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Evaluation and Improvement of Web Information System Accessibility with Markup Language Possibilities

Gatis Vitols, *Latvia University of Agriculture*, Irina Arhipova, *Latvia University of Agriculture*

***Abstract* – Markup languages are used to describe the content published in the World Wide Web. Aim of this article is to analyze hypertext markup language versions and identify possibilities of improvement accessibility for the web information systems with markup language elements appropriate application. Analysis of the document structure is performed. Document structure and text description elements are selected. Selected elements are practically evaluated with screen readers. From the evaluation results, it can be seen that markup language possibilities for accessibility improvement can be significant.**

***Keywords* – hypertext markup language, screen readers, web accessibility**

I. Introduction

Web information systems accessibility and technological solutions accessibility in general, are often closely associated with the people who have special needs. However, the term special needs are very broad, and with difficult to identify boundaries. It is not easy to determine special needs for program or person in a particular situation. To access information on the global network, various tools are used. A web browser is one of the main tools. Web browser acquires descriptions of published information on the World Wide Web and form appropriate graphical interpretation [1].

Developers of web resources often pay attention to achievement of the correct graphical interpretation of published information across various web browsers. However, to a large part of the web information systems content readers graphical representation is secondary, or even non important feature.

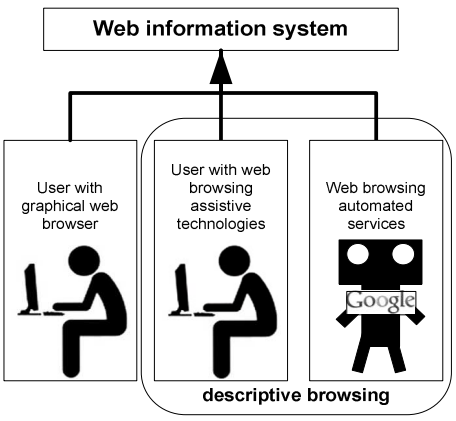

Fig. 1. Possible web information system content readers

There are many readers who care about semantically correct description of information. These readers perform so called descriptive browsing. As it can be seen from Fig. 1, descriptive browsing can be performed by two major groups. One of the groups is users with the web browsing assistive technologies, such as screen readers or voice synthesizers. And another major group is web browsing automated services, such as various search engines. Information description in the World Wide Web primarily is done with the help of markup languages. Markup language is an approach for annotating a text in a way that is syntactically distinguishable from that text [1]. Markup languages can be divided in two categories. Those that have a pre-defined markup semantics, such as the hypertext markup language, or HTML, and those that have no pre-defined markup semantics, such as extensible markup language, or XML [1]. Markup language elements are usually merged together with the data that are marked in a single data stream. In development process of the web information systems, both kinds of markup languages are used. However, dominant kind is markup languages with the pre-defined information marking semantics. This fact is related to the backbone language of the web content marking – HTML. HTML has been historically derived from the previously dominant, standard generalized markup language, or SGML [2].

Aim of this article is to analyze HTML versions specifications and identify possibilities of improvement accessibility for the web information systems with tag and their attribute appropriate application. To achieve the goal, following tasks are brought forward:

1) Analyze HTML document structure;
2) Identify HTML versions elements and select tags and attributes that can improve accessibility in the web information systems;
3) Practically apply selected elements in the web information system page;
4) Evaluate selected element interpretations with the screen readers.

II. Web Information System Document Structure

From the logical view, web information system document can be structured in multiple layers.

Fig. 2 displays document layers, where layer name is marked with bigger letters and layer content with smaller letters. Document copy is a base layer. This layer includes

data that are prepared for publishing in the World Wide Web. Layer can contain texts, pictures, diagrams and other data.

