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SMART BUILDING
Using Web Application
(Second Controlling Method)

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***Abstract*—As technology advances, there is an increasing demand for the internet to allow us to control every facet of our lives, usually from apps on our phones or our smart devices Whether we are able to remotely turn on our heating, set timers on our lights to ensure they are shining, etc..**

This work aims to study the possibility of controlling the smart building using Web Application to provide User Friendly Interface and Remote Connection through the internet or intranet.

Smart building web application is an example of what's possible with based Internet of Things projects.

This paper describes part of an integrated project for implementation of smart building controlled by several ways, which is considered as a Second Method to control the building.

***Keywords*—Web application, C# language, ASP.NET, Smart building.**

I. INTRODUCTION

Today, Smart buildings are complex concatenations of structures, systems and technology. Over time, each of the components inside a building has been developed and improved, allowing building owners to select lighting, security, heating, ventilation and air conditioning systems independently.

There is a possibility to develop a practical way to control the whole building more easily, As well as the possibility of controlling the devices and equipment inside the building remotely from anywhere, and to identify the current state of the building.

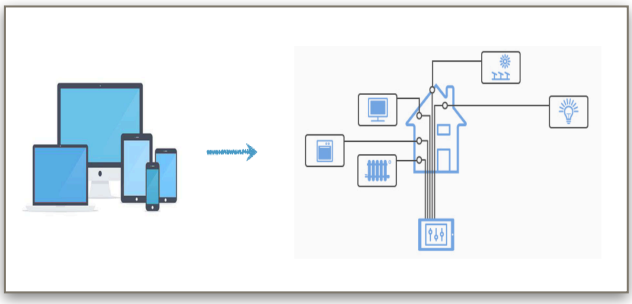
A Property Management Software is an online program or software designed for residential or commercial property management. It is an effective and easy-to-use tool.

Property management systems are utilized by homes, hotels, conference centers and organizations...etc. Some property management software can integrate with applications already running.

They can be based online, or hosted internally on the current computer systems of the building. Property management systems can be used to manage single or multiple properties simultaneously. These softwares help people to know the real state of the building. It is a quick response application that can store each detail of the whole building.

The Web Application is considered as one of the Property Management Software.

This work aims to design and use the Web Application to control the building through any smart device from anywhere via the internet. as shown in Fig1.



1. Intelligent Building Diagram

This work is organized as follows: Section II covering the main concepts of the Web Based Application. Section III representing important information about Programming Language C#. Then the ASP.NET Web Application is defined in section IV . Section V contains the practical part of Smart Building Web Application. Finally section VI drawing the major conclusions from this work.

II. WEB BASED APPLICATION

The Web Application has been created and used in this work to control building appliances by any smart device from anywhere.

A web application " web app " is a software program that is stored on a remote web server and delivered over the Internet through a browser interface. Unlike traditional desktop applications, which are launched by operating system. It will make it independent of operating system, place, and used hardware.

Web applications are the ultimate way to take advantage of today's technology to enhance organizations productivity and efficiency. Web application gives an opportunity to access the information from anywhere in the world at anytime. It also facilitates us to save time and

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money and improve the interactivity with the customers and partners.

Web apps have several advantages over desktop applications. Since they run inside web browsers, developers do not need to develop web apps for multiple platforms because the appearance is dependent on the browser rather than the operating system, also they do not need to distribute software updates to users when the web app is updated. By updating the application on the server, all users have access to the updated version.

Additionally, the data you entered into a web app is processed and saved remotely. This allows to access the same data from multiple devices, rather than transferring files between computer systems.

A. *Advantages of Web Apps*

Web-based applications offer a range of advantages over traditional desktop applications:

- Web Application are accessible anytime, anywhere, via any smart device with an Internet connection.
- Web based applications are far more compatible across platforms than traditional installed software [1].
- Installation and maintenance becomes less complicated.
- The upgrades for web application are only performed by an experienced professional to a single server, the results are more predictable and reliable [2].
- Web based applications can considerably lower the costs because of reduced support and maintenance, lower requirements on the end user system.
- The web application takes a couple of minutes to set up, it just need the URL, a user name, and password.
- There are many technologies can be used for building web-based applications, depending on the requirements of the application, such as the newer Microsoft .NET platform uses Active Server Pages, SQL Server and .NET scripting languages [2].
- Web applications do not need the storage space on Users' computers because most of the information is stored somewhere on a server.

