DOI: 10.15625/vap.2017.00024

FLEXIBLE RENDER MEDICAL DATA IN A CDA DOCUMENT ON MOBILE BROWSERS

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ABSTRACT: *Visual display medical data, medical image together exactly annotated a region of interest (ROI) is good practice for a physician to make a diagnosis. However, it may require a special-purpose system or good connectivity to view them, which is an unfeasible solution when a physician is on business or there is limited connectivity. In this study, we propose an method to share clinical document and visual display medical data together with ROIs via smartphone on a mobile browser. Achievement of this method is implemented and based on Health Level Seven Clinical Document Architecture (HL7 CDA) and eXtensible Markup Language (XML) Stylesheet Language for Transformation (XSLT) standards.*

Keywords: *Clinical Document Architecture, Region of Interest (ROI), Medical data, Medical Image, Mobile Device.*

I. INTRODUCTION

The integration architecture for a CDA generator enables embedding of ROIs and simultaneous auto-generation of corresponding style sheets. Using the CDA document and style sheet, a sender can transmit clinical documents and medical images together with coordinate values of ROIs to recipients. Recipients can easily view the documents and display embedded ROIs by rendering them in their web browser of choice [1].

Advantages of the approach can be indicated that if a physician works at a small and poorly equipped hospital has to examine a medical image of a patient. He finds an abnormal area on the image but is not able to determine what it is. He wonders if it is a malicious tumor. Therefore, the physician wants to arrange a consultation with other experts and wants to show them both the clinical document of the patient and the exact areas of concern (the ROIs) in the image. In this circumstance, a linguistic description is not the most effective method to explain the shapes and locations of the ROIs, thus cannot ensure a high level of understanding of the image at the other end, not allowing the expert to make a confident determination. By taking the approach, the physician can send the related information to an expert, and the expert can visualize the information within any web browser.

Fig.1. shows an example of rendering CDA document by using Mozilla FireFox 3.6.3. The document contents are presented by the patient's personal information section, image exam section, history of present illness section, etc. The original medical image and the shapes of ROIs are visually shown to recipients in the image exam section. The shapes of ROIs are represented by white polygons overlaid on the original image which is kept intact so that the recipient can further process it using any other preferred software tool, if necessary.

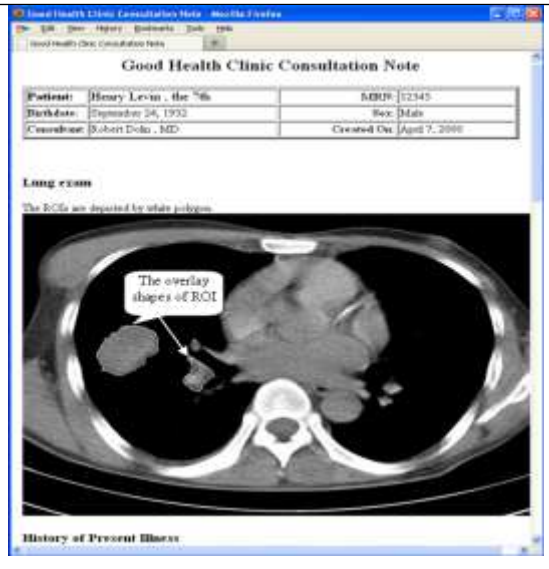

Fig. 1. Rendering CDA document by Mozilla FireFox

Using the CDA document, we tested against with six mobile browsers to see how they can render the CDA document containing ROIs, which are Android, Opera, Dolphin, Google Chrome, Internet Explorer and Firefox browser for mobile because they were the three most popular browsers as of May 2017 [2]. The testing results show that the CDA document can be well rendered on the mobile browsers. However, the shapes of ROIs do NOT properly appear overlaid on medical image.

In rendering the clinical information on a web or mobile browser, the corresponding style sheet pays a big role. The sub-function in the style sheet is important factor to present the corresponding shapes of ROIs overlaid on the medical image. The tested results also show that the function can work well on personal computer browser. However, it does not properly work on a mobile browser, due to different recognition of upper left hand corner of a medical image between web and mobile browser when the CDA document is browsed.

Fig.2 shows an example when we use Firefox browser for mobile to browse the CDA document on smartphone.