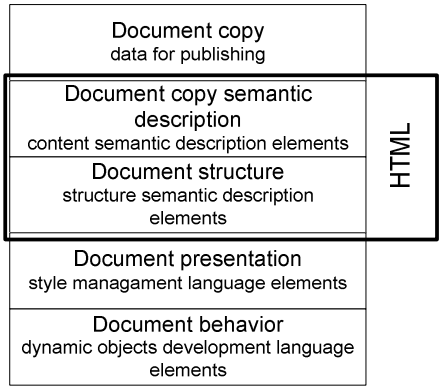

Fig. 2. Typical web information systems document structure

Document copy semantic description layer and document structure layer can be directly managed with the help of HTML elements. These layers form description about documents structural design and meaning of published data. Document presentation layer can be also partly managed with the help of HTML. However, with the development of HTML and appearance of new specifications, practically all presentation elements are deprecated. Presentation layer are managed with the help of style management languages, such as Cascade Style sheets, or CSS [1], [3].

Document behavior layer include objects that are integrated into document with some certain technology or programming language. It can include, for example, dynamic menus created by JavaScript, Flash technology objects and other types of objects.

As there are various groups of users with the demands of various data interpretations, there was a need for certain documents that regulate markup language borders and element meanings. So the markup languages specifications were appearing to not allow chaos that once was happening on the World Wide Web. Back then web browsers such as Internet Explorer and Netscape Navigator were competing and performing interpretation of wide spectrum of elements. Problem was that many elements got supported on one or another web browser, for example, element that allowed text to blink was only supported in Internet Explorer [4]. These actions gave impact on accessibility matters. Not only people with web browsing assistive technologies or web automated services could meet often accessibility problems, also other groups of users were unable to see web information system page in a meant to be interpretation [1], [4].

Paying attention to proper development of document copy semantic description layer and document structure layer, can improve the accessibility of the web information systems for users who perform descriptive browsing.

To verify this claim, it is necessary to identify and evaluate elements that are mentioned in HTML specifications and could be used in practice.

III. Development Of HTML Specifications

There are various versions of HTML specifications. The latest of them are about HTML5 [5]. HTML was originally created with the idea of providing a way to share scientific documents. Because of this aim, HTML's developer's main principle was to create set of elements for simplified marking of the documents. Set of base elements were developed. These elements allowed World Wide Web document developers to markup the structure, semantics and presentation of the document [4].

With the release of each new specification, HTML was revised and updated with new elements. Also it can be seen, that each new specification is cleaned up from elements that allows to markup document presentation. When HTML 4.01 version specification was approved, elements that allow describing presentation of the document were not recommended anymore. Instead CSS are brought forward as main styling language. However, presentation elements still are supported, to ensure compatibility of older documents with new generations of web browsers [6] - [9].

With an aim to improve order in the World Wide Web, HTML specifications include recommendation that says to separate the presentation layer of the document from the document structure and semantics [4], [8]-[9].

Between the publications of HTML 4.01 and HTML 5.0 more than ten years has passed. Actually HTML 5.0 specification still is in the development stage, although basic elements are already specified and supported by new generation browsers [5]. To ensure semantics and structure in the document, there has been introduced a set of elements that are already supported by new generation browsers and could be used to improve accessibility matters in the web information systems.

IV. HTML Document Structure Description Elements

When performing identification of the document structure markup elements, it can be seen that the most widely applied are and <table>. With an attributes, these tags allow to perform general structure description [5]. However, these tags don't bring any semantics. User web browsing assistive technologies, such as screen readers, cannot interpret these elements for structure description. These tags can gain some semantics only with the help of attributes and developers appropriate naming of the elements [10]. Instead of these elements, it would be necessary to consider using tags with semantic meaning, such as <header> to describe header part of the document.

A typical web document usually is structured in a similar way. It contains information about the document header, which usually includes, for example, data that describe the content of the document. Also navigation menu is included. Navigation menu usually holds key links to other pages of the web information system. Document includes also body part. This part usually is for publishing main information for the visitor. After the body, usually follows footer. In typical cases,

footer holds information about copyrights, developer contacts and links to binding documents [5].

For description development of these sections, often mistakenly or <table> tag are used. For improvement of accessibility, there is a need to use appropriate, semantic elements. The <header> element can accurately describe document head part. Starting with the HTML5 specification, there is available <hgroup> tag that allows to group heading tags, such as <h1> to <h5>. Grouping allows forming description of relation between headers. From the perspective of accessibility, it does not allow users to get confused on meaning of and relation between headings.