B. *Types of Web Apps*

Web app development is not limited to only smartphones or tablets. It is designed to run on any browser, work on desktop computers, laptops or mobile devices. In this subsection, the different types of web applications will be classify.

The classification is based on how web apps show the content it provides. These can be categorised into 6 different types of web applications [3]:

1) *Static web application*: Web app displays very little content and is not very flexible like professional portfolios or digital curriculums
2) *Dynamic web application*: More complex. Have an administration panel (called CMS) from where administrators can correct or modify the app's content including text and images.
3) *Online store or e-commerce*: Enable electronic payments via credit cards, PayPal or other payment methods.
4) *Portal web app*: Lets you access several of its sections or categories through a home page like forums, chats, email, browsers.
5) *Animated web application*: Use Flash technology. Present content with animated effects.
6) *Web application with a 'content management system'*: Very common among content pages: personal blogs, corporate blogs, professional blogs, news pages, articles, media, etc. Examples could be WordPress, Joomla, and Drupal.

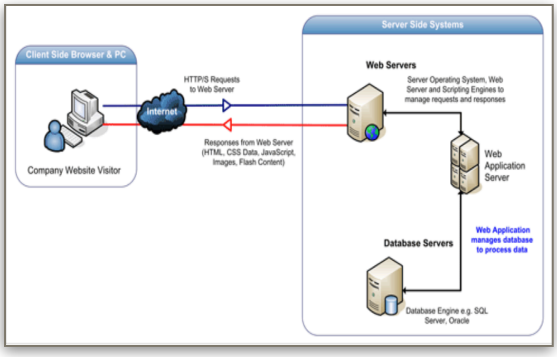
Each kind of web application has its strengths and weaknesses, but they ultimately remain to be a website. They are not native apps, no matter how similar they may be in appearance to these (this will depend on the web app's design, not on its development). we will have to comply with regulations on cookies and strengthen the app's security against possible hacker attacks − in a similar way as needs to be done with websites.

C. *The Way The Web application function*

Most web applications are based on the client-server architecture where the client enters information while the server stores and retrieves information. Web applications can provide the same functionality and gain the benefit of working across multiple platforms.

The Fig2 details the three-layered web application model [4]:

- The first layer is normally a web browser or the user interface.
- The second layer is the dynamic content generation technology tool such as Java servlets (JSP) or Active Server Pages (ASP).
- The third layer is the database containing content and customer data.



2. The three-layered web application model

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A user goes to their browser, types in a website and hits Enter. The browser goes out and finds the internet-facing computer that the website lives on and asks the server for the specific page. The server responds to the request by sending some files over to the browser. The browser executes those files and shows something to the user [5].

Activities involved from making a 'user request from the browser' to 'getting response back to the browser' can be divided into five steps:

1) User requests the app from the browser.
2) Browser sends request to the server.
3) Server finds the request and generates the requested app as a response to the request.
4) Data is returned in response to the request.
5) then the browser replaces view with the data sent as response from the server.

III. PROGRAMMING LANGUAGE C#

The programming language has been used to program the smart building web application is C#.

C# (pronounced "C sharp") is a programming language that is designed for building a variety of applications that run on the .NET Framework. C# is simple, powerful, type-safe, and object-oriented language. The many innovations in C# enable rapid application development while retaining the expressiveness and elegance of C-style languages [6].

C# can be used to create Windows client applications, Web services, distributed components, client-server applications, database applications, and much, much more. Visual C# provides an advanced code editor, convenient user interface designers, integrated debugger, and many other tools to make it easier to develop applications based on the C# language and the .NET Framework [6].

Visual Studio is one of the programs that can be used to design programs written through C Sharp language, because it includes C#. (The Visual Studio has been used in this work to develop a web application for the Smart Building).

Windows is the dominating Operating System on client computers. The best GUI frameworks for Windows applications is Winforms and WPF together with .NET Framework. The best programming language to work with the .NET Framework and it's APIs is C# [7].

C# is designed to work with Microsoft's .Net platform. Microsoft's aim is to facilitate the exchange of information and services over the Web, and to enable developers to build highly portable applications. C# simplifies programming through its use of Extensible Markup Language (XML) and Simple Object Access Protocol (SOAP) which allow access to a programming object or method without requiring the programmer to write additional code for each step. Because programmers can build on existing code, rather than repeatedly duplicating it, C# is expected to make it faster and less expensive to get new products and services to market [8].

