Design and Implementation of a Web based Compliance Analysis System for Mobile Content

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Abstract. A model of web-based compliance analysis system for mobile content is proposed. It is said that the content is compliant if the content can be executed properly in mobile environment. The model was designed using the Factory Method pattern and the Facade pattern. The workflow of the system was described through collaborations of classes in the model. Core Java APIs for implementation are also proposed. As a case study, the mobile compliance analysis system for WML and HDML contents has been built. The model is flexible so that you can easily add new modules or remove some modules to analyze certain mobile content. Although the proposed model is based on the JSP and Java beans, it can be expanded to support any other programming technique such as EJB.

1 Introduction

As mobile wireless devices with Internet access become more widespread (such as cellular phones, PDAs, etc.), M-business is growing. M-business is Internet business using mobile devices. That is, communication businesses which enable wireless internet services, or solutions and softwares to support these are included to M-business[1].

The most important thing in M-business is the development of suitable contents in the wireless Internet environment. Through wireless Internet, users desire to do the same things that have been done through wire Internet. Suitable contents should be developed in wireless Internet environment to satisfy the desires of users. Presently, while wireless Internet users increase, contents for services to satisfy their desires are absolutely lacking.

Many Mobile Content Providers(MCPs) are in the process of developing mobile contents and trying to serve the contents through mobile devices. Futhermore, Communication Service Providers(MCSPs) should reserve the contents to serve if wireless Internet services of high speed come true. Therefore, cooperation is needed

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by the MCSPs and the MCPs. In the wireless internet environments, the MCSPs are mediators, which connect customers and MCPs[1][2].

Accordingly, MCPs must propose their contents to the MCSPs. The MCSPs accept or reject the contents of MCPs after examining them. It is necessary that MCSPs confirm that the contents are suitable for mobile devices while they examine the contents because the contents cannot be served if they are not suitable for mobile devices even though they are very valuable. It also needs that MCPs confirm whether contents were developed to be suitable for mobile devices while they develop the contents.

Because of these necessities, this research paper proposes a web-based model for implementation of compliance analysis system for mobile content. The compliance analysis system shows the information that can know whether the contents are suitable to be executed in mobile device.

2 Mobile Content

Mobile content is a concept that appears newly by wireless Internet technology and growth of mobile device technology. Mobile contents can offer various information and entertainment services through cellular phones or wireless communication devices[3]. Mobile contents have some limit such as small display, restricted input capability, limited memory and processing power, and low-speed network connections with high latency [11].

Current mobile contents are mostly developed with HDML [5], WML [6], WML Script [6] and XHTML Basic [7] for WAP [4][13] and Java based on CLDC/MIDP [8][12] platform.

HDML is a markup language invented by Unwired Planet. It is used to format content for Web-enabled mobile phones. WML is a fully XML-compliant descendant of HDML, is part of the WAP standard. WML contains the scripting language WMLScript for performing simple tasks on the mobile device, such as validating user input[11]. XHTML is the XML-based successor of HTML 4.0. HTML and XHTML are recommendations for the Internet community defined by the W3C[11]. The XHTML Basic document type includes the minimal set of modules required to be an XHTML host language document type, and in addition it includes images, forms, basic tables, and object support[7].

3 Compliance Analysis for Mobile Content

3.1 Compliance of mobile content

It is said that the mobile content is compliant if the content can be executed properly in mobile environments. In order to determine the compliance of the content to the mobile environments, the content should be analyzed to find out if there are inappropriate parts to be performed in mobile devices and there are non-functional

errors. It is important that the mobile content should comply with any severe environments from the viewpoints of processor, memory, communication speed, display, etc. Accordingly, the compliance analysis system for mobile content is needed. Users of this system are MCSPs and MCPs. The MCSPs use this system in order to determine the acceptance of the content and the MCPs use this system in order to test the compliance of the content.