The application mechanism for <hgroup> tag can look like following example:

```
<header>
<hgroup>
  <h1>Latvia University of Agriculture</h1>
  <h2>Faculty of Information Technologies</h2>
</hgroup>
</header>
```

If the heading tags are used without <hgroup>, there is no relation defined between <h1> and <h2> tags. With the help of <hgroup> it is semantically told that heading "Faculty of Information Technologies" is subordinate of heading "Latvia University of Agriculture".

Instead of there is also a possibility to use <article> tag. This tag allows describing individual sections of the page, such as block of news, article or some other form of data. For example, user assistive technologies could identify blocks of document body by using this tag.

Also, the navigation menu has special semantic tag. Since the navigation menu is usually displayed on each page of the web information system, then, for example, screen readers re-read navigation menu each time user reload page or move to another page of the system [11].

In such cases, it is necessary to identify the navigation menu to allow users with assistive technologies identify this object and with a help of certain functions on, for example, screen readers, decide to read menu or jump over menu directly to information published in the <article> block. Such markup for navigation menu is possible with <nav> tag.

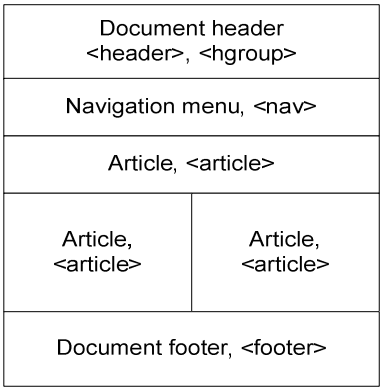

Fig. 3. Document structure markup with semantic elements

To apply this tag, it is necessary to include navigation menu code, for example HTML list between <nav> tags, such as following example:

```
<nav>
<ul>
  <li><a href="">Main page</a></li>
  <li><a href="">Faculties</a></li>
  <li><a href="">Studies</a></li>
</ul>
</nav>
```

Also for the markup of footer of the document, there is a tag, such as <footer>. With the use of this tag, descriptive browsers, for example, web automated services, can index copyright information or other typical footer data [5].

Fig. 3 shows possible document structure markup which includes meaning and can be more accessible for users who perform descriptive browsing.

V. HTML DOCUMENT TEXT DESCRIPTION ELEMENTS

HTML provides certain amount of elements that can be used for document semantic description and are directly related to accessibility improvement. For this paper a group of elements for marking up the HTML document text were chosen.

There are several tags that can be used to improve accessibility, but, same as structure description tags, also text description tags are often replaced by other, less semantic tags, such as or <font>. Main reason for this tendency is web browsers visual interpretations or, to be more precise, web layout engines renderings. For example, two different tag visual interpretations on user screen can be identical, but semantically they are different [5]. From the HTML specifications, following text accessibility improvement tags can be brought forward [6] - [9]:

- <abbr> tag that allows to describe abbreviations;
- <acronym> tag that allows to describe acronyms;
- <address> tag that allows to describe address, for example, user contact information.
- <blockquote> tag that allows to describe longer quotes;
- <cite> tag that allows to describe citations and references;
- <code> tag that allow to describe programming language code;
- <dfn> tag that allows to describe definitions;
- tag that allows to describe emphasis of part from the text or word;
- <kbd> tag that allows to describe user entered text, for example, commentary made by user;
- <q> tag that allows to describe short quotes;
- <samp> tag that allows to describe examples made by author;
- tag that allows to describe strong emphasis.

Each of these tags has their own semantics that can be used by assistive technologies and web browsers to interpret the

document. However, the visual interpretations made by web layout engines built into web browsers of these elements can be identical [12]. Small experiment can be carried out to prove mentioned fact. On two selected web browsers Mozilla Firefox 3.6 and Apple's Safari 5.0 execution of named tags shows visual interpretation results summarized in Table 1.