IV. ASP.NET WEB APPLICATION

ASP.NET (originally called ASP+) is the next generation of Microsoft's Active Server Page (ASP). It is an open source web framework for building modern web applications and services. With ASP.NET we can quickly create web sites based on HTML, CSS and JavaScript, scale them to millions of users and easily add more complex capabilities[6].

ASP.NET is a unified Web development model that includes the services necessary to build enterprise-class Web applications with a minimum of coding. ASP.NET is part of the .NET Framework, so that it provides access to all of the features of that framework. For instance, we can create ASP.NET Web applications using any .NET programming language and .NET debugging facilities [4].

The ASP.NET application codes can be written in any of the following languages [9]:

- C#
- VisualBasic.Net
- Jscript
- J#

ASP.NET is used to produce interactive, data-driven web applications over the internet. It consists of a large number of controls such as text boxes, buttons, and labels for assembling, configuring, and manipulating code to create HTML pages.

A. Frameworks of ASP.NET

ASP.NET offers three frameworks for creating web applications: ASP.NET Web Forms, ASP.NET MVC, and ASP.NET Web Pages. All three frameworks are stable and mature, and we can create great web applications with any of them [6].

Each framework targets a different type of application. Which one we choose depends on a combination of the web development experience and which is the best fit for the type of application we're creating [6].

All three frameworks will be supported, updated, and improved in future releases of ASP.NET.

The ASP.NET MVC framework has been used to create the smart building web application by C#, so it will be discussed in more details in this section.

B. ASP.NETMVC:

ASP.NET MVC (That we used in our project) is a part of the ASP.NET web application framework and is included with Visual Studio.

The Model-View-Controller (MVC) architectural pattern separates an application into three main components: the model, the view, and the controller. The ASP.NET MVC framework provides an alternative to the ASP.NET Web Forms pattern for creating Web applications. The ASP.NET MVC framework is a lightweight, highly testable presentation framework that is integrated with existing ASP.NET features [6].

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By dividing the application into the Model(M), Views(V), and Controllers(C), ASP.NET MVC can make it easier to manage complexity in larger applications, also it works well for Web applications that are supported by large teams of developers and Web designers who need a high degree of control over the application behavior.

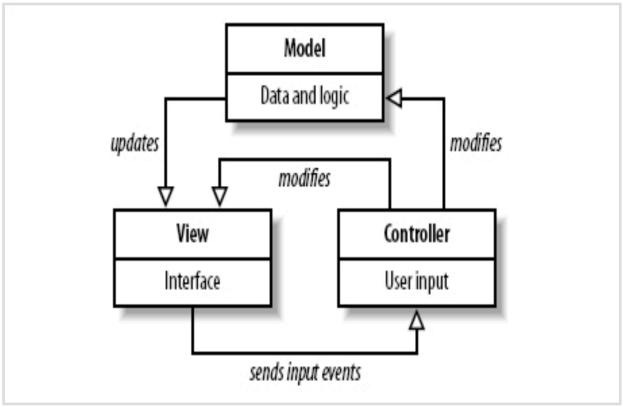
In addition, MVC was designed to be extensible, providing power developers the ability to customize the framework for their application needs.

The MVC framework includes the following components as shown in Fig3 [6]:

- *Models*: Model objects are the parts of the application that implement the logic for the application's data domain. Often, model objects retrieve and store model state in a database. For example, a Product object might retrieve information from a database, operate on it, and then write updated information back to a Products table in a SQL Server database.

- *Views*: Views are the components that display the application's user interface (UI). Typically, this UI is created from the model data. An example would be an edit view of a Products table that displays text boxes, drop-down lists, and check boxes based on the current state of a Product object.

- *Controllers*: Controllers are the components that handle user interaction, work with the model, and ultimately select a view to render that displays UI. In an MVC application, the view only displays information, the controller handles and responds to user input and interaction. For example, the controller handles query-string values, and passes these values to the model, which in turn might use these values to query the database.



