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A Software Application for Querying AQI Index Parameter Related to Air Pollution Using cURL in PHP

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Abstract: ***Air pollution is one of the main problems for humanity. The quality of air in terms of pollution changes according to the intensity of air pollutants in atmosphere. Monitoring air quality is crucial for asthma sufferers and people affected by air pollution. In Turkey, air quality monitoring stations are established by Environment and Urban Ministry for each province. These stations have been hourly measuring air pollutant parameters according to its places. While some of stations only measure PM10 and SO2, some of them measure PM10, SO2, NO2 and etc. According to these parameters, air quality indexes (AQI) are instantly calculated for each station daily. These parameters have been publishing on the web page of ministry. A mobile based application on air pollution monitoring is not available yet. In this study, a new web and mobile based application instantly getting PM10, SO2 and AQI data from Adıyaman air quality monitoring station is developed in PHP with cURL. And the developed application has been running in a web server located in Adiyaman University. The mobile application has been developed in Android operating system. Consequently, a mobile application has been developed for monitoring air quality parameters in this study. And the air pollutant parameters can be instantly monitored from mobile phones.***

Keywords: Air Pollution, Monitoring System, Web programming, PHP, Android, cURL

1. Introduction

Pollution has been a problem in developing world conditions. Human beings are intentionally or unintentionally affected by it. Mankind is adversely affected from the consequences of pollution directly or indirectly. There is nothing permanent energy source in the world. Although air is seen as an endless energy source, contamination of this source is increased the importance of precautions related to air. Today, air pollution is also a problem due to its negative effect on human health, eyeshot, materials, plants and animal health. Air pollution is sourced from urbanization, traffic and industry. However, meteorological factors and topographic structure prevent the spreading of air pollution in atmosphere. Since people are affected from air pollution as little as possible, air pollution indicators must be predicted and air pollution early warning system must be developed[1].

The indicator examines exceed of Environmental Standards for Air Quality, for four air pollutants: particulate matter with a diameter of less than 10 micrometers (PM10), sulfur dioxide (SO2), carbon monoxide (CO) and nitrogen dioxide (NO2). Air Quality Index (AQI) is a numerical scale used for reporting daily air quality. The daily results of the air quality index are used to convey an estimate about air pollution levelto the public. It gives information about pollution level in air and associated health effects. The AQI centers on the health effects that may be experienced within a few days or hours after breathing polluted air[2–4].

High levels of PM10 from coal employed for heating is adversely affected the most poor air quality in Turkey. Especially, main air pollution is sourced from home heating in Adiyaman province; however this impact has not been proven yet. For obtaining findings, air quality mechanism and its variables must be analyzed. Road transportation is a different air pollution reason in Adiyaman. Thus, atmospheric reactions of SO2, NO2 and organic compounds, dust, pollen, ash and soil components also produce particulates [5,6].

One of the most important indicators in technological development is to increase in use of internet in today's world. Moreover, environmental science has been under the influence of technological progress like other sciences [7]. In this study, a technological method related to air pollution monitoring system is proposed in environmental science. PHP is a scripting language that can be embedded into HTML, specifically designed for development over virtual locations, used by a large audience. Dynamic softwares (especially database applications) can be easily developed using PHP[8]. cURL (Client URL library function) is a tool transferring data among servers employing some known protocols. PHP supports cURL tool allowing for communications among many different types of computers with many different protocols. Furthermore, http and https protocols are supported by cURL.

There are 211 air pollution stations (APS) are currently and hourly working at different locations in Turkey. While some of them are located in city centers, some are found at the places where there is a lot of air pollution. Different parameters (PM10, SO2, NO2, NO, CO, etc.) determining the air pollution are measured according to some specifications in air stations. The station in Adiyaman measures only PM10 and SO2 air pollutant parameters. Although these parameter values are hourly measured and published from formal web site of ministry, there aren't any mobile device applications for monitoring these parameters instantly. Moreover, to fulfil this requirement it is decided to develop a web and mobile based application monitoring air quality parameters in the study. Firstly, this application has been developed as a web site. Then this application has been

converted for using in mobile device. Because there aren't any web services for getting these parameters, a parser has been developed in PHP monitoring these parameters and air quality index (AQI). cURL tool in PHP have been employed for parsing these parameters. cURL tool has many procedures and function for transferring data among servers to realize this application. If the literature is reviewed, some similar studies are seen. The most studied topics among computational methods in air pollution projects are related with analyzing the atmosphere views. Besides, there is a close study[9] with the proposed study in literature. In this study; CO and NO parameters of air pollution were measured in a special environment, and the measured values were transferred to the mobile system via wireless network. However, in the developed application; the data available in a remote server is received and displayed on a mobile device.