TABLE I
TEXT DESCRIPTION TAG VISUAL INTERPRETATIONS ON THE WEB BROWSERS

Tag	Mozilla Firefox 3.6	Apple Safari 5.0
<abbr>	unformatted text	unformatted text
<acronym>	unformatted text	unformatted text
<address>	italic text	italic text
<blockquote>	unformatted text	unformatted text
<cite>	italic text	italic text
<code>	Courier New font text	Courier New font text
<dfn>	italic text	unformatted text
	italic text	italic text
<kbd>	Courier New font text	Courier New font text
<q>	unformatted text in apostrophes	unformatted text in apostrophes
<samp>	Courier New font text	Courier New font text
	bold text	bold text

From the results included in Table 1, it can be seen, that from the point of visual interpretations it is not possible to identify semantics of elements. Web browsers interpretations are similar, although with slight differences, for example, definition tag interpretations. However, from the results, it can be seen that web browsers use 3-4 visual styling for more than ten elements. Often there are cases when developers use CSS or other styling techniques to mark texts with different meanings, for example, some developers can use italic to mark foreign word in the article, or at the same time other developer can use italic to mark up questions in a published interviews, etc.

However, for example, screen readers are not only reading browser interpretations, quite the reverse, most modern screen readers process the source code, reading the HTML descriptions [13], [14].

Also, for example, certain services from Google company are crawling around World Wide Web documents and indexing the contents for its own needs, such as for improvement of their search engine. As an example Google definition storage and retrieval service can be named. While companies, including Google, conceal their service algorithms, it can be considered that, for example, definition service use <dfn> tag as main basis for indexing the definitions content. This claim can be also confirmed by Google published request for web developers to improve the accessibility of published documents, especially to perform implementation of semantic elements [15].

VI. HTML DOCUMENT TEXT AND STRUCTURE DESCRIPTION ATTRIBUTES

From the HTML specifications there can be brought forward certain attributes that can be used in conjunction with previously mentioned tags for improvement of accessibility. The key attributes for those tags are [6] - [9]:

- cite – attribute, which can be used to indicate quoted source for abbreviations and acronyms;
- title – attribute which can be used to define name to the element. Usually in the visual interpretation, data that are placed in the title attribute are displayed as a tooltip for particular element. User's assistive technologies can use this attribute for element meaning identification purposes, with condition if the developer has been giving appropriate and informative titles;
- dir – attribute, which can be used to tell markup interpreter how to read the described text. By default, all texts are red from left to right, however, to process certain languages, there is a need to change the direction of reading, from right to left, for example, for the Arabic language;
- lang - attribute, which can be used to permit the identification of a language for a specific area of the text or word. It can be used in cases when a particular fragment of the text or word is placed in other language in contradistinction to main language of published content. For example, screen readers could adopt the marked text pronunciation to a specific language, so to improve the content accessibility. This attribute values are taken from the ISO 3166-1 standard as a two-digit language codes [16].

VII. HTML TAG AND ATTRIBUTE EVALUATION

In order to evaluate the above mentioned tag and attribute role for the web information system accessibility, certain HTML documents were developed. Documents include various combinations of tags and attributes. For evaluation of accessibility, specific user assistive technology, such as screen readers were chosen. From the published data [12], in a year 2009, one of the most used web browsers was Mozilla company developed Firefox with a tendency and predictions to keep gaining popularity between web users. Mozilla Firefox was chosen as a web browser for this evaluation.

During screen reader software review, it can be seen that frequently used screen readers are Freedom Scientific developed Job Access with Speech, or JAWS, NonVisual Desktop Access, or NVDA and GW Micro company product Window Eyes [1], [5]. Selected screen readers were installed and configured for performance on Window XP SP2 operating system with the Mozilla Firefox 3.5 web browser. Selected screen readers include JAWS 12, NVDA 2010.1 and Window Eye 7.0.