3.2 Categories of compliance analysis

This section presents the categories of compliance analysis for mobile content. The thirteen categories of compliance analysis are presented in this paper. Nine of these categories are related to the restrictions of mobile devices. Because CPU, memory, communication speed and display restrict mobile devices, the content must be developed in consideration of file size, number of download files, number of image files, etc. It also should be developed in consideration of operating systems and wireless network because these are different according to the kinds of mobile device. These thirteen categories of compliance analysis provide the information to judge whether the content has any problems in the restrictive situations. The restrictions are different according to the kinds of mobile devices. The compliance and non-compliance of content can be determined according to the kinds of mobile devices being used, based on the analysis of these categories.

① *Examination of the kind of content*

Kinds of content can take HDML, WML, WML Script, XHTML Basic, Java, etc. If the kind of content is examined, then it will be known what language should be used for development of the content.

② *Check of Well-formed-ness*

In case of mobile content written in markup language of XML-base such as WML, XHTML, etc., it can be executed just in case open tags and closed tags are properly. So check of well-formed-ness is essential in compliance analysis of content written in markup language.

③ *Validation check*

Content that is written in markup language of XML-base can be executed correctly just in case it is made according to the DTD. So validation check of content is essential in compliance analysis of content in case mobile content is written in markup language of XML base such as WML, XHTML, etc.

④ *Identifying the number of links*

The content makes connections to other contents through links. Because it takes additional time to move the content to be linked during execution, it can take a long time to execute content if there are many links in the source content. Another problem arises when there are a lot of links. Therefore, execution time and complexity of content can be estimated approximately by identifying the number of links in the content.

⑤ *Identifying the number of image files*

The more image files are attached, the more it takes time to load the content and the content occupies much area of screen. Therefore, time to load the content and

occupied area of screen by the content can be estimated approximately by identifying the number of image files.

⑥ *Identifying the total size of image files*

The bigger the size of an image file, the more download time. It also takes more time to load a very large image file than load many image files of small size. Therefore, the estimation for the content can be more exact if the total size of image files is known with the number of image files.

⑦ *Identifying the number of media files*

The more the number of media files, the more execution time. Also, because a media file has to be linked continually with the server that a media file is extant during run-time unlike an image file, a media file can not be executed properly in situation that network is bad. Therefore, identifying the number of media files is important for estimation about content.

⑧ *Identifying the total size of media files*

If the total size of media files is analyzed with the number of media files, the estimation for content can be more exact. Single big media file also makes execution time of content longer than several media files of small size and media files are affected by network much more than other kinds of file. Therefore, identifying the total size of media files is important for estimation about content.

⑨ *Identifying the size of content file*

The size of content file except linked image files and media files is measured.

⑩ *Identifying the total size of downloaded files*

The total size of all files that must be downloaded to execute content including image files and media files is measured.

⑪ *Identifying the kinds of executable device*

According to the kinds of content, the kind of executable device is different. Even if the content is good, it is unusable in the unsupportable kinds of mobile devices. The kinds of executable devices must be known according to the kinds of content. If the kinds of devices that can execute the content are identified, it is going to aid accepting or rejecting the content.

⑫*Identifying compatible operating systems*

It is also important to know executable OS because mobile content is used in not only mobile phone but also PDA or any other kinds of mobile devices.

⑬ *Examination the attributes of Java class*

If the content includes Java classes, it is necessary to know the information about the Java classes such as name and size. It can be estimated execution time or download size of the content from this information of Java classes. This examination mostly is done for the content that is developed in Java.

4 A Web-based compliance analysis model for mobile content

This paper proposes a model for the implementation of the web-based compliance analysis system for mobile content in this section.

4.1 Model

The model proposed in this paper was designed based on the Factory Method and the Façade design patterns [9][10], and it is the basic model for web-based compliance analysis system using JSP (Fig.1).

The compliance analysis system for mobile content should analyze any kind of mobile content and cannot know the kind of a content before the URL of the content is inputted. Therefore, the system should create appropriate object and analyze the content according to the kind of an inputted content during execution. The model was designed using Factory Method design pattern for solving this problem. Furthermore, the model was designed using Façade design pattern for offering simple interface to users about the system. If the compliance analysis system for mobile content is implemented using this model, it makes it easier to add the codes for a new kind of content or remove the codes for an existent kind of content. Moreover, users can access the system through a simple interface although they don't know internal structure of the system.

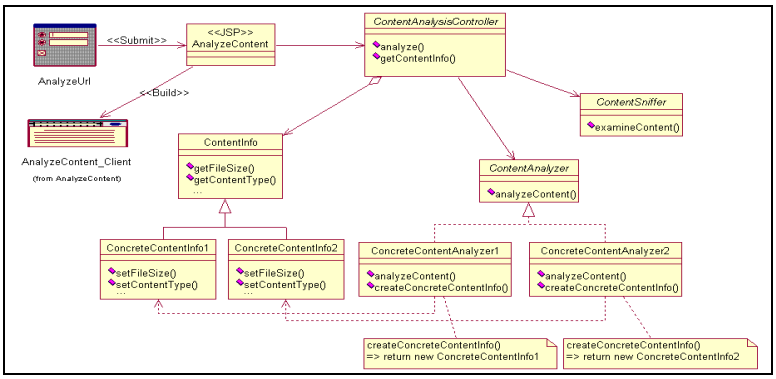

Fig. 1. Web-based compliance analysis model for mobile content

4.2 Participants

· *ContentAnalysisController*

The ContentAnalysisController is an abstract class that is responsible for all classes. This class declares an interface for operations to call suitable class with the inputted URL of content to achieve compliance analysis.

· *ContentSniffer*

This class is also an abstract class that declares an interface for operations to examine the kind of content. If the ContentSniffer class is called by the ContentAnalysisController, it then examines the content and returns the kind of the content.

· *ContentAnalyzer*

The ContentAnalyzer is an interface class that declares methods for content compliance analysis. This interface declares only basic methods for compliance

analysis of content. Therefore, compliance analysis of content is performed actually in the ConcreteContentAnalyzer class, which implements this interface and defines additional methods for analysis according to the kinds of content.

· *ConcreteContentAnalyzer*

This is a concrete class that implements operations to analyze each kind of content. The compliance analysis of mobile content is performed actually in this class. According to the kinds of content, appropriate ConcreteContentAnalyzer class is created. It implements the ContentAnalyzer interface, and creates a ConcreteContentInfo object by the corresponding concrete analyzer.

· *ContentInfo*

ContentInfo is a class to store analyzed information about content. It has the information about the thirteen categories of compliance analysis proposed in section 3.2 and defines methods to get the information.

· *ConcreteContentInfo*

This is a concrete class that defines the methods to set the analyzed information of content according to each kind of content. This class inherits the Content Info class. This class sets the information into the fields inherited from the Content Info class.

4.3 Internal Collaborations of Compliance Analysis Model

A process that the compliance analysis system for mobile content performs the request of client is represented with a sequence diagram of UML (Fig.2).

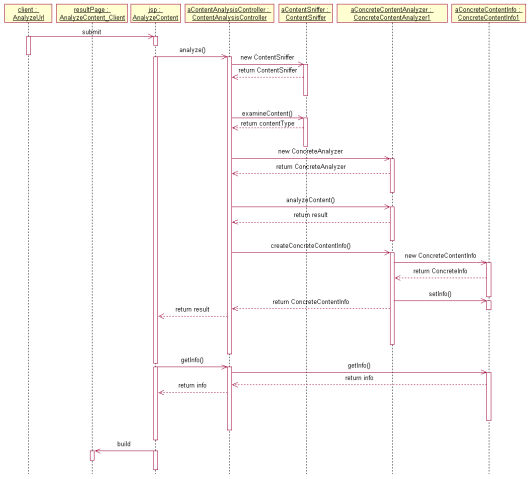

Fig. 2. Internal Collaborations of Compliance Analysis Model

If inputted URL of the content through HTML page is submitted, a JSP file receives the URL and passes it to a ContentAnalysisController object. A ContentAnalysis-Controller object calls a ContentSniffer object to find out kind of the content and then calls a correct ConcreteContentAnalyzer object according to the kinds of content to achieve analysis. If analysis for the content was finished, a

ConcreteContentAnalyzer object creates a relevant ConcreteContentInfo object to set the result. The JSP file gets the information from ConcreteContentInfo object and displays to client.