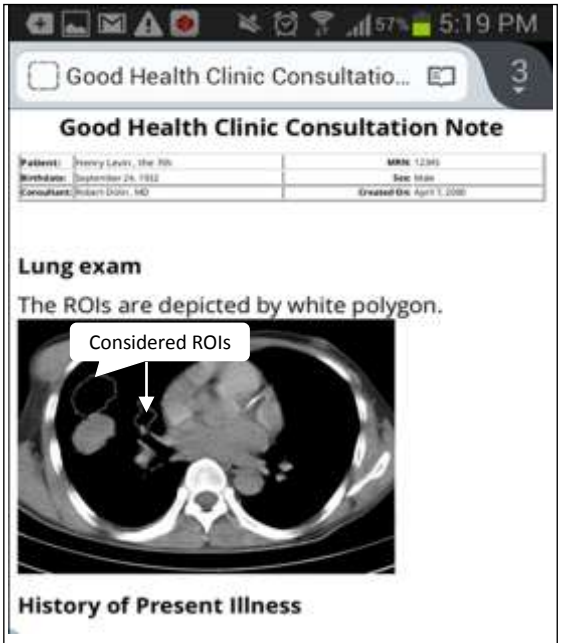

Fig. 2. Rendering ROIs and CDA contents on mobile browser before sub-function has been upgraded

So, in this study, we propose a method, which allows physician receiving and rendering clinical document, medical image together with ROIs via smartphone. Furthermore, this method enables the function to properly work on both web and mobile browsers. Finally, this will facilitate a physician's performance because using the mobile technologies physician can connect with internet, access email and exchange of documents via a smartphone at anytime and from anywhere through multi-connection such as: 3G, 4G and event Wi-Fi, etc.

II. METHODS

In this section, we will briefly present the some necessary techniques, which are used to implement the proposal.

The HL7 CDA document

The HL7 CDA Release 2 became an ANSI-approved standard in May 2005 [3]. It is an XML-based document markup standard that specifies the structure and semantics of clinical documents, and its primary purpose is exchanging clinical documents among heterogeneous software systems. CDA is also defined as a complete information object that can include text, images, sounds, and other multimedia contents.

A CDA document is wrapped in `<ClinicalDocument>` tags, and contains a header and a body. The header lies between the `<ClinicalDocument>` and `<structuredBody>` tags, identifies and classifies the document, and provides information on authentication, encounter, patient, and involved providers. The document body contains the clinical report and can be either an unstructured blob, or a structured markup. This architecture has the following six characteristics: persistence, stewardship, potential for authentication, context, wholeness, and human readability.

The region of interest (ROI)

The `RegionOfInterest` entry is a derivative of the Reference Information Model `Observation` class that represents a region of interest on an image, and the ROI is used to refer to specific regions in images. The units of

the coordinate values in `RegionOfInterest.value` are in pixels, expressed as a list of integers. The origin is in the upper left hand corner, with the positive `X` values going to the right and positive `Y` values going down [3]. There are four types of basic shapes that can be used in taking notes: circle, ellipse, point, and polyline. A circle is defined by two pairs (column, row), the first point is the center of the circle and the second is a point on the perimeter of the circle. An ellipse is defined by four pairs (column, row); the first two points specify the endpoints of the major axis, while the second two points specify the endpoints of the minor axis. A single point is denoted by a single pair (column, row) or multiple points each denoted by a column, row pairs. A polyline is a series of connected line segments with ordered vertices denoted by (column, row) pairs; if the first and last vertices are the same, then we have a closed polygon. In fact, the shape on the ROI in a medical image is varied; therefore, we cannot directly place information into CDA documents, so we need pre-processing for the related ROI information before embedding into the CDA document.

XSLT style sheet design and upgraded sub-function

As mentioned in the previous section, the XSLT style sheet is used to support the rendering of the CDA contents and the embedded shapes of ROIs. The sub-function in the style sheet is important factor to present the corresponding shapes of ROIs overlaid on the medical image. In this section, we will describe the design and how to upgrade the sub-function so that it can properly work on both web and mobile browsers.