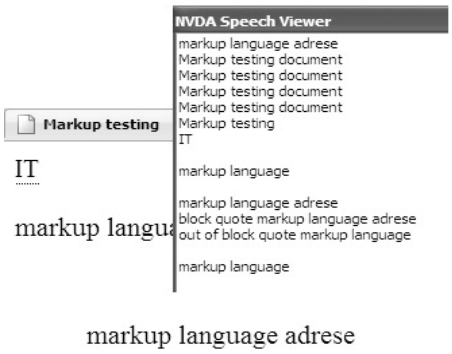

Fig. 4. Evaluations of the document markup interpretations with the NVDA screen reader

In order to evaluate screen reader interpretations, two level tests were performed. The first level include audio information recording from the screen reader synthesized voice. Second level includes reading published texts from the screen reader built-in tools, such as NVDA Speech Viewer, seen also in Fig. 4. For example, NVDA Speech Viewer transcript the synthesized voice data. Second level evaluation can not be sufficient, because it cannot display, for example, voice intonation. It can be used only as a support testing tool. In the Fig. 4 background, part clipping from the HTML document with quote tag interpretation made by Mozilla Firefox can be seen. In front of this clipping NVDA Speech Viewer interpretation can be seen.

VIII. Results and Discussion

From the HTML tag evaluations, following results summaries were created.

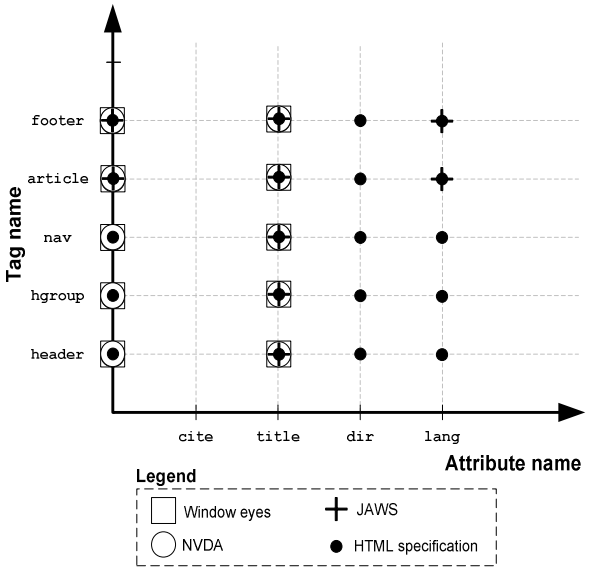

Fig. 5. HTML structure description tags (on vertical axis) and attributes (on horizontal axis) interpretation results

Graph, seen in Fig. 5, shows HTML structure description tags and attributes interpretations, but graph, seen in Fig. 6, shows HTML text description tags and attributes interpretations with the screen readers.

As it is seen from the screen reader interpretation results, screen readers do support structure tags, except JAWS had problems to interpret heading part elements, such as <header>. Users with screen readers can identify the blocks of the HTML document and choose certain actions, for example, jump over navigation menu.

HTML text description tag interpretation results show, that there is a lack of support for semantic text marking elements.

Even these elements are mentioned in specifications, screen readers lack to support such elements, as address, cite, code, dfn and others.

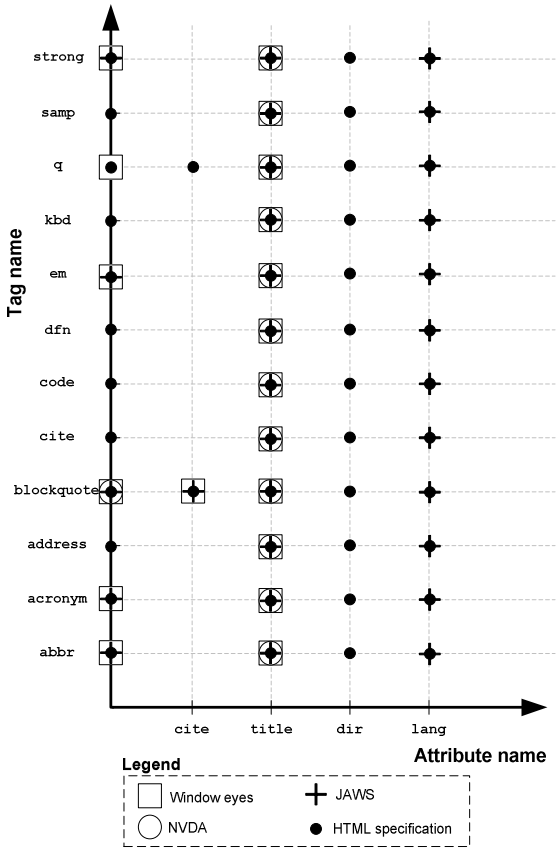

Fig. 6. HTML text description tags (on vertical axis) and attributes (on horizontal axis) interpretation results

Better support is for quotation elements, such as blockquote and q. Also the emphasis and strong emphasis are supported. Interpretation of these elements is made with an intonation change of synthesized voice by screen reading software. Abbreviation and acronym tags can gain full support only with a composition with the title attribute. Otherwise screen readers cannot distinguish these elements from main text.