3. The MVC framework

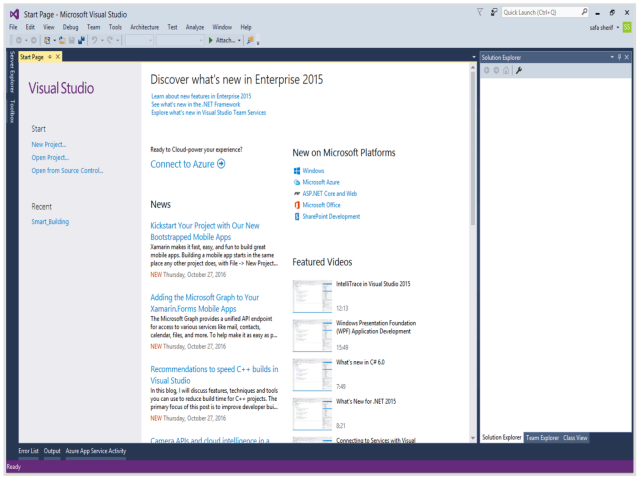
C. *Integrated Development Environment*

For all the software and web developers, the right tool for the job can really make all the difference. However, Integrated Development Environment suites (IDE) tend to offer a richer code editing experience that can include extras like wizards, debug mode and color coding... etc. One of the most famous IDE used to develop Web application is Microsoft Visual Studio.

Microsoft Visual Studio used by Any Developer, to Any App and Any Platform, it is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as a complete set of development tools for building ASP.NET Web applications, XML Web Services, web sites and mobile applications [10].

Visual Studio supports different programming languages include Visual Basic, Visual C#, and Visual C++ and so on. which enables tool sharing and eases the creation of mixed-language solutions. In addition, these languages use the functionality of the .NET Framework, which provides access to key technologies that simplify the development of ASP Web applications and XML Web Services [6].

There are many versions of Microsoft Visual Studio and the latest version is Visual Studio 2015، which has been used in our project to develop a web application for the Smart Building. The Fig4 shows the GUI of the Microsoft Visual Studio.



4. Microsoft Visual Studio

V. PRACTICAL PART " SMART BUILDING WEB APPLICATION"

Web application is used to control the smart building by using any device from anywhere via the Internet.

Web application has several advantages over desktop applications. They run inside web browsers which mean it will operate in any device has a web browser rather than the operating system, so it can considerably lower the costs because of reduced requirements on the end user system.

In this work, Smart building web application has been created by using ASP.NET MVC framework and C# language via Microsoft visual studio.

After the creation of web application, it has been published in a local web server, and can be opened and used by any smart device exist on the same network of the local Web server by writing the URL (***http://localhost/smartBuilding/***) of the application in the device's browser.

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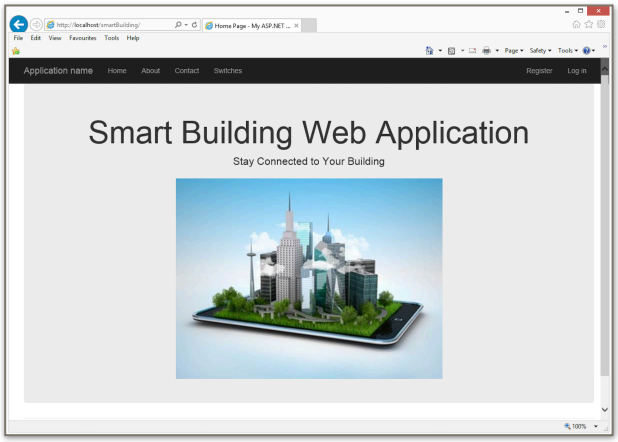
A. The Interface of The Smart Building Web Application

The Smart Building Web Application consists of four pages (Home Page, About, Contact, Switches)

1. Home Page

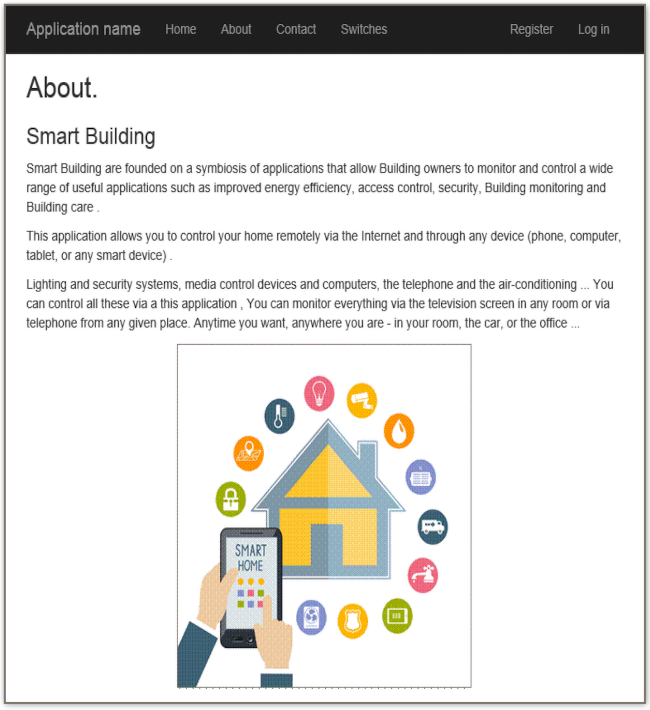
Home Page as shown in Fig5 is the first interface of the web application, it contains the name of the application.