Normally, a design of XSLT style sheet can be divided into three declarative sections: file header, template section, and a template for the HTML section. Its specifications must be satisfied the requirements of XSL [4]. In our design, it also includes these sections, but there are five key points [1]. Fig.3. briefly shows the design and those five key points in the corresponding style sheet.

```
<?xml version="1.0"?>
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
xmlns:cd1="http://www.w3.org/1999/xhtml" xmlns:cd2="urn:hl7-org:v3"
xmlns:cd3="urn:hl7-org:v3/meta/voc" xmlns:voc="urn:hl7-org:v3/voc"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<!-------------------------------------------------------------------------------->
<xsl:template match="cd2:renderMultiMedia"> (1)
   <xsl:variable name="imageRef" select="@referencedObject"/>
   <xsl:choose>
      <xsl:when test="//cd2:regionOfInterest[@ID=$imageRef]">
 <xsl:if
test='//cd2:regionOfInterest[@ID=$imageRef]//cd2:observationMedia/cd2:value[@
mediaType="image/gif" or @mediaType="image/jpeg"]'>
       ...
       </xsl:when>
       <xsl:otherwise>
        </xsl:otherwise>
    </xsl:choose>
</xsl:template>
<!-------------------------------------------------------------------------------->
<xsl:template match="cd2:ClinicalDocument">
  <html>
   <head>
          ...
  <style type="text/css"> (2)
     body > div
                {...}
    </style>
     <script type="text/javascript">
    window.onload = init; (3)
function init
{ ...
invokeEmbeddedROI.appendChild(createLine(x1*,y1*,x2*,y2*,distance*));
... }
var d= SupplementalPixels(browserID, ScreenOrientationType);
function createLine(x1,y1+d,x2,y2+d,distance) (4)
 { ...
  return line;
 }
function SupplementalPixels(browserID, ScreenOrientationType)
 { ....
  return numberOfSuplementations;
 }
 </script>
 </head>
  <body>
<div id="MyID"style="position:relative;height:0px;width:0px;">(5)
</div>
 </body>
  </html>
</xsl:template>
```

Fig. 3. The style sheet template for rendering CDA documents

As we mentioned in previous section, there is a different recognition of upper left hand corner of a medical mage between web browser and mobile browser when the CDA document is browsed. So, the sub-function has been upgraded by integrating three more functionalities:

- Detecting a browser that is used to render CDA document;
- Detecting screen orientation;
- And determining a supplemental distance pixel.

Therefore, the positive Y values in the creatLine function are supplemented by adding the d parameter so that the shapes of ROIs correctly render on web and mobile browsers.

Rendering CDA document on mobile browser

We emphasize that the proposed method be as simple as possible that it should not require the recipient to go through any excessive extra work. Ideally, the recipient only needs to take two steps to view the CDA contents:

(a) Receiving the CDA document and corresponding style sheet via any standard transport schemes or email;

(b) Browsing the received CDA document on smartphone by using a browser on choice.

III. RESULTS

To see how the CDA document and embedded ROIs render by a preferred mobile browser. We created a fictitious CDA document that includes the patient personal information section, image exam section, history of present illness section, etc. We tested the document against with most popular mobile browsers, which are Android, Opera, Dolphin, Google Chrome, Internet Explorer and Firefox browser for mobile.

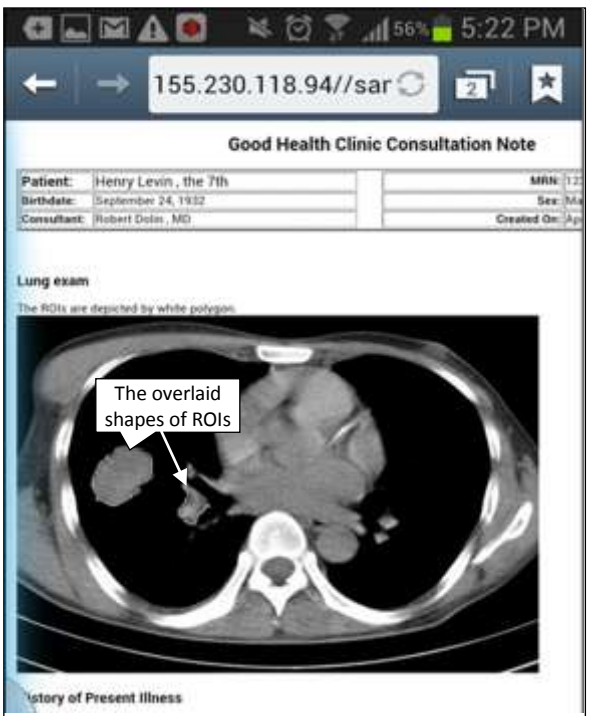

Fig. 4. Rendering the CDA document on Android mobile browser

The testing results indicate that:

(1) CDA document and the ROIs are well rendered by the browsers with good quality;

(2) User can easily zoom in/out the ROIs and medical image;

(3) The mobile browsers can be divided into two groups: (a) Directly supporting the rendering XML document, which are Internet Explorer, Firefox and Dolphin browser for mobile. (b) NOT directly supporting the rendering the XML document when document is locally stored in external memory card of mobile which are Android, Opera and Google Chrome browser for mobile.