5 APIs for implementation of compliance analysis system

Core Java APIs that can implement the compliance analysis system for mobile content is presented in this section. Because APIs presented in this paper are all-important minimum things, developers may define and use new classes inherited from presented classes in case there are additional methods or fields.

The Java APIs of four core classes were defined to implement the model proposed in this paper. The four core classes are ContentAnalysisController, ContentSniffer, ContentAnalyzer and ContentInfo. Table 1 displays the detailed APIs of four core classes.

Table 1. Core Java APIs

Class
public abstract class ContentAnalysisController
Fields
protected ContentInfo _contentInfo : Stores instance of ContentInfo class.
Methods
public abstract boolean analyze(String url) : Analyzes content in the URL. public ContentInfo getContentInfo() : Returns the instance of ContentInfo class.
Class
public abstract class ContentSniffer
Methods
public abstract String examineContent(String strUrl) : Returns kind of content in the URL. public abstract String examineContent(byte[] data) : Returns kind of content transformed into byte codes.
Class
public interface ContentAnalyzer
Methods
public boolean analyzeContent(String url, byte[] data) : Analyze content transformed into byte codes in the URL according to the kind of content.
Class
public class ContentInfo
Fields
protected String _contentType : Stores kind of content. protected boolean _wellFormedDocument : Stores “true” if the content is well-formed document else stores “false”. protected boolean _validDocument : Stores “true” if the content is valid document else stores “false”. protected int _numOfLink : Stores the number of links in the content. protected int _numOfImageFile : Stores the number of image files in the content. protected int _imageSize : Stores total size of image files in the content. protected int _numOfMovieFile : Stores the number of movie files in the content. protected int _movieFileSize : Stores total size of movie files in the content. protected int _contentSize : Stores the size of content. protected int _totalSize : Stores total download size of the content. protected String _deviceType : Stores kinds of executable devices according to the kind of content. protected String _OSType : Stores kinds of compatible OS according to the kind of content. protected String _classFileName : Stores names of class files in the content. protected String _errMessage : Stores an error message.
Methods
public String getContentType() : Returns the kind of content. public boolean getWellFormedDocument() : Returns whether or not the content is a well-formed document. public boolean getValidDocument() : Returns whether or not the content is a valid documents. public int getNumOfLink() : Returns the number of links in the contents. public int getNumOfImageFile() : Returns the number of image files in the contents.

public int getImageSize() : Returns total size of image files in the contents.
public int getNumOfMovieFile() : Returns the number of movie files in the contents.
public int getMovieFileSize() : Returns total size of movie files in the contents.
public int getContentSize() : Returns the size of contents.
public int getTotalSize() : Returns total download size of the content.
public String getDeviceType() : Returns the kinds of executable devices.
public String getOSType() : Returns the kinds of compatible OS.
public String getClassFileName() : Returns names of class files in the content.
public String getErrorMessage() : Returns an error message.

6 Case Study

The compliance analysis system for HDML and WML contents based on the model is presented as a case study in this chapter. The usability of the model is verified through this case study.

6.1 Design of compliance analysis system for HDML and WML contents

The compliance analysis system was designed based on the proposed model(Fig.3).

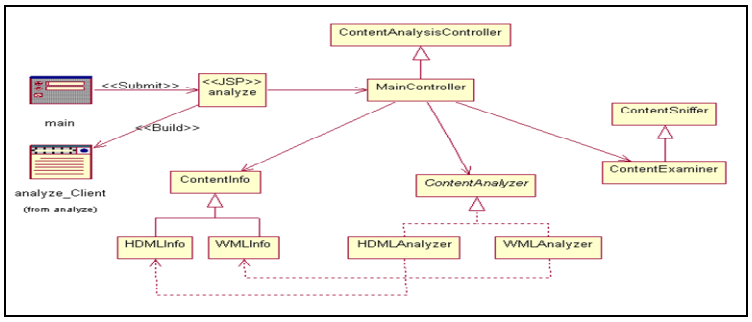

Fig. 3. The design model of compliance analysis system for HDML and WML contents

The MainController class which inherits the ContentAnalysisController class controls all operations for compliance analysis of mobile content. The ContentExaminer class which inherits the ContentSniffer class examines whether the inputted content is written in HDML or WML. The HDMLAnalyzer and WMLAnalyzer classes which implement the ContentAnalyzer interface analyze the compliance of inputted content written in HDML or WML. The HDMLInfo and WMLInfo classes which inherit the ContentInfo class store the result of compliance analysis.

