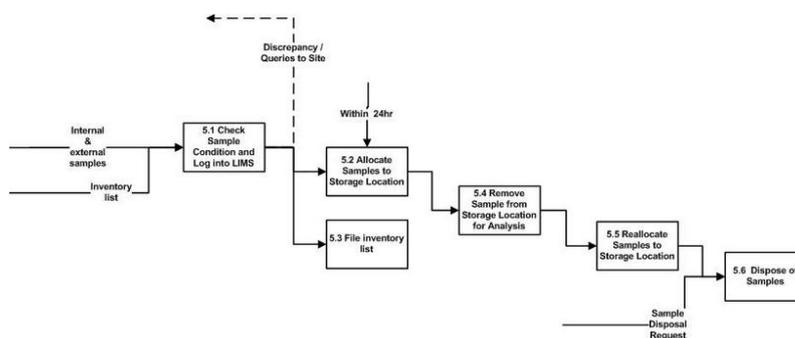


Figure 4. Optimized Sample management process in a LIMS

Figure 4. shows the improved sample management process that can be implemented in the LIMS, with a help of a two-way data binding method. Comparing figures 3. and 4., we can conclude that optimization of standard processes and improving of data search can lead to overall, system's better performance.

4. Conclusion

Data interoperability and data quality are some of the main issues in modern clinical information systems today. The main aim of our paper was to suggest developers of clinical information systems an easier method for developing standard features like search for patients, or sorting of sample results by using AngularJS framework two-way data binding model. Also, we intended to show how combining of these techniques and standard web languages like HTML and JavaScript can have effect on better end user experience and increased performance.

In this paper, we showed how:

- Optimized data search and filtering can improve user experience with EMR or LIMS apps.
- Drastically reduced programming code lines, comparing to ordinary JavaScript and jQuery.

5. Contact Us

If you have any further questions regarding this paper, then please do not hesitate to get in touch with us.

- For all questions related to our web-based clinical and eHealth applications, your contact person is: Mr. Nihad Omerbegović, e-mail: nihad.omerbegovic@gmail.com.
- For overall technical questions concerning the choice of technologies and optimization of the LIMS databases, please contact Mr. Nedim Omerbegović, e-mail: nedim230@gmail.com.

6. References

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