(4) When a recipient wants to use the browser group (b). Recipient must save the documents in a location that is recognized by a server, and then browse XML document.

Fig. 5. shows a rendering result of the test CDA document on Firefox mobile browser. Fig. 6 shows a rendering result of the test CDA document on Firefox mobile browser when CDA document is stored in in a location that is recognized by a server.

IV. CONCLUSIONS

The proposed method is designed based on CDA and XSLT standards. So, clinical documents are compatible with most of browsers.

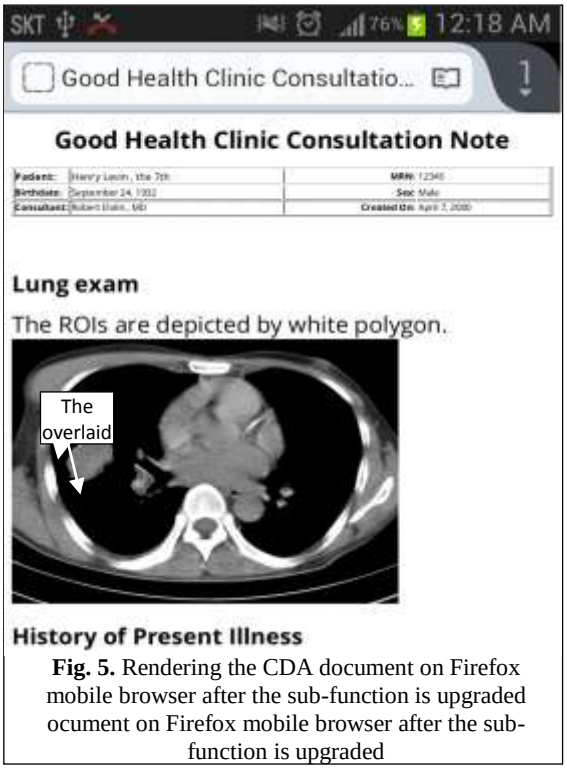

Fig. 5. Rendering the CDA document on Firefox mobile browser after the sub-function is upgraded ocument on Firefox mobile browser after the sub-function is upgraded

One of the key features of this method is users only need a smartphone or PC and use a browser of choice to view the document, images, and ROIs, without the need for a special viewer. The feature could be particularly useful in Low and Middle Income Countries (LMICs) where expensive special software packages are not affordable.

ACKNOWLEDGEMENTS

We would like to express our thankful to the support of projects ĐTĐL.CN.02/15 of Information Technology Institute - Vietnam National University, Hanoi and ĐH2016-TN07-03 of University of Information and Communication Technology - Thai Nguyen.

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HIỂN THỊ THÔNG TIN DỮ LIỆU LÂM SÀNG TRONG CHUẨN TÀI LIỆU CDA TRÊN CÁC TRÌNH DUYỆT MOBILE

Nguyễn Hải Minh, Nguyễn Văn Núi, Lê Quang Minh

TÓM TẮT: *Hiển thị trực quan thông tin kết quả khám chữa bệnh, ảnh chụp chiếu cùng với kết quả những nghi vấn dựa trên các vùng ảnh bất thường (Region of Interest - ROI) trong một tài liệu lâm sàng là việc rất cần thiết trong việc hỗ trợ các bác sỹ ra quyết định chẩn đoán. Theo cách phổ thông, thì tại các cơ sở khám chữa bệnh đều phải cần đến phần mềm chuyên dụng. Do đó, trong nghiên cứu này chúng tôi đề xuất một giải pháp hỗ trợ trao đổi tài liệu lâm sàng và hiển thị nội dung, ảnh y tế và thông tin vùng ROI của một tài liệu lâm sàng trên các trình duyệt Mobile. Kết quả nghiên cứu này được thực hiện dựa trên các chuẩn tin học trong Y tế Health Level Seven Clinical Document Architecture (HL7 CDA), chuẩn eXtensible Markup Language (XML) và Stylesheet Language for Transformation (XSLT).*