5. Web Application (Home Page)

2. About

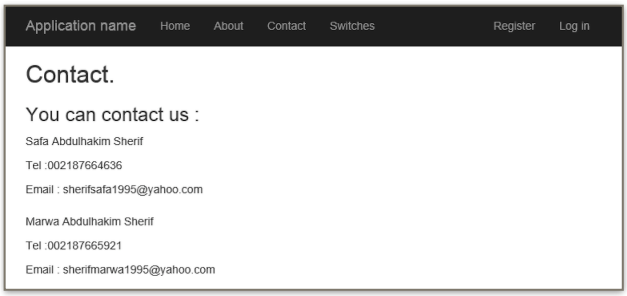
This page contains a brief explanation about the basic idea of smart buildings, as well as a simplified explanation about the idea of this application as shown in Fig6.



6. Web Application (About Page)

3. Contact

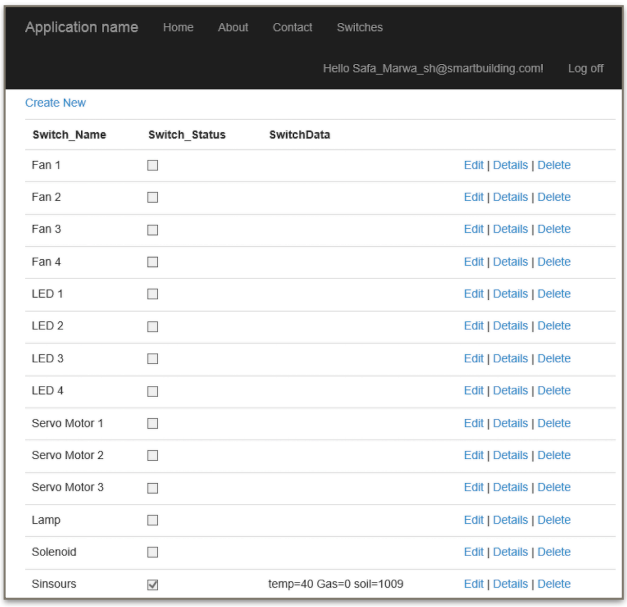
This page contains our contact information to communicate with us for any queries as shown in Fig7.



7. Web Application (Contact Page)

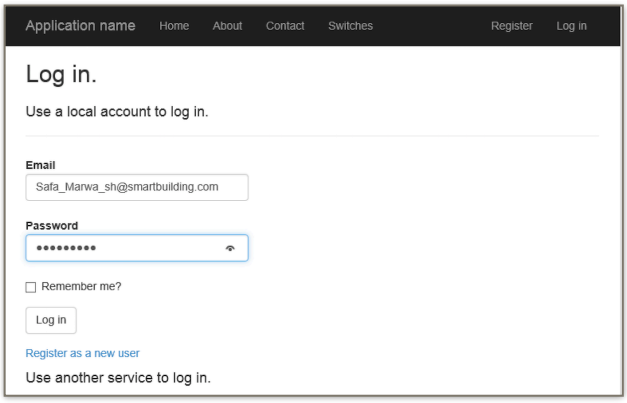
4. Switches

This page as shown in Fig8 contains an index includes a set of switches that allow us to control equipments and components in the building, in addition to the knowledge of the current status of this equipment.



8. Web Application (Switches Page)

To open Switches page must first log in by entering the email and Password as shown in Fig9.



9. Web Application (Log in Page)

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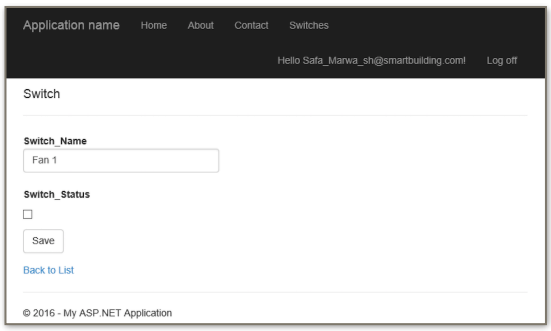
To change the current status of any switch, we must click on the edit button that located next to each switch in the index as shown in Fig8.