Most screen readers probably will support "title" attribute. However, for example, for mentioned structure description elements, this attribute does not assist in the meaning definition. Usually title attribute visually is interpreted as a tooltip for a particular text or object.

Attribute "dir" has more impact on visual interpretation of description than meaning. Those screen readers that have multiple language support, automatically can adjust reading direction from, for example, language defined by the "lang" attribute. It may be the reason why none of the examined screen readers support this attribute.

Attribute "lang" value interpretation is supported by JAWS screen reader. With the help of this attribute, screen reader can adjust the pronunciation for foreign words. For example French word "merci" can be pronounced with French pronunciation, not English pronunciation. If this attribute is placed for, for example, quote, screen reader also read the quote name in defined language. For example, line `<blockquote lang=″fr″>Merci</blockquote>` is interpreted as a text line that says in French "There is a quote which say thank you".

IX. Conclusions

From the evaluation of performance of screen readers, it can be seen that this user web browsing assistive technology successfully interpret document structure description semantic elements. There are seen problems with the interpretation of certain text description elements, although developers can and should use elements for quote, emphasis, abbreviation and acronym descriptions.

When developing web information systems, also the use of screen readers not supported semantic elements should be considered, because there is a seen competition in the software market between screen reader developers. This leads for an improvement of support for semantic markup interpretation with the release of software new versions. It is seen tendency that, for example text semantic elements can get full support with the releases of future versions of screen readers, as these elements are still preserved and recommended for use in HTML 5.0 specification.

For the improvement of web information systems accessibility with markup language possibilities, there is a need to use presentation separation methodology. That means markup language should be used to describe what element are not what they look like. With a description of what element looks like, there is a mixing of presentation layer with the document structure and semantic layers and that can therefore feed a lot of useless information to screen readers, therefore decreasing web information system accessibility.

Analysis of the screen reader performance shows that with the use of semantic elements instead of no meaning elements, give no seen impact on visual browsing, but can give benefits and improve accessibility for users who perform descriptive browsing.

In this paper there was done analysis only for one type of user web browsing assistive technology, so there is a need for future evaluations on appropriate markup language usage for improvement of accessibility for the web automated services or users with other types of web browsing assistive technologies. However, tendency and available researches shows that appropriate usage of the markup language possibilities is an important factor for improvement of accessibility in the web information systems.

Developers also have to consider that many users can use older versions of, for example, screen readers or web browsers that can lead to less or no support for new elements mentioned first time only in HTML 5.0 specification.

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Gatis Vitols is a PhD student in the Department of Computer Science of Faculty of Information Technologies at the Latvia University of Agriculture. Author received Computer Science and Management diploma of Bc.sc.ing in 2006 following Information Technologies diploma of Mg.sc.ing in 2008 from the Latvia University of Agriculture.
Author primary research fields are web technologies, accessibility of information systems, and management of database systems.
G. Vitols has worked as a Web Developer, Assistant Lecturer and currently is a Lecturer at the Faculty of Information Technologies at the Latvia University of Agriculture.

Irina Arhipova is a professor of econometrics in the Department of Systems Control of Faculty of Information Technologies at the Latvia University of Agriculture. Dr. Arhipova received her Dr.sc.ing. from the Latvia University of Agriculture in 1994.
Dr. Arhipova main research topics are related to economics statistics and its applications, system analysis and risk management methods of e-government and forest management planning process.