In the next section, Air Quality Index, Particular Matter (PM10), Sulphur dioxide (SO2) pollutant parameters, PHP, cURL tool and Android Applications are described. In third section, the results of the study are discussed. And the last section, study is concluded with some proposal goals in the next.

2. Material and Method

In this section, the methods employed in the study are described.

2.1 Air Quality Index (AQI)

Air pollution, which is the result of urbanization brought about by modern life, has an impact on the global scale as well as local and regional. Since air pollution has a significant impact on human health, the issue of air quality has great importance all over the world. When air pollution / air quality is explained to the public, a classification system is employed. This classification system is widely used all over the world. And the air quality is made ratings as good, medium, bad, dangerous and etc. according to this air classification system. The methods and criteria used in the calculation of the index have been established in accordance with the air quality standards applied in their countries in the world. It is of great importance to develop a suitable tool to understand pollutant levels in a region. Moreover, while this tool should provide accurate and understandable information about the level of air pollution to the citizen, it can be useable by the authorities for taking precaution to protect public health. To this end, developed standard values should be presented by being translated into an index so as to be stimulating, understandable and widespread in terms of use. The index which countries convert to their own limit values and pollution is classified in order to characterize the air quality in a certain region is Air Quality Index (AQI). AQI has some level of categories in terms of different level of health concern [2,3,5,6]. National air quality index cutting points is given in the Table 1.

Table 1: National Air Quality Index Cutting Points

Index	Good	Medium	Sensitive	Unhealthy	Bad	Dangerous
AQI	0-50	51-100	101-150	151-200	201-300	301-500
SO2 [µg/m³]	0-100	101-250	251-500	501-800	851-1100	>1101
NO2 [µg/m³]	0-100	101-200	201-500	501-1000	1001-2000	>2001
CO [µg/m³]	0-5500	5501-10000	1001-16000	16001-24000	24001-32000	>32001
O3 [µg/m³]	0-120	121-160	161-180	181-240	241-700	>701
PM10 [µg/m³]	0-50	51-100	101-260	261-400	401-520	>521

2.2 Particulate Matter (PM10) AND (SO2)

The particulate matter comprises various and complex mixtures of particles suspended in air. Particulate matter occurs as a result of natural and anthropogenic activities. The main sources of particulate matter are factories, power plants, incineration plants, construction activities, fires and wind. While the PM10 is stored in the upper respiratory tract, fine and ultra-fine particles are collected in the alveoli. The diameter, surface, composition and number of the particle play an important role in evaluating PM's health effects. The main components of PM are metals, organic compounds, and materials of biological origin, ions, reactive gases and particulate carbon. In addition, metal, poly-aromatic hydrocarbons and other organic compounds such as endotoxins cause PM to be toxic. From a health perspective, it can be said that ultra-fine and fine particles are more dangerous than coarse particles [2,3,5,6].

Since the gas pollutants are the result of the burning of fossil fuels, they have a great effect on negative change of the composition of the atmosphere. Sulphur dioxide is a primary pollutant. It may deposit to the earth's surface either as a gaseous molecule or dissolved in rain droplets. The more important fate, however, is atmospheric oxidation to sulphuric acid and subsequent deposition. The oxidation process has a time scale of several days and may occur either in the gas phase or in liquid water droplets. SO2 is respiratory irritant that can have adverse effects on breathing, contribute to respiratory illness, alter the defence mechanisms of the lungs, and aggravate existing pulmonary and cardiovascular disease. Sulphur dioxide can also damage crops and trees [2,3,5,6].

2.3 Air Quality Monitoring Stations

The Air Quality Monitoring Stations have been installed under the control of the Republic of Turkey's Ministry of Environment and Forest in Turkey. These stations have measured and published air quality and air pollution values according to the predefined air pollutants parameters. Air pollution stations have tracked local changes in the atmosphere as well as pollutants from domestic sources and neighboring countries. These pollutants come as gases and trace elements, in rainwater and as airborne particulates. Particulates also include dust from natural sources. Two

control parameter air pollutants, which are sulphur dioxide (SO2) and particulate matter (PM10), can be commonly monitored at the stations connected to the system network in Turkey. In addition to these two criteria pollutants, some other pollutants have also been monitored at a very limited number of stations. In this study, the data from Adiyaman station have been employed at the developed software. And PM10, SO2 and HKI parameters can be monitored belonging to Adiyaman air pollution station in real-time. Images from Adiyaman air pollution stations are given in the following figure.

(a) (b)

Figure 1: Some images from Adiyaman air pollution station (a) PM10 measurement system, (b) particulate matter accumulation

2.4 PHP and CURL

PHP scripting language was developed by RasmusLerdorf in 1994 and PHP was re-coded by AndiGutmans, ZeevSuraski and Lerdorf as PHP3 in 1997 [10]. PHP is a scripting language. Namely, codes in PHP are written in plain text and recorded in this format. Moreover, today PHP is most widely used all over the world as server side scripting language. PHP codes are written in HTML codes with its special brackets. A sample code is given in the following code snippet.

```
<html>
<?PHP
        echo"Hello PHP"
?>
</html>
```

Code Sinepet 1. A sample codes for PHP scripting language

Too many different types of servers can communicate each other using PHP. Because PHP comprises LIBCURL library coded by Daniel Stenberg. LIBCURL library include cURL (Client URL library function). This library function allows us to connect and communicate too many different types of server. And it employs many different types of protocols while doing this. Moreover, HTTP, HTTPS, FTP, GOPHER, TELNET, DICT, FILE and LDAP protocols are supported by LIBCURL. It also supports web certificates, HTTP POST, HTTP PUT, FTP uploading, proxies, cookies and user-password authentication. In PHP, if one wants to use a cURL function that is time he/she needs to install LIBCURL package[11]. A basic cURL example in PHP is given in the following code snippet.

```
<?PHP
$CH = CURL_INIT("HTTP://WWW.ZZ.COM/");
$FP = FOPEN("EXAMPLE.TXT", "W");
CURL_SETOPT($CH, CURLOPT_FILE, $FP);
CURL_SETOPT($CH, CURLOPT_HEADER, 0);
CURL_EXEC($CH);
CURL_CLOSE($CH);
FCLOSE($FP);
?>
```

Code Snippet 2. A sample Codes Belonging to cURL in PHP

In above codes, cURL session is initialized using the curl_init(), then all options can be set with the curl_setopt(), then the session can be executed with the curl_exec() and then session is finished off using the curl_close().

2.5 Android Operating System

Android is an operating system employed Linux kernel. It is developed by Google, Open Handset Alliance and free software communities. It is primarily designed for touchscreens, however Android is also popular among high-tech devices looking for a low-cost, customizable operating system. Initially, Android has been used only in devices such as mobile devices and tablets; today it has also been used in devices such as televisions, cars, game consoles, digital cameras and clocks. According to a survey, more than 71% of software specialists are developing their apps in Android operating system.

For Android, applications are written in Java language using the Android Software Development Kit (SDK). This SDK provides software engineer some utilities such as debugger, software libraries and emulator. Android is especially developed for 32-bit ARMv7 processors. Furthermore, the Android x-86 project supports x86 processors. The requirements for Android 5.1 are as follows: 512 MB RAM, 32-bit ARMv7, MIPS or x86 architecture processor, a GPU is compatible with OpenGL ES 2.0. 64-bit support for x86, ARM and MIPS platforms is also available with the Android 5.x Lollipop release. Because each manufacturer product a

ROM containing its own Android variant, updates may not be appropriate for every model of Android operating system at the same time.

3. Results and Discussion

Air pollution parameters are hourly recorded by the Environment and Urban Ministry. Furthermore, the pollutant parameters published on a web site for public use at each province in Turkey. However, there are no mobile applications showing these parameters instantly according to a specific station yet. Since recording of the atmosphere images in accordance with the pollution of air is needed in another study, a software system displaying air pollution condition is developed in the study. Furthermore, this system gives early warning service for air pollution learning need. Thus, the warning system will inform people about the air pollution, also we will direct to take an atmosphere views for collecting the data for another project. This study constitutes an infrastructure to the next project. In addition, a web application in PHP using cURL has been developed both to make such a need and to build an infrastructure of mobile software displaying air pollution. The web application aims to read the data belonging air pollution parameters from the formal web site of the ministry. The developed application parses the web site in HTML format and gets the related air parameters (PM10, SO2) related to pollution. The parameters are monitored in the developed web site too. The developed software is run on a web site's URL (http://ozbeyaz.adiyaman.edu.tr/HKI.php). Calling web site and its view are given in the following figure.

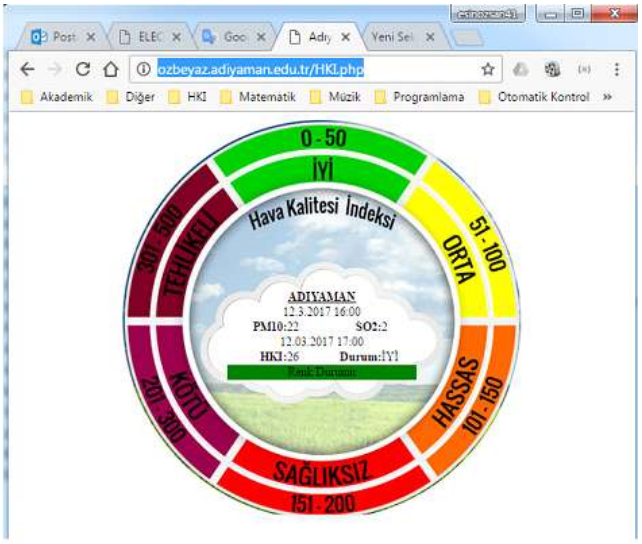

Figure 2: An interface view from developed web application.

In this application five values are displayed. These are date-time, PM10, SO2, AQI values, and air quality situation with its colour at the current time. The lower rectangular box takes a color according to the value of the air pollution quality level. Since the air pollution situation in this way is good, this rectangular box is painted in green color above figure. The cURL function employed in the software is given below.

```
function curl($url, $post=false){
  $user_agent = 'Mozilla/5.0 (Windows NT 6.1; WOW64)  AppleWebKit/537.17(KHTML, like
Gecko) Chrome/24.0.1312.52 Safari/537.17';
  $ch = curl_init();
curl_setopt ($ch, CURLOPT_URL, trim($url));
curl_setopt($ch, CURLOPT_USERAGENT,$user_agent);
curl_setopt($ch, CURLOPT_TIMEOUT, 60);
curl_setopt($ch, CURLOPT_FOLLOWLOCATION, true);
curl_setopt($ch, CURLOPT_RETURNTRANSFER, true);
curl_setopt($ch, CURLOPT_COOKIEFILE,"");
curl_setopt($ch, CURLOPT_COOKIEJAR,"/cookie.txt");
curl_setopt($ch, CURLOPT_SSL_VERIFYPEER, false);
$result = curl_exec($ch);
if(curl_errno($ch)){
echo'Curl error: ' . curl_error($ch);
  }
else{
curl_close($ch);
return $result;
}
}
```

Code Snippet 3. cURL function developed in the study.

In this function; CURLOPT_URL is used to retrieve content of URL, CURLOPT_USERAGENT includes the contents of the User-Agent header to be used in the HTTP request, CURLOPT_TIMEOUT adjusts maximum number of seconds to allow cURL functions to work, as part of the HTTP header CURLOPT_FOLLOWLOCATION must be TRUE to track the Location header that the server sends. CURLOPT_RETURNTRANSFER must be TRUE to return the transport from the internal function as a string, CURLOPT_COOKIEFILE keeps name of the file containing the cookie data, CURLOPT_COOKIEJAR is name of the file where all internal cookies are saved when the connection is closed, and CURLOPT_SSL_VERIFYPEER must be FALSE to stop validating the peer certificate of cURL.

Moreover, air pollution monitoring system in PHP was developed using cURL in Android operating system. This operation is simply done with a tool that calls a website over Android. The interface of the software monitoring air pollution quality level for Adiyaman Province is given below figure.

Figure 3: Application of the developed software interface is Arduino.

4. Conclusion

In this study, a mobile and web based software application has been developed. This application gets the air pollution parameters (PM10, SO2 and AQI)belonging to Adiyaman air pollution station from the web address (http://havaizleme.gov.tr/Default.ltr.aspx)andmonitorsthe parameters in the developed web (http://ozbeyaz.adiyaman.edu.tr/HKI.php)and mobile applications. Furthermore, there aren't any mobile based application monitoring air quality level on a smart phone. And the absence of such a mobile application is a shortcoming. So, aim of the study is to develop a mobile application for monitoring air pollutant parameters. Thanks to our developed software, the data recorded in anair pollution station at a certain region can be displayed on Android based smart phones anymore. Moreover, we will observe the air pollutant parameters for Adiyaman Provincefastly using the developed software. Furthermore, taking off atmosphere images is mandatory for us in another project. So it will be possible to decide the times of taking off atmosphere imageswith the help of this application when air pollution level is dirtier. The developed software is a web based application and written in PHP using cURL toolkit. The application has been served in a specific web address ((http://ozbeyaz.adiyaman.edu.tr/HKI.php). Five different values can be monitored for Adiyaman province anymore. These parameters are PM10, SO2, AQI, air pollution situation and instant date-time which the datais received. Besides, this application is developed for Android operating system too. Some benefits obtained from this developed software are given in the following clauses;

- This software is an infrastructure for an application with which one can monitor air pollution parameters through mobile devices.
- When air quality levels are bad conditions, weather images will be taken off from atmosphere. This application plays an important role in improving another project.
- The developed software shows only the air pollution parameters for Adiyamanair pollution station in Turkey, however feasibility of this software has been demonstrated and more robust software will be developed to inform aboutthe condition of air pollution for all stations in Turkey in the future.

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