6.2 Implementation

In this section, the source codes of the compliance analysis system for HDML and WML contents are described.

```
public class MainController extends ContentAnalysisController {
   public boolean analyze(String url) {
      try {
         ContentExaminer sniffer = new ContentExaminer();
         contentType = sniffer.examineContent(url);
         if(contentType.equals(ContentExaminer.CONTENTTYPE_WML))     {
             WMLAnalyzer wmlA = new WMLAnalyzer();
             analyzeResult = wmlA.analyzeContent(url, data);
            _contentInfo = wmlA.createWMLInfo();
         }
         else if(contentType.equals(ContentExaminer.CONTENTTYPE_HDML))
        {
             HDMLAnalyzer hdmlA = new HDMLAnalyzer();
             analyzeResult = hdmlA.analyzeContent(url, data);
           _contentInfo = hdmlA.createHDMLInfo();
         }
         return analyzeResult;
      } catch(Exception e) {
         return false;
      }
   }
}
```

The MainController class which inherits the ContentAnalysisController class has the code to control all operations for compliance analysis of mobile content. Following code is a part of the MainController class for compliance analysis of HDML and WML contents.

6.3 Practical use of compliance analysis system

In this section, the practical use of compliance analysis system is presented through the system for HDML and WML contents.

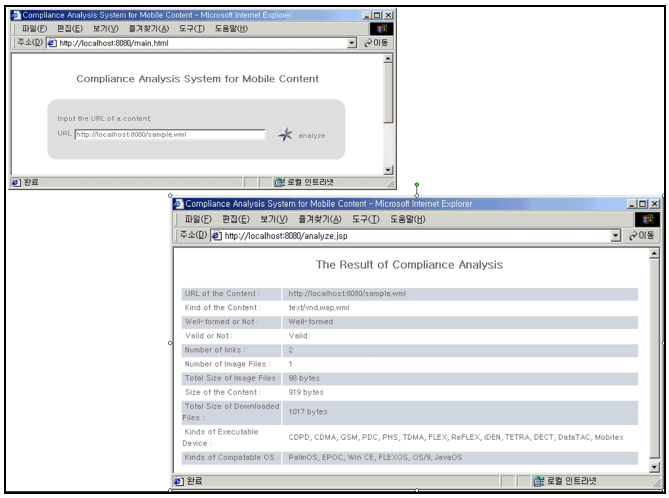

Fig. 4. Web pages of Compliance Analysis System

Fig.4 shows web pages of compliance analysis system for mobile content. The system displays the result of compliance analysis if the URL of a mobile content is

inputted and the “analyze” button is clicked in upper page. In the result, the number of links is 2. This means that there are links to another two contents or CARD. Moreover, the number of image files is 1. This number is total number of image files included in the inputted content and linked contents.

Through the result of compliance analysis of “sample.wml”, users can know that the content has two links, one image file of 98 bytes should download to execute the content, size of the content is 919 bytes and total download size is 1017 bytes.

According to the information, MCSPs can predict whether the content has no problems to execute on mobile devices and can determine whether they service the content. Furthermore, MCPs can know the problems if there are problems in the content so that they can easily modify the content.

7 Conclusion

In present, compilers, integration development tools, or simulators are used for compliance analysis of mobile contents. However, these tools check simple things in the contents such as syntax and should be installed to use. Furthermore, different tools must be installed according to the kind of the content.

The model of this paper is a model for implementation of compliance analysis system which can be accessed easily anywhere through the web browser and can analyze the compliance of the mobile contents regardless of the kind of the content.

Recent computing environments are changing to web-based computing environments. It is believed that most systems will be executed through the web in the future. From these tendencies, the system should be used usefully if you develop the compliance analysis system for mobile content using the model of this paper.

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