

Mini Project Report

Tanmay Jain — IMT2021015

Instructor: Prof. B. Thangaraju

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Introduction:

The purpose of this project is to develop a client-server shopping system. The goal of the system is to allow users to browse and purchase products, while also providing administrative functionality for managing the inventory of products. The system is designed to be scalable, and secure also ensuring that data is properly synchronized and protected.

In this report, we will discuss a detailed description of the approach to the problem, system architecture, implementation, and testing. We will also discuss various edge cases that were considered during the development of the system.

Approach to the problem:

0.1 Data structures used :

- A struct of product that stores id, name, quantity and price for each product available with both user and server
- An array of struct product **Products** to store all the products that the admin has added. It is available only to the server
- An array of struct product **Cart** to store all the products that the user has added to cart.
- Two arrays of semaphores 1 for cart array and 1 for product array, available only to user and server respectively.

0.2 Implementation of the server :

As the server is maintained by the Admin only, there are 4 options available to the client :

- **Add product to the Products array :** It asks the user to enter the details of the product and the product is added to the **Products** array. Binary Semaphore lock is issued to the individual product after it is added to the Products array to prevent any other process from deteriorating its original content.
- **Delete product :** It asks for the product id to be deleted and removes the product from the Products array.
- **Update price/quantity of a product :** It asks the product id of the product which is to be updated. New quantity and price are also asked to the admin and the product is updated in the Products array.
- **Exit and generate Report :** The Admin exits after performing all the operations on the products keeping them locked and a detailed report of the available inventory is generated.

0.3 Implementation of the user :

The user is provided with 5 options:

- **Display all items :** All the available products' name, quantity and price are shown
- **Display the Cart :** To display all the items that the user has currently in their cart. If no item is available, *Cart Empty* is printed.
- **Add product to cart :** A list of available products is displayed and the user enters the product id and quantity of the product to be added into cart. If the product is already present in the cart or the user entered quantity is not available, a suitable message is displayed and the user can again add the item with corrected inputs. Items in cart are immediately locked after they are added, using semaphores.
- **Edit the cart :** The user can edit the products existing in the cart or delete it. The user enters the product id and the new quantity to update it. The user choices are checked for edge cases.
- **Go to payment gateway :** After the user has added all the desired items into the cart, they can proceed to the payment gateway where user is asked to enter the total amount and a bill is generated. But before this, a check is performed on the server side whether the quantities demanded by the user cart are available with the admin or not. This is to maintain the edge case of concurrently another user buying the same product or admin updating the quantity.

Use of O.S. concepts

- **Socket Programming :** The user communicates with the server using the Socket programming concepts. A connection between server and client is established and all the communications between them is done using sockets.
- **Semaphores :** They are used for locking the products in the cart and Products array for synchronisation and to prevent two clients from attempting to purchase the same product simultaneously and leading to incorrect results.
- **File reading and writing using system calls :** Open, close, read and write system calls are used to generate Admin report and user bill files.

Handling edge cases:

0.4 Handling invalid inputs:

The system checks for the validity of the inputs provided by the user or administrator and handles any invalid inputs by notifying the user or administrator and asking them to provide valid inputs. for example quantity of products to be added into cart shouldn't exceed available quantity, product id, etc.

0.5 Synchronization between multiple clients:

The application handles synchronization between multiple clients by using semaphores to ensure that only one client can access the shared resources (e.g., cart) at a time.

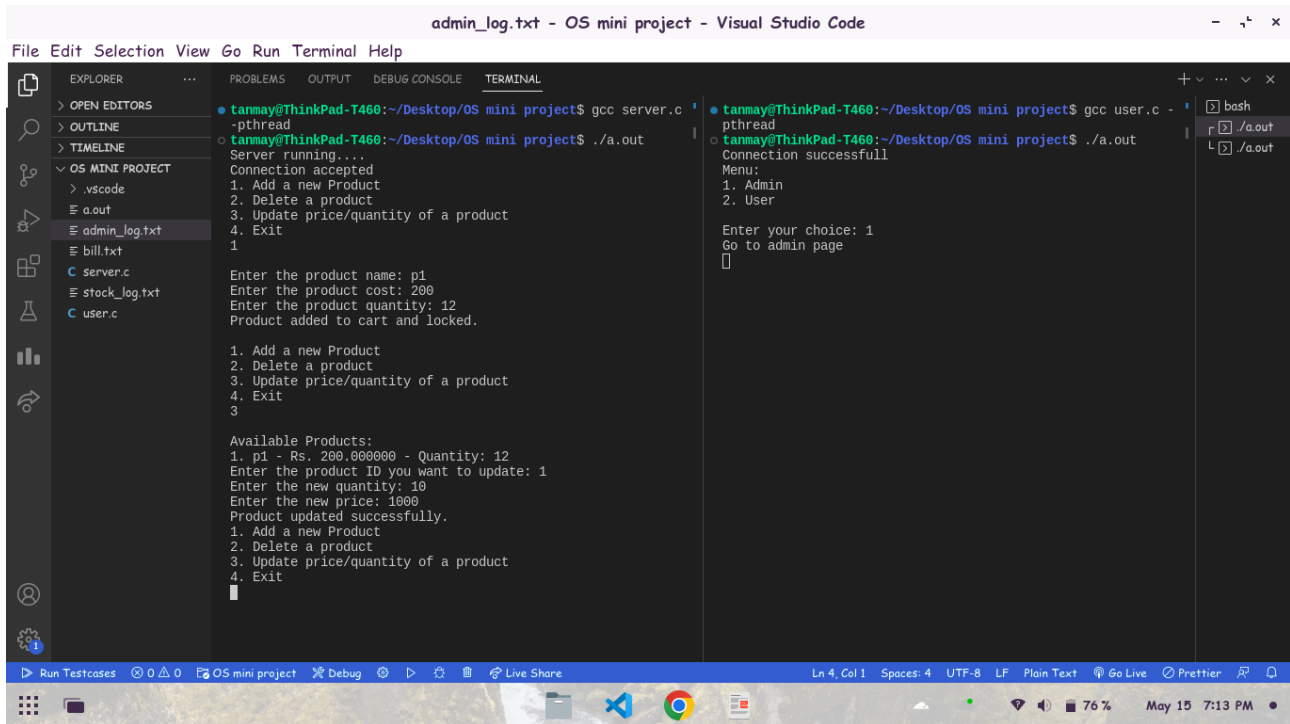
0.6 Handling race conditions:

The application uses semaphores to handle race conditions between different processes accessing the shared resources. For example, when a client is adding a product to the cart, the semaphore is acquired to ensure that no other client can modify the cart at the same time.

0.7 Handling concurrent modifications:

The application handles concurrent modifications to the same product by an administrator and a client by acquiring a semaphore lock on the product and cart arrays. This ensures that the modification is atomic and that the updated product is reflected in the cart.

Screenshots for code execution :



```

admin_log.txt - OS mini project - Visual Studio Code
File Edit Selection View Go Run Terminal Help

EXPLORER
> OPEN EDITORS
> OUTLINE
> TIMELINE
OS MINI PROJECT
  .vscode
  a.out
  admin_log.txt
  bill.txt
  server.c
  stock_log.txt
  user.c

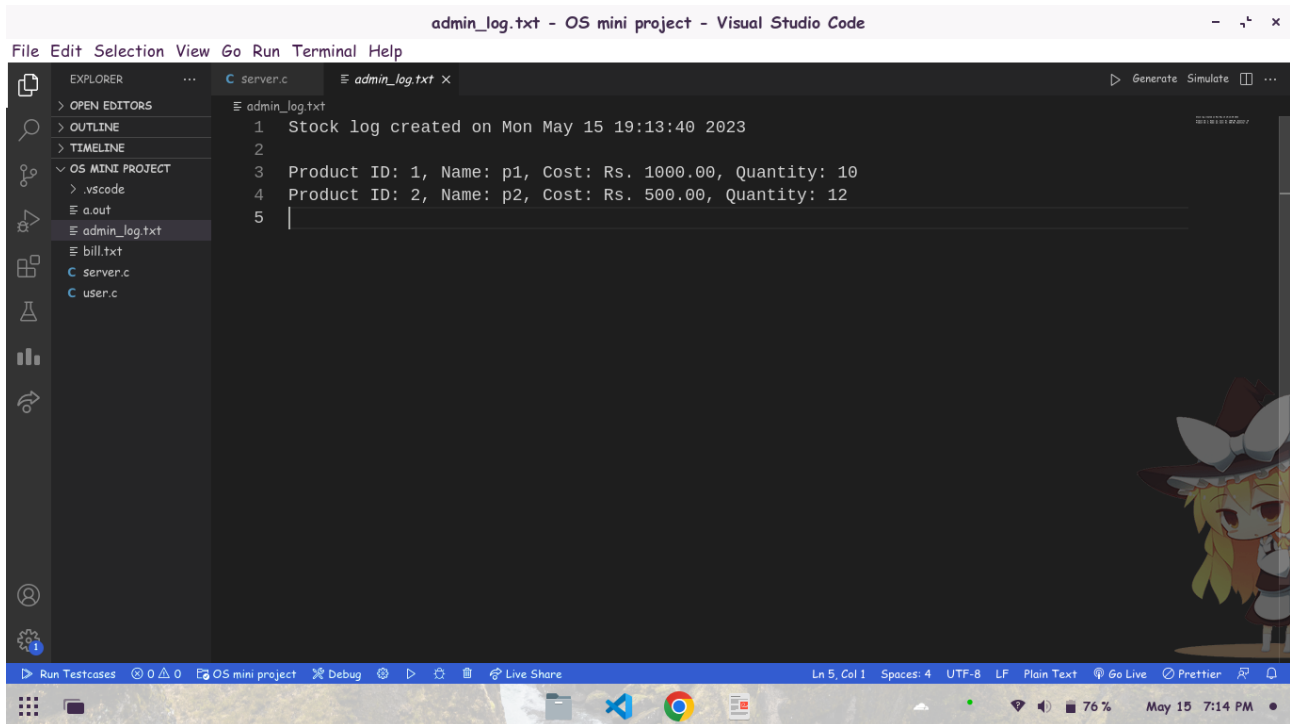
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

tanmay@ThinkPad-T460:~/Desktop/OS mini project$ gcc server.c -pthread
tanmay@ThinkPad-T460:~/Desktop/OS mini project$ ./a.out
Server running...
Connection accepted
Menu:
1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
1
Enter the product name: p1
Enter the product cost: 200
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
3
Available Products:
1. p1 - Rs. 200.000000 - Quantity: 12
Enter the product ID you want to update: 1
Enter the new quantity: 10
Enter the new price: 1000
Product updated successfully.
1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit

```

Figure 1: Login as Admin and add products to **Products** array. And updating the existing products

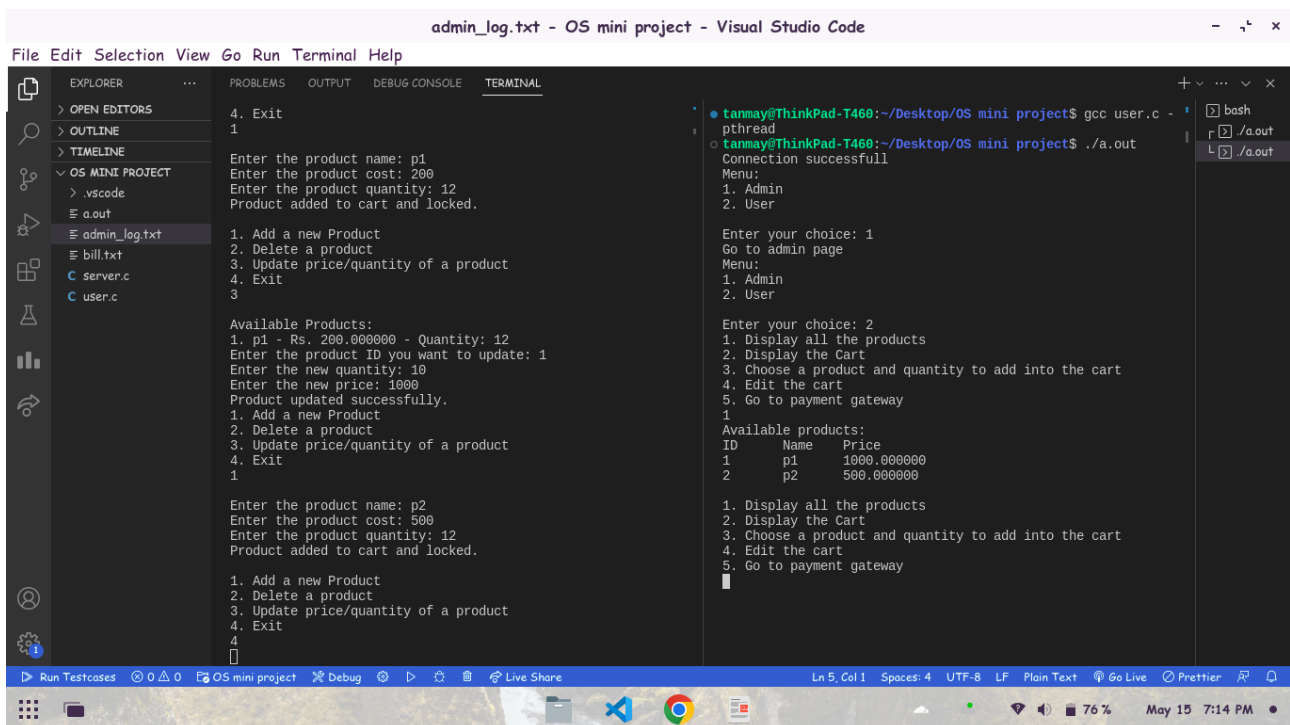


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admin_log.txt - OS mini project - Visual Studio Code
File Edit Selection View Go Run Terminal Help
EXPLORER
> OPEN EDITORS
> OUTLINE
> TIMELINE
OS MINI PROJECT
  .vscode
  a.out
  admin_log.txt
  bill.txt
  server.c
  user.c
admin_log.txt
1 Stock log created on Mon May 15 19:13:40 2023
2
3 Product ID: 1, Name: p1, Cost: Rs. 1000.00, Quantity: 10
4 Product ID: 2, Name: p2, Cost: Rs. 500.00, Quantity: 12
5

```

Figure 2: Updating of products completed and adding multiple products into the Products array and exit and generate an Admin log file

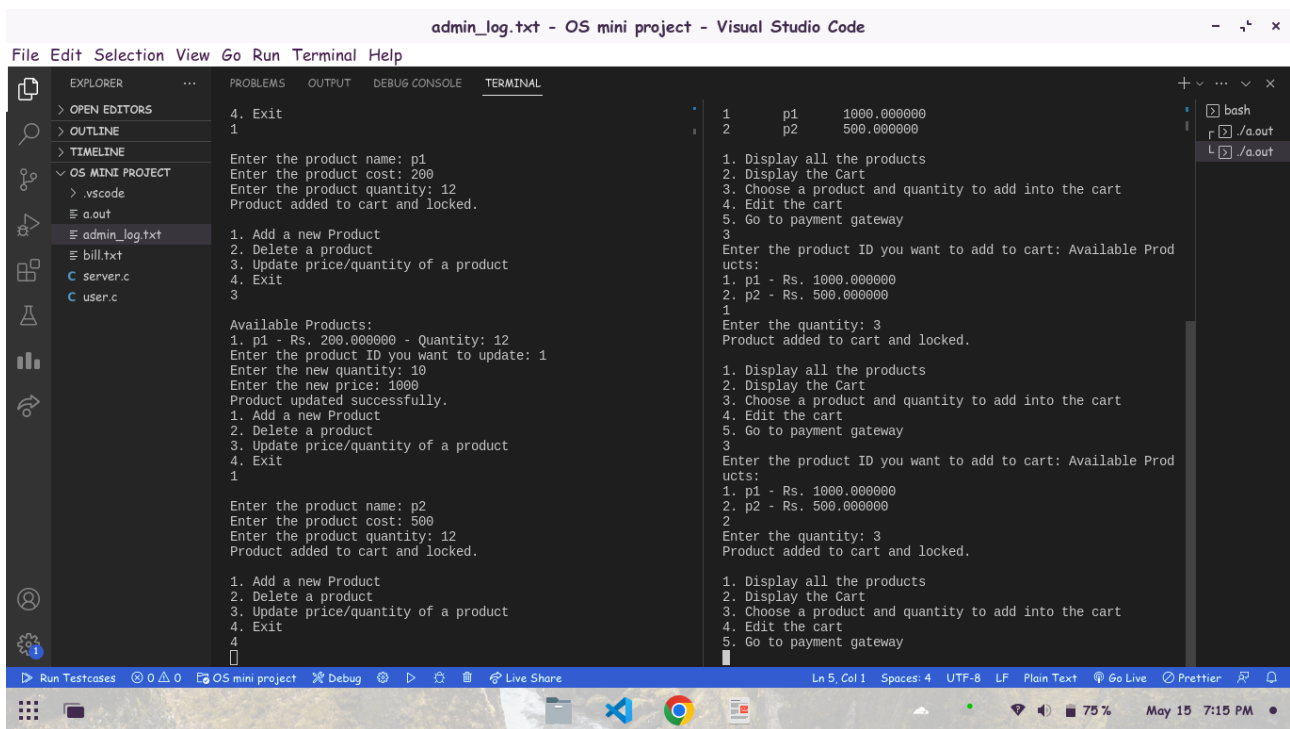


```

admin_log.txt - OS mini project - Visual Studio Code
File Edit Selection View Go Run Terminal Help
EXPLORER
> OPEN EDITORS
> OUTLINE
> TIMELINE
OS MINI PROJECT
  .vscode
  a.out
  admin_log.txt
  bill.txt
  server.c
  user.c
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
4. Exit
1
Enter the product name: p1
Enter the product cost: 200
Enter the product quantity: 12
Product added to cart and locked.
1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
3
Available Products:
1. p1 - Rs. 200.000000 - Quantity: 12
Enter the product ID you want to update: 1
Enter the new quantity: 10
Enter the new price: 1000
Product updated successfully.
1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
1
Enter the product name: p2
Enter the product cost: 500
Enter the product quantity: 12
Product added to cart and locked.
1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4
1
tanmay@ThinkPad-T460:~/Desktop/OS mini project$ gcc user.c -
pthread
tanmay@ThinkPad-T460:~/Desktop/OS mini project$ ./a.out
Connection successfull
Menu:
1. Admin
2. User
Enter your choice: 1
Go to admin page
Menu:
1. Admin
2. User
Enter your choice: 2
1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
1
Available products:
ID Name Price
1 p1 1000.000000
2 p2 500.000000
1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway

```

Figure 3: Logging in as user and displaying all the products



admin_log.txt - OS mini project - Visual Studio Code

File Edit Selection View Go Run Terminal Help

EXPLORER

- OPEN EDITORS
- OUTLINE
- TIMELINE
- OS MINI PROJECT
 - .vscode
 - a.out
 - admin_log.txt
 - bill.txt
 - server.c
 - user.c

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

4. Exit

1

Enter the product name: p1
Enter the product cost: 200
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
3

Available Products:
1. p1 - Rs. 200.000000 - Quantity: 12
Enter the product ID you want to update: 1
Enter the new quantity: 10
Enter the new price: 1000
Product updated successfully.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4

Enter the product name: p2
Enter the product cost: 500
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4

1

1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
3

Enter the product ID you want to add to cart: Available Products:
1. p1 - Rs. 1000.000000
2. p2 - Rs. 500.000000
1

Enter the quantity: 3
Product added to cart and locked.

1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
3

Enter the product ID you want to add to cart: Available Products:
1. p1 - Rs. 1000.000000
2. p2 - Rs. 500.000000
2

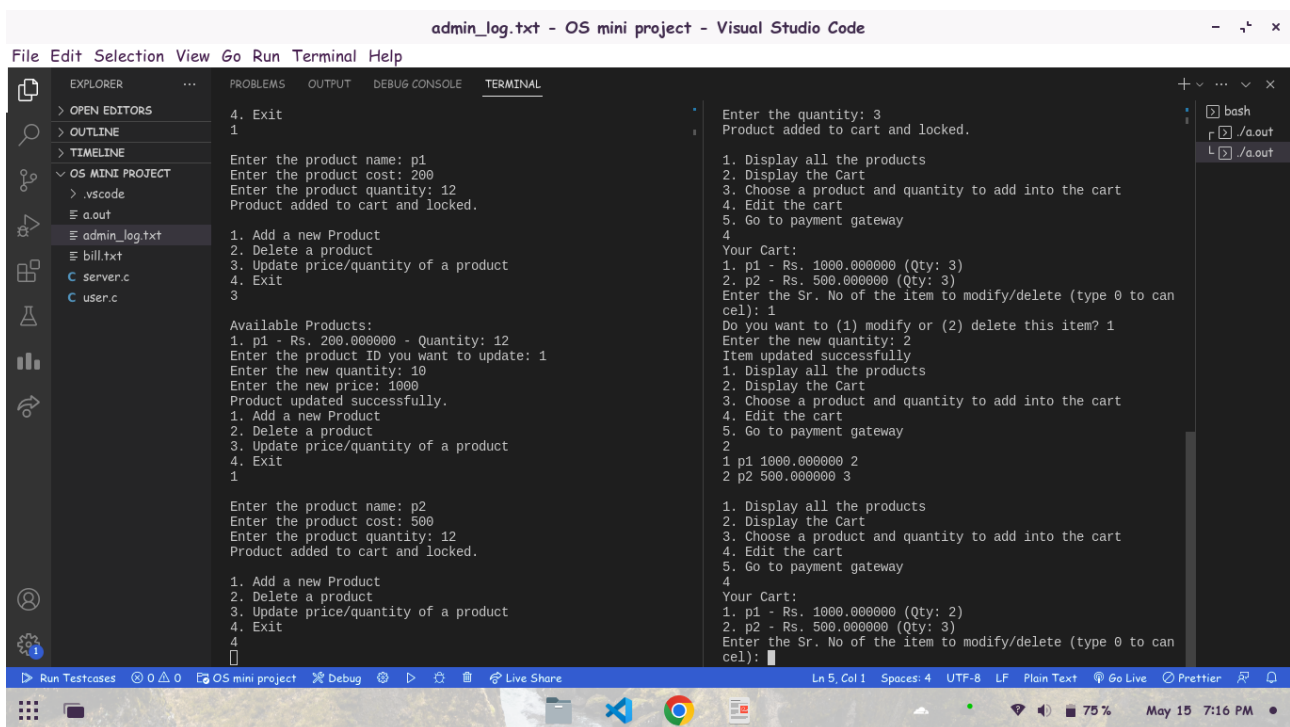
Enter the quantity: 3
Product added to cart and locked.

1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
5

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Figure 4: Displaying all the products to the user



admin_log.txt - OS mini project - Visual Studio Code

File Edit Selection View Go Run Terminal Help

EXPLORER

- OPEN EDITORS
- OUTLINE
- TIMELINE
- OS MINI PROJECT
 - .vscode
 - a.out
 - admin_log.txt
 - bill.txt
 - server.c
 - user.c

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

4. Exit

1

Enter the product name: p1
Enter the product cost: 200
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
3

Available Products:
1. p1 - Rs. 200.000000 - Quantity: 12
Enter the product ID you want to update: 1
Enter the new quantity: 10
Enter the new price: 1000
Product updated successfully.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4

Enter the product name: p2
Enter the product cost: 500
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4

1

Enter the quantity: 3
Product added to cart and locked.

1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
4

Your Cart:
1. p1 - Rs. 1000.000000 (Qty: 3)
2. p2 - Rs. 500.000000 (Qty: 3)
Enter the Sr. No of the item to modify/delete (type 0 to cancel): 1
Do you want to (1) modify or (2) delete this item? 1
Enter the new quantity: 2
Item updated successfully

1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
2

1 p1 1000.000000 2
2 p2 500.000000 3

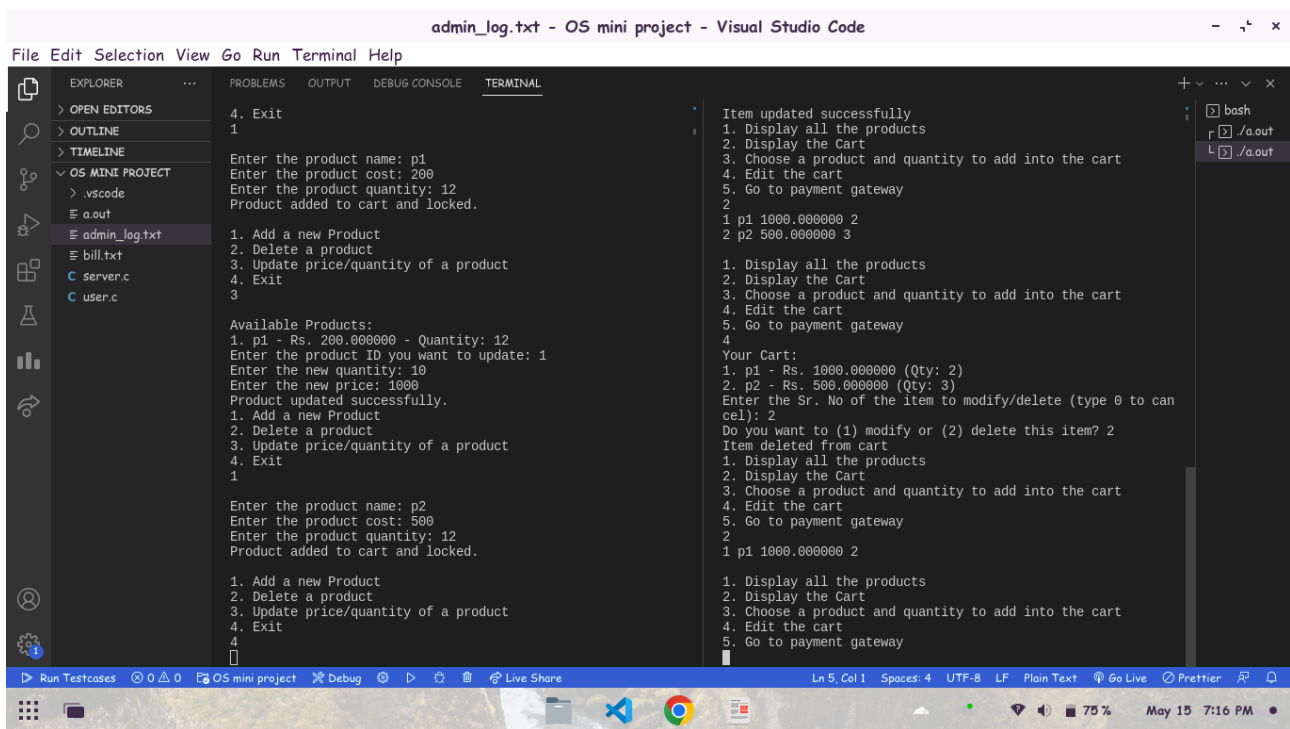
1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
4

Your Cart:
1. p1 - Rs. 1000.000000 (Qty: 2)
2. p2 - Rs. 500.000000 (Qty: 3)
Enter the Sr. No of the item to modify/delete (type 0 to cancel):

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May 15 7:16 PM

Figure 5: Updating items in the user cart



admin_log.txt - OS mini project - Visual Studio Code

File Edit Selection View Go Run Terminal Help

EXPLORER

- OPEN EDITORS
- OUTLINE
- TIMELINE
- OS MINI PROