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FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT**

Project Report
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CENG 407
Innovative System Design and Development I

**System Resource Monitoring
and Visualization**

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Abstract

In this project Virtual Machine will be controlled and visualization of the machine data will be carried out. Windows operating system will be used to take out the virtual machines data. The data will be taken from virtual machine. Virtual machines data samples can be processor spending, ram spending, how many user are available in the operating system, what are the IP addresses of the users, how many hours has it been open..etc. Data will be visualized by using website. In this website authentication will be carried out. If enough time is available in the project plan, Stationary virtual machine can be started by using a website by sending a message or command to the server. **PHP** or **Python** programming languages will be worked in the project implementation. Moreover, **Bootstrap** framework can be used to implementation.

ÖZ

Bu projede Sanal Makine kontrol edilecek ve makine verilerinin görselleştirilmesi gerçekleştirilecektir. Sanal makine verilerini çıkarmak için Windows işletim sistemi kullanılacaktır. Veriler sanal makineden alınacaktır. Sanal makine veri örnekleri işlemci harcaması, ram harcaması, işletim sisteminde kaç kullanıcı bulunduğu, kullanıcıların IP adresleri nelerdir, kaç saat açık kaldığı vb. olabilir. Veriler web sitesi kullanarak görselleştirilecektir. Bu web sitesinde kimlik doğrulaması yapılacaktır. Proje planında yeterli zaman varsa, sunucuya bir mesaj veya komut gönderilerek bir web sitesi kullanılarak Sabit sanal makine başlatılabilir. Proje uygulamasında PHP veya Python programlama dilleri üzerinde çalışılacaktır. Ayrıca, Bootstrap çerçevesi uygulama için kullanılabilir.

1. Introduction

1.1 Problem Statement

As technology developed, physical computers turned into virtual machines. Afterwards, these virtual machines were moved to servers and their numbers increased. But as the number of virtual machines increased, it became harder to control them. It has become difficult to control who is logged into the virtual machines and the number of these people, the competence of the virtual machine at that time, how long the machine has been on, and its communication with other machines. This project aims for instant control of virtual machines.

1.2 Related Work

As a result of our research, we found the Virt-Manager applet. The Virt-Manager applet is a desktop user interface for managing virtual machines with libvirt. Virt-Manager provides a summary view of worker domains, their live performance, and resource usage statistics [1]. Even if the project we are working on has similar features to the Virt-Manager application, our project will run on a website and only relevant people will be allowed to access this website. Our project is not the same as this application.

1.3 Solution Statement

As a solution to this problem, we aimed to design a website and connect to the virtual machine through the website, to capture the current system data of the virtual machine and to show it with charts and graphics on the website. We also aimed to put a virtual

machine start button on the website, because if the virtual machine has not been opened for some reasons, opening that machine through the website will be shorter than connecting to the server where the machine is located. In addition, we have put an authentication screen at the website login so that a team that only deals with virtual machines can access this website. People other than this team will not be able to control the virtual machine part. This solution will be implemented on virtual machines with windows operating system.

2. Literature Search

2.1 Introduction

2.1.1 Background Definition of Terms

As technology improved, the management of businesses also changed and improved. We are now able to manage a large part of the work from the phone and the computer. We can keep more data for the company and use this data as well.

2.1.2 Context

Companies use virtual machines to save energy [2]. Managers use admin panels developed for their own companies. The Admin Panel (or admin panel for short) is the primary tool for working with the online company [3]. Admin panels are prepared, implemented and used with the Bootstrap framework [4]. Ready-made admin panel templates can also be purchased [5].

2.1.3 Purpose of the Report

This report explores the visualization of data from a virtual machine on a website. Virtual machine technology applies the virtualization concept to the whole machine. It eliminates real machine compatibility constraints and hardware constraints. Virtual machine technologies are generally designed to solve problems in combining and using components in a computer system. It plays an important role in many parts of the computer system [6]. Data visualization is one of the effective tools to reveal hidden patterns in data [7]. Data visualization displays abstract and non-physical data with computer-based visuals for better understanding. The main goal here is to make statistical and complex data understandable using graphical interfaces [8]. It aims to show the data obtained from the previous times of the virtual machine on the website with graphics and graphics to this time. The data will be visualized on the bootstrap based website using Python or php [9].

2.2 Website Threads

2.2.1 Discussion – Identifying the Problems

Since the admin page works online, it is not possible to contact the company in a place without internet access. Since the admin page will be open on a server, its connections must be allowed, otherwise the company cannot be contacted. If it is not allowed by the virtual machine, the Admin panel cannot pull data, cannot visualize it.

2.2.2 Sentences Introducing Bullet Points

Below are four key items for the admin page:

1. Profile pages of company executives.
2. Chat mechanism for managers to talk to each other.
3. Button to start the virtual machine.
4. Visualization of the company's data from the past to this time.

2.3 Website Implementation

2.3.1 Website Design

The bootstrap framework will be implemented when making the admin panel. **Vuexy Admin Template** will be modified with Bootstrap framework [10]. Administrators will login to the admin panel with their username and password. Admins will be in communication with each other and will be able to view and change their profile pages if they wish. Admins will be able to see graphs and charts showing the company's data. The virtual machine can be started with the help of a button on the website.

2.3.2 Website Database

While preparing the website, a database will be developed that will work dynamically with the admin panel. The following four items explain why the database should be developed:

1. Records of usernames and passwords of admins.
2. Records of virtual machine connection times.
3. Records of admins' information on profile pages.
4. Records of data captured from the virtual machine.

2.4 Conclusion

While preparing this report, bootstrap, virtual machine and data visualization technologies were researched and information was obtained about them. Data visualization with PHP or Python languages has been researched and necessary information has been obtained. Admin panel templates were researched and information about the design was taken.

3. Software Requirements Specification

3.1 Introduction

The following subsections are an overview of the entire "Software Requirements Specification" (SRS) document.

3.1.1 Purpose

This document provides information about "System Resource Monitoring and Visualization".

3.1.2 Scope

This software is based on showing the data of a virtual machine with the help of graphs and charts in a website. Virtual machines data samples can be processor spending, ram spending, how many user are available in the operating system, what are the IP addresses of the users, how many hours has it been open..etc. In this website authentication will be carried out. After logging in to the website, users can see the status of the virtual machine on the website and start it if they wish. Users can edit their own profiles on the website.

The purpose of this software:

It is see the status of a virtual machine or machines and to control them (the virtual machine can be launched through the website).

3.1.3 Definitions, Abbreviations, Acronyms

TERM	DEFINITIONS
User	Right to login to the website.
SRS	Software Requirements Specifications
IEEE	Institute of Electrical and Electronics Engineers
VMI	Virtual Machine Introspection

3.1.4 Overview

This document is prepared to give details, technical information, and required specifications for this software aim.

3.2 Overall Description

3.2.1 Product Perspective

This software is software that aims to view the data of a virtual machine through a website. Virtual machine data will be captured by Virtual Machine Introspection (VMI) technique and displayed on the website via bootstrap-based graphics and charts [11]. The data captured from the virtual machine will be kept in the database and this database will work dynamically with the website. Virtual machine can be started with the help of a button on the website.

3.2.2 User Interfaces

There are 2 interfaces for the user to use. The user can choose one of these interfaces according to his/her wishes. Light colors are used in one of the interfaces, and dark

colors are used in the other. There are graphics displaying virtual machine data in the interface and a button to start the virtual machine.

3.2.3 Software Interfaces

3.2.3.1 For Website Software

FRONT-END	BACK-END
HTML5	PHP(To be determined)
CSS3	Python(To be determined)
Javascript	Laravel
jQuery	Laravel Telescope
Vue.js	Laravel Horizon
ApexCharts Addition	

3.2.3.2 Server-Side

- Linux Ubuntu (>=16.04)
- Nginx (Web Server)
- MySQL (For database)
- Redis (For cache database)
- Supervisor (For background operations)

3.2.3.3 For Visual Machine

- Windows Operating System.

3.2.4 Hardware Interfaces

Users must have at least one tablet, phone or computer to use the software. The systems of the phone, tablet or computer's to be used must be up-to-date. They do not need to be the latest model.

3.2.5 Assumptions and Dependencies

- A new user record can be created.
- If the user has forgotten his/her password, he/she can get the new a password.
- If the user wants, he/she can view her profile.
- If the user wishes, he/she can press the button to start the virtual machine.

3.3 Requirements Specification

3.3.1 External Interface Requirements

Mysql will be used for the database. There will be two or more different tables in the database, virtual machine data and user data. Virtual machine must have windows operating system. At certain times, the data of the virtual machine (processor spending, ram spending, how many users are available in the operating system, what are the IP addresses of the users, how many hours has it been open..etc.) Will be pulled into the database's virtual machine table will be recorded. The data of the virtual machine will be pull with the Virtual Machine Introspection (VMI) technique [11]. The table containing the data of the virtual machine in the database has to work dynamically with the website.

3.3.2 Functional Requirements

3.3.2.1 *Login Function*

- Introduction: Users can login with their email, private question and password.
- Input: User's email and password.
- Output: Error (The user's username or password are incorrect) or login.
- Process: All users will enter the login page and enter their email and password. The system logs in or displays an error message depending on whether the email and password match.

3.3.2.2 *Register Function*

- Introduction: A new user can be created.
- Input: User's email, password, user's name and private question.
- Output: Error (Under filled / passwords are not the same) or create.
- Process: Enter user's name, email and private question. The system checks whether the user is in the database and adds it to the database if it is not present in the database.

3.3.2.3 *Forgot Password*

- Introduction: A new one can be created instead of the forgotten password.
- Input: User's email, private question.
- Output: Error (User's email or admin's private question is wrong) or create password.
- Process: Enter user email and private question. The system checks whether the user's mail and private question are in the database. If there is no match, it gives an error message.

3.3.2.4 Reset Password

- Introduction: The password can be changed to a new one.
- Input: User's old password, User's new password(x2).
- Output: Error (The new passwords are not the same or the old password is wrong) or change.
- Process: Enter user old password and new password (x2). The system checks if the user's old password is the same as the password in the database and checks the equality of their new password. If an error occurs, it gives an error message.

3.4 Software System Attributes

3.4.1 Portability

- This website can be run on local host or on a server.
- Php or python libraries required for the operation of the website must be installed.
- Mysql must be installed to communicate with the database.
- If the server will be operated, the following should be checked:
 - Having Linux ubuntu operating system.
 - SSH feature is active because due to data exchange over SSH connection.
 - Since the servers will be connected remotely, they must be open to the internet and their firewall settings must allow this.
 - Establishing a connection with the root user for full control of the server.

3.4.2 Usability

- After logging into the website, the current status of the data can be viewed from the charts and graphs on the home page.
- After logging into the website, the profile can be changed from the login screen if desired.
- After logging into the website, a virtual machine can be started with the help of a button.

3.4.3 Adaptability

- Since the data are received from the moment the website is run, the data will be adaptable.

3.4.4 Scalability

- There is no scalability requirement as users will see the same data graphics when they log in.

4. Software Design Description

4.1 Introduction

Software Design Descriptions (SDD) provides documentation to use to assist. This document is a document that explains and graphically illustrates the software design. This document has been prepared to better explain what to do to System Resource Monitoring and Visualization(SRMV) developers. SDD is prepared according to the application of design methods and design documentation recommended in IEEE Std 1016-1987 is described [12].

4.1.1 Purpose

The purpose of System Resource Monitoring and Visualization (SRMV) is to show the system data of a virtual machine by using graphics and charts in a website interface. Virtual machine can be run from the website if desired. In this website authentication will be carried out.

4.1.2 Scope

This software is based on showing the data of a virtual machine with the help of graphs and charts in a website. Virtual machines data samples can be processor spending, ram spending, how many user are available in the operating system, what are the IP addresses of the users, how many hours has it been open..etc. In this website authentication will be carried out. After logging in to the website, users can see the status of the virtual machine on the website and start it if they wish. Users can edit their own profiles on the website.

4.1.3 Definitions, Abbreviations, Acronyms

TERM	DEFINITIONS
User	Right to login to the website.
SDD	Software Design Description
IEEE	Institute of Electrical and Electronics Engineers
SRMV	System Resource Monitoring and Visualization

4.1.4 Overview

- Chapter1 Introduction
- Chapter2 Design Considerations
- Chapter3 Architecture
- Chapter4 System Interfaces
- Chapter5 User Interface Design
- Chapter6 Process Design

- Chapter7 Database Design

4.2 Design Considerations

4.2.1 Approach

Controlling virtual machines connected to a server is related to the number of virtual machines connected to that server. In other words, the more virtual machines there are, the more difficult it will be to control them. The SRMV project is about controlling these virtual machines and aims to present the system data of each one in a more readable way.

4.2.2 Tools Used

4.2.2.1 For Website Software

FRONT-END	BACK-END
HTML5	PHP(To be determined)
CSS3	Python(To be determined)
Javascript	Laravel
jQuery	Laravel Telescope
Vue.js	Laravel Horizon
ApexCharts Addition	

4.2.2.2 Server-Side

- Nginx (Web Server)
- MySQL (For database)
- Redis (For cache database)
- Supervisor (For background operations)

4.2.2.3 For Visual Machine

- Windows Operating System.

4.2.3 Constrains

- User information must be known in order to enter the web interface.
- Virtual machines for which system data will be retrieved must use the windows operating system.
- User can switch between dark mode and light mode according to his/her wishes.

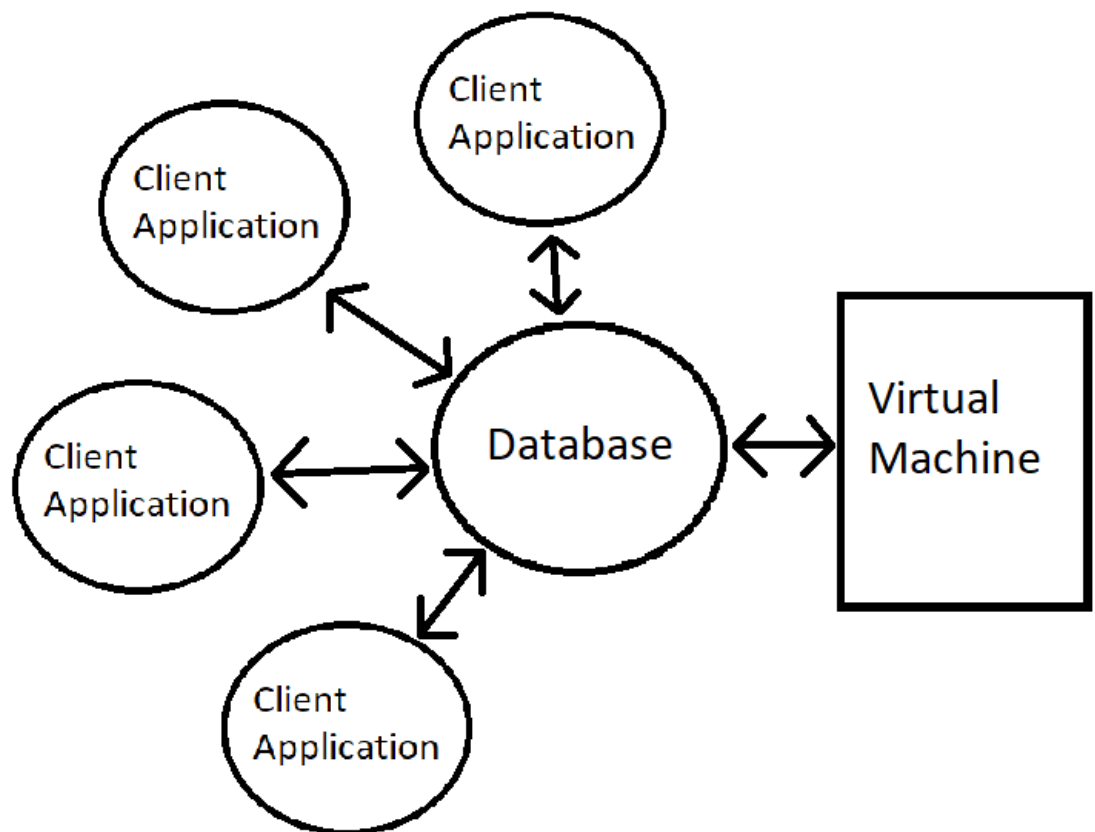
4.2.4 Assumptions and Dependencies

- The systems in the tools used section must be up to date.

- Virtual machines whose data will be read must have a windows operating system.
- If only the data will be displayed (no installation will be made on the system), it is important that the systems of the ipad, mobile phone or computer to be used are up-to-date.
- Internet must be active for communication.

4.3 Architecture

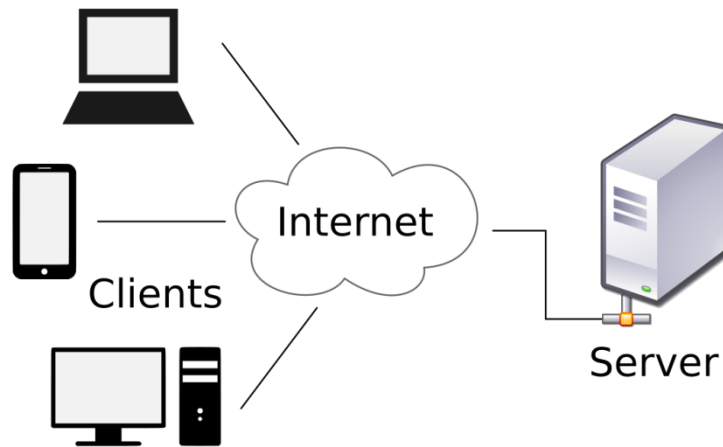
4.3.1 Software Architecture



SRMV will have a data-centric software architecture.

4.3.2 Hardware Architecture

SRMV project will use client-server architecture. Client-server architecture describes how a server provides services to its clients. Clients can be one or more. TCP / IP protocol will be used to establish a client connection with the server.



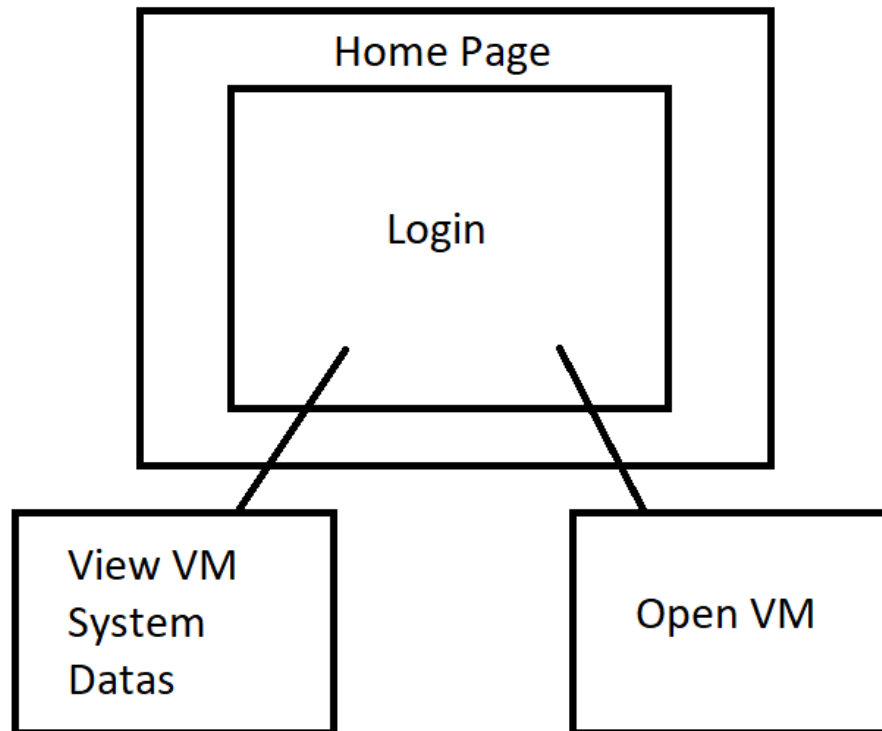
4.4 System Interfaces

4.4.1 External System Interfaces

Mysql will be used for the database. There will be two or more different tables in the database, virtual machine data and user data. Virtual machine must have windows operating system. At certain times, the data of the virtual machine (processor spending, ram spending, how many users are available in the operating system, what are the IP addresses of the users, how many hours has it been open..etc.) Will be pulled into the database's virtual machine table will be recorded. The data of the virtual machine will be pull with the Virtual Machine Introspection (VMI) technique [10]. The table containing the data of the virtual machine in the database has to work dynamically with the website.

4.5 User Interface Design

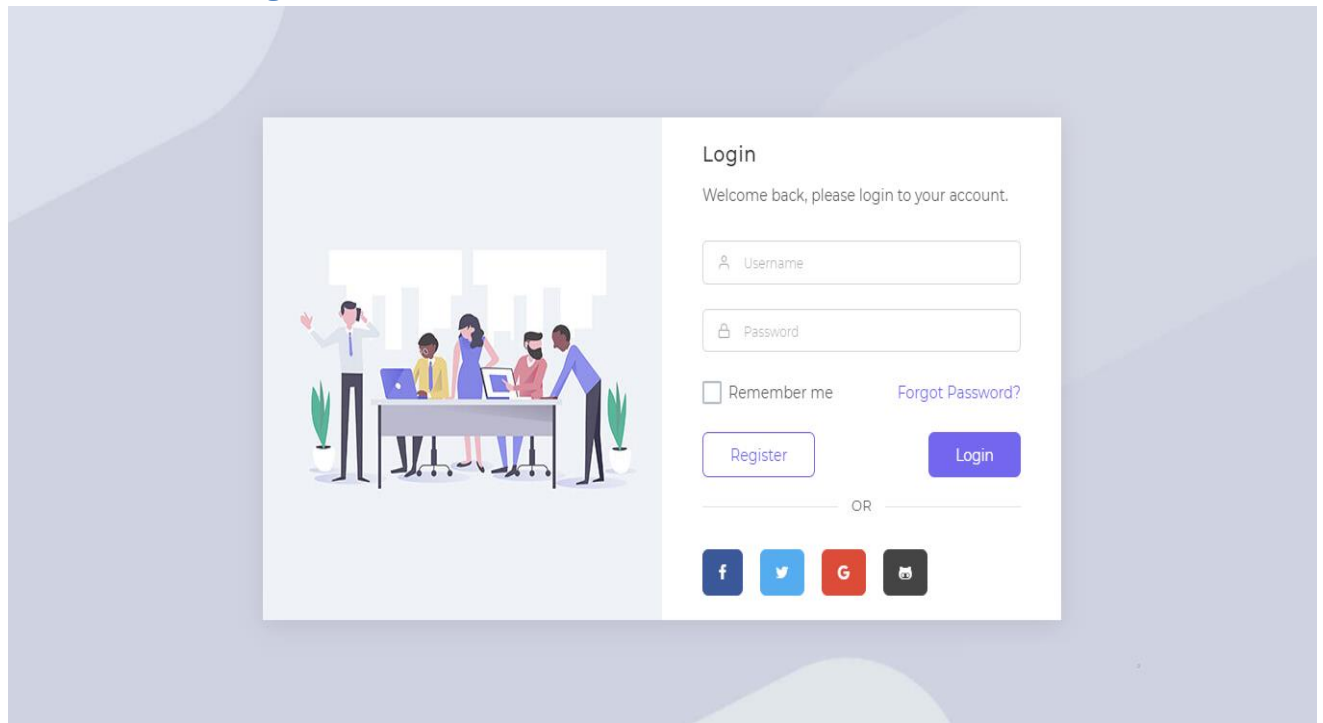
4.5.1 Navigation



- When users connect to the site, they are directed to the "Home page" page and have to login.
- After logging in, they can both see the virtual machine data on their servers and start the virtual machine from the "Open VM" button if they wish.

4.5.2 Screen Definitions

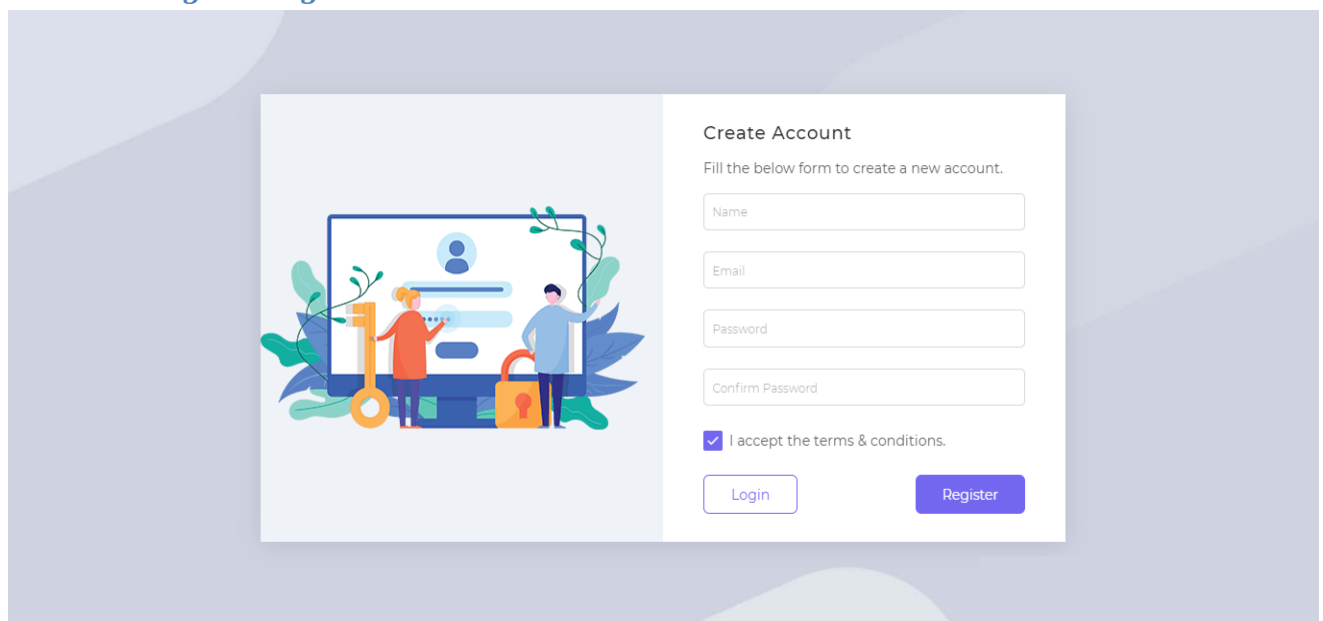
4.5.2.1 Home Page



The Home Page features a login form on the right side of a light purple background. On the left, there is an illustration of five people (three men and two women) in business attire standing around a table with laptops. The login form is titled "Login" and includes a welcome message: "Welcome back, please login to your account." It contains two input fields for "Username" and "Password", each with a corresponding icon (a person for username and a lock for password). Below these fields are checkboxes for "Remember me" and a link for "Forgot Password?". There are two buttons: "Register" (outlined) and "Login" (solid purple). Below the buttons is a horizontal line with "OR" in the center, followed by four social media icons: Facebook, Twitter, Google+, and GitHub.

- Input: User's email and password.
- Output: Error (The user's username or password are incorrect) or login.

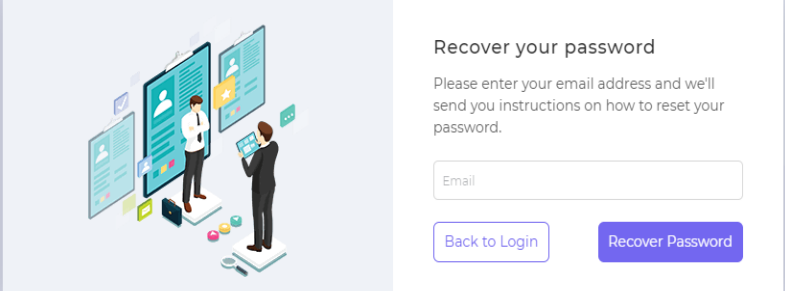
4.5.2.2 Register Page



The Register Page features a "Create Account" form on the right side of a light purple background. On the left, there is an illustration of two people (a man and a woman) standing next to a large screen displaying a user profile. The form is titled "Create Account" and includes a message: "Fill the below form to create a new account." It contains four input fields: "Name", "Email", "Password", and "Confirm Password". Below these fields is a checkbox labeled "I accept the terms & conditions." with a checked mark. There are two buttons: "Login" (outlined) and "Register" (solid purple).

- Input: User's email, password, user's name and private question.
- Output: Error (Under filled / passwords are not the same) or create.

4.5.2.3 *Forgot Password*



The image shows a 'Recover your password' form. On the left is an illustration of two people interacting with large digital screens. The form on the right has a title 'Recover your password', a subtext 'Please enter your email address and we'll send you instructions on how to reset your password.', an 'Email' input field, a 'Back to Login' button, and a 'Recover Password' button.

Recover your password

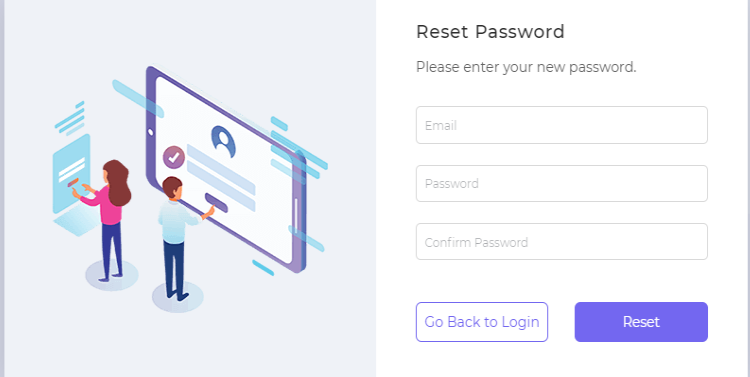
Please enter your email address and we'll send you instructions on how to reset your password.

Email

[Back to Login](#) [Recover Password](#)

- Input: User's email(If it true), private question.
- Output: Error (User's email or admin's private question is wrong) or create password.

4.5.2.4 *Reset Password*



The image shows a 'Reset Password' form. On the left is an illustration of two people interacting with large digital screens. The form on the right has a title 'Reset Password', a subtext 'Please enter your new password.', three input fields for 'Email', 'Password', and 'Confirm Password', a 'Go Back to Login' button, and a 'Reset' button.

Reset Password

Please enter your new password.

Email

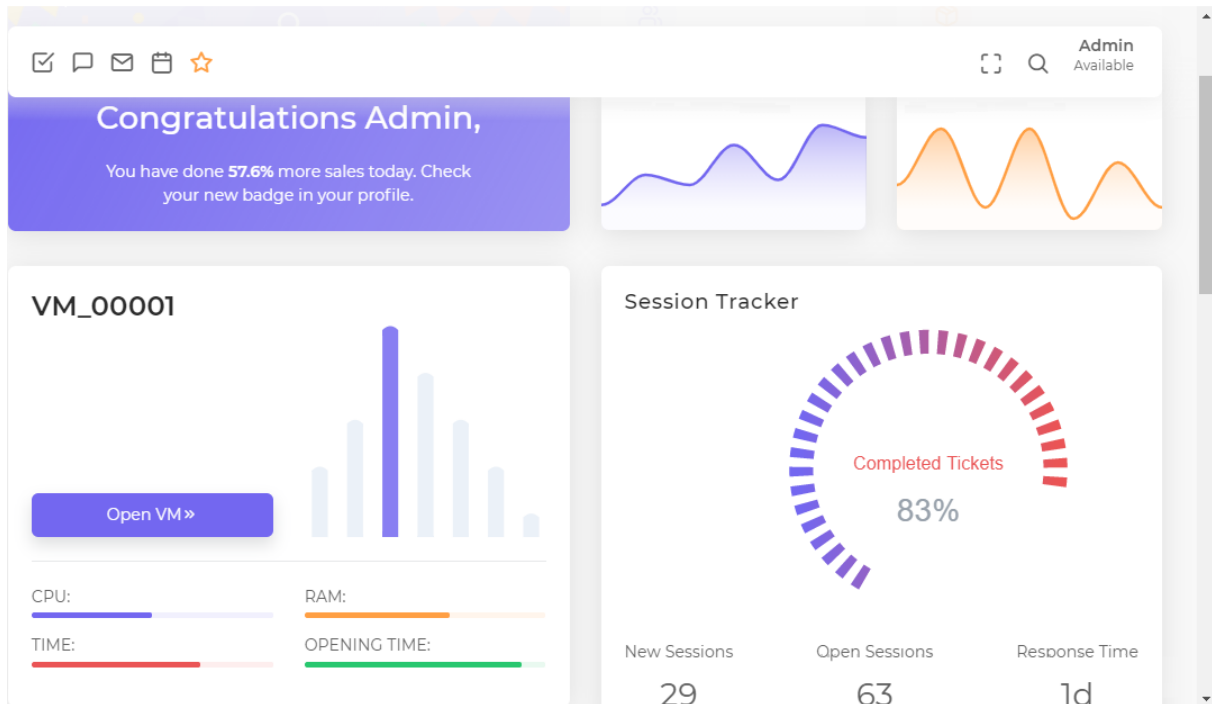
Password

Confirm Password

[Go Back to Login](#) [Reset](#)

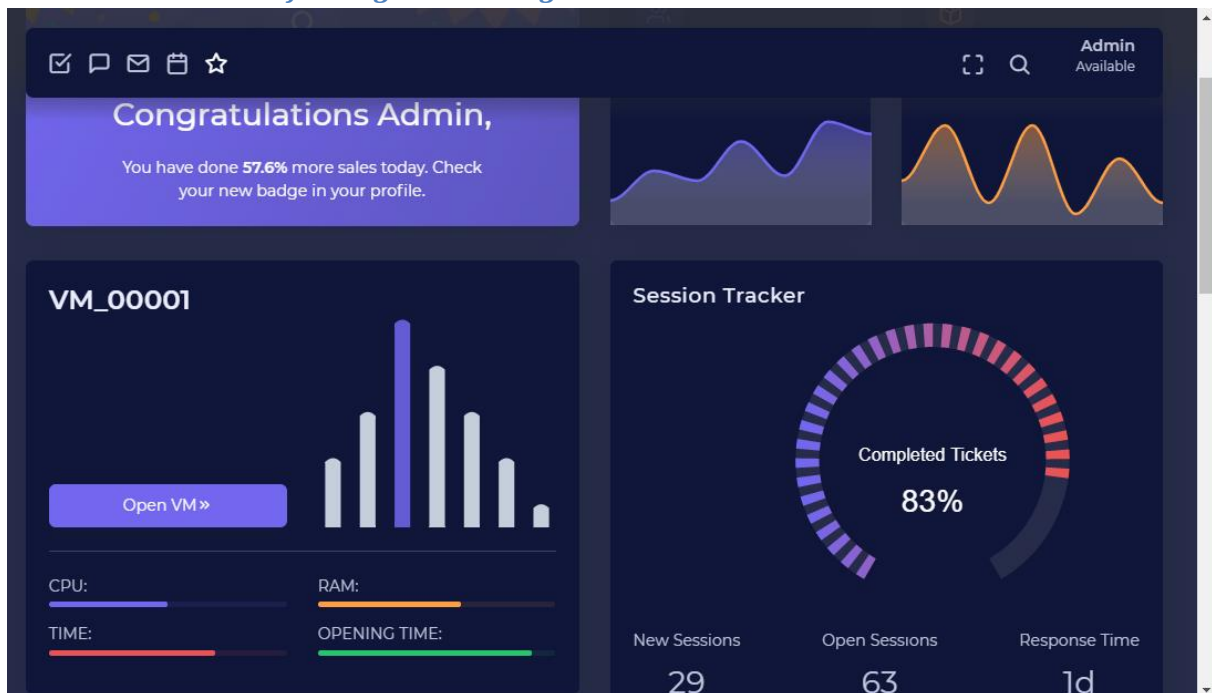
- Input: Email, User's new password(x2).
- Output: Error (The new passwords are not the same or the old password is wrong) or change.

4.5.2.5 After Login Home Page



- VM data can be viewed.
- The virtual machine can be opened using the "Open VM" button.

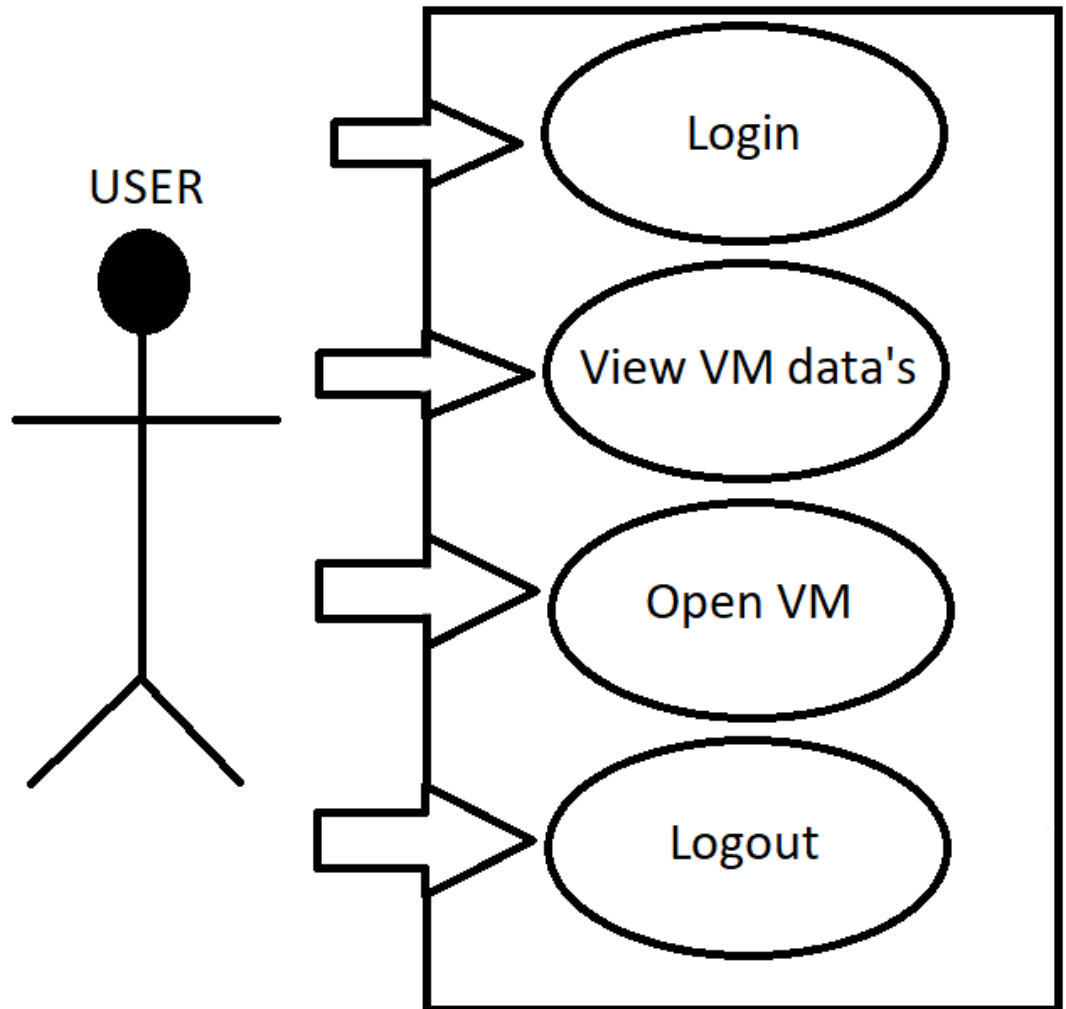
4.5.2.6 Dark After Login Home Page



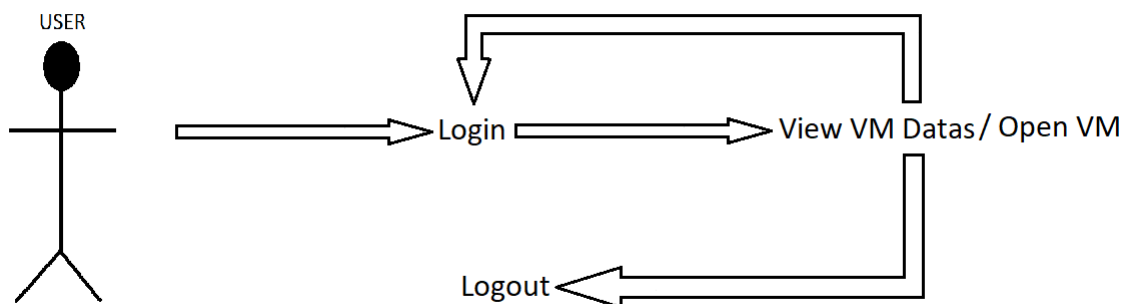
- VM data can be viewed.
- The virtual machine can be opened using the "Open VM" button.

4.6 Process Design

4.6.1 Use Case




4.6.2 Sequence Diagram




4.7 Database Design

4.7.1 User Database

	Column Name	Data Type	Allow Nulls
	id	int	<input type="checkbox"/>
	Name	nvarchar(50)	<input checked="" type="checkbox"/>
	Surname	nvarchar(50)	<input checked="" type="checkbox"/>
	Email	nvarchar(MAX)	<input type="checkbox"/>
	Password	nvarchar(MAX)	<input type="checkbox"/>
	Private	nvarchar(MAX)	<input type="checkbox"/>

4.7.2 Virtual Machine Database

	Column Name	Data Type	Allow Nulls
	id	int	<input type="checkbox"/>
	Processor_Expense	float	<input checked="" type="checkbox"/>
	Ram_Expense	float	<input checked="" type="checkbox"/>
	Users	int	<input checked="" type="checkbox"/>
	Users_IP	int	<input checked="" type="checkbox"/>
	Wht_Time_Opened	time(7)	<input checked="" type="checkbox"/>

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