Gatis Vītols, Irina Arhipova. Tīmekļa informācijas sistēmu pieejamības izvērtēšana un uzlabošana ar iezīmju valodas iespējām
Iezīmju valodas ir viens no pamatrīkiem tīmekļa informācijas sistēmu izstrādātājiem, kuru pielieto datu aprakstu veikšanai globālajā tīmeklī. Globālā tīmekļa lietotāji lasa šos aprakstus, interpretē un veido atbilstošus datu attēlojumus. Tomēr informācijas sistēmu izstrādātāji, projektējot, bieži cenšas panākt korektu tikai datu vizuāli iecerēto interpretējumu. Šāda tendence krasi ietekmē informācijas sistēmu pieejamību tiem lietotājiem, kam vizuālais interpretējums ir sekundārs vai pat nenozīmīgs. Ir plašs lietotāju klāsts, kuri lieto datu semantisku aprakstu, kuru var veikt ar vienu no globālā tīmekļa satura apraksta veidošanas pamata iezīmju valodām: hiperteksta iezīmju valodu jeb HTML.
Šī raksta mērķis ir analizēt hiperteksta iezīmju valodas versiju specifikācijas un identificēt iezīmju un to atribūtu pielietošanas iespējas pieejamības uzlabošanai tīmekļa informācijas sistēmās.
Tiek analizēta globālā tīmekļa dokumenta struktūra, sadalot to pa slāņiem. Noteikta HTML loma slāņu aprakstam. Analizējot HTML specifikācijas, tiek izvirzītas dokumenta strukturēšanas un teksta apraksta veidošanas elementi, kas var tikt pielietoti pieejamības uzlabošanai. Atlasītie elementi tiek praktiski novērtēti ar lietotāja atbalsta tehnoloģiju: ekrāna lasītājiem. Analizējot ekrāna lasītāju JAWS 12, NVDA 2010.1 un Window Eyes 7.0 interpretējumu rezultātus, var secināt, ka šī atbalsta tehnoloģija sekmīgi atpazīst dokumenta struktūras definēšanas elementus, tomēr ne tik prasmīgi spēj interpretēt teksta apraksta elementus. Kopumā HTML iespējas datu aprakstu veikšanā ir plašas, un tās spēj uzlabot tīmekļa informācijas sistēmu pieejamību. Ir nepieciešams lietot HTML struktūru definēšanas nozīmi iekļaujošos elementus, kā arī papildus izvērtēt HTML iespējas pieejamības uzlabošanā tīmekļa servisiem, piemēram, informācijas meklētājiem.

Гатис Витолс, Ирина Архипова. Оценка и улучшение доступа к Веб-информационным системам, используя возможности языка разметки
Язык разметки - один из основных инструментов веб-разработчиков информационных систем, которые используют для выполнения описания ресурсов World Wide Web. Пользователи глобальной сети читают эти описания, интерпретируют и создают соответствующие отображения данных. Однако, проектируя, веб-разработчики пытаются достигнуть только визуально коректной интерпретации данных. Эта тенденция существенно влияет на доступность информационных систем для тех пользователей, у которых визуальное интерпретация вторична или даже неважна. Есть широкий круг пользователей, которые используют семантическое описание данных. Это описание можно осуществлять с одним из основных языков разметки - HTML.
Цель данной статьи – анализ спецификации версии языка HTML и идентификация возможности приложений разметок и их атрибутов для улучшения доступности веб-информационных систем.
Проанализована структура WWW-документа, разделенного по слоям. Определена роль HTML для описания слоев. При анализе спецификации HTML были определены элементы разработки для структурирования документа и описания текста. Отобранные элементы были оценены на практике с использованием технологии поддержки пользователя, а именно с помощью считывателя экрана. Проанализировав результаты интерпретирования считывателей экранов JAWS 12, NVDA 2010.1 и Window Eyes 7.0, можно сделать вывод, что данные технологии поддержки успешно распознают элементы, которые определяют структуру документа, но не так успешно могут интерпретировать элементы описания текста. В общем возможности HTML для описания данных являются достаточно обширными и могут обеспечить улучшение доступности веб-информационных систем. Необходимо использовать HTML-структуру определяющие элементы, а так же дополнительно оценить возможности использования HTML для улучшения доступности веб-сервисов, например, для информационных поисковиков.