After pressing the edit button, edit page as shown in Fig10 will appear and Allows us to change the status of the switch.

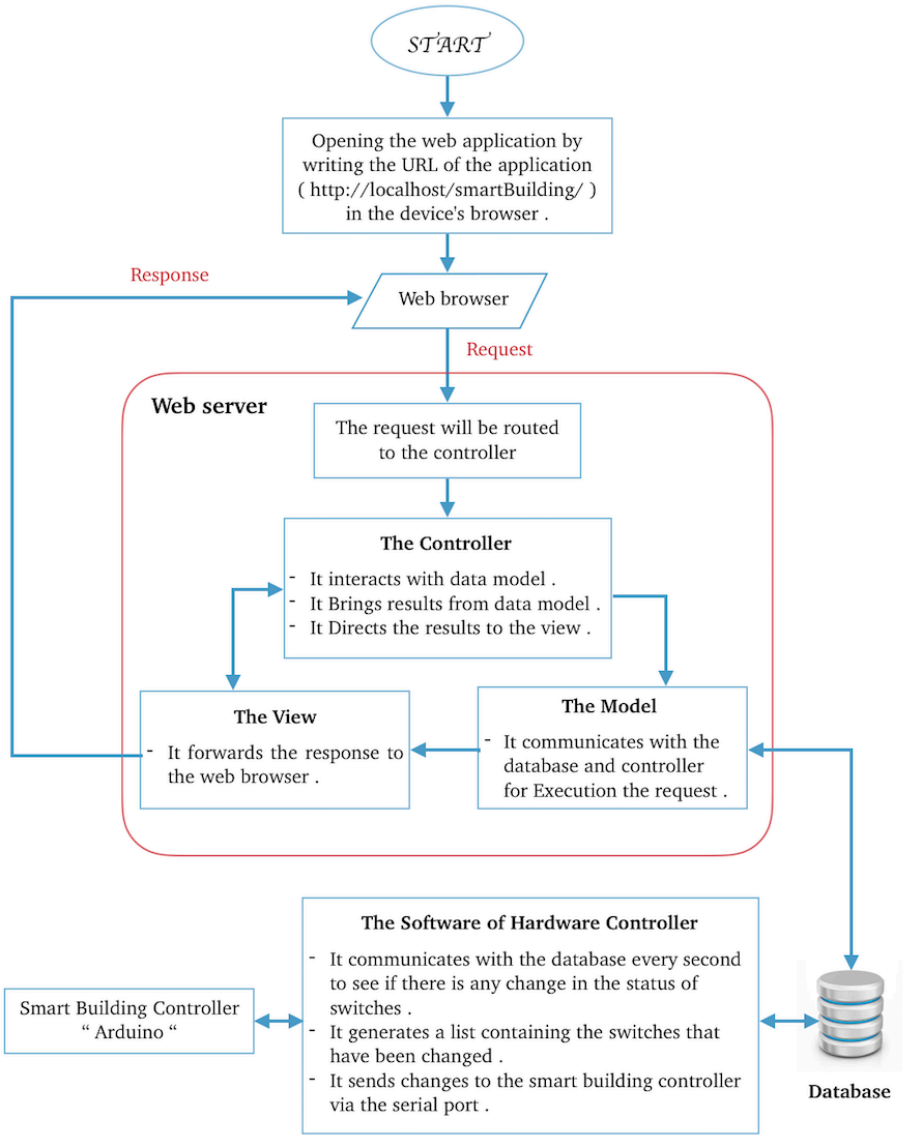


10. Web Application (Edit Page)

B. Web Application Flow Chart

Smart Building Web Application provides " User Friendly Interface " to control the smart building from any smart device.

The flow chart in Fig11 is clarifying how the web application works and how it communicate with database, as well as how to communicate with smart building controller.



11. Web Application Flow Chart

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VI. CONCLUSION

A web application " web app " is a software program that is stored on a remote web server and delivered over the Internet through a browser interface.

Web application has several advantages over desktop applications. They run inside web browsers which mean it will operate in any device has a web browser rather than the operating system, so it can considerably lower the costs because of reduced requirements on the end user system.

In this work the Smart Building Web Application is designed to control the smart building by using any device from anywhere via the Internet.

The Smart Building Web Application consists of four pages (Home Page, About, Contact, Switches)

After the creation of web application, it has been published in a local web server, and can be opened by writing the URL (***http://localhost/smartBuilding/***) of the application in the device's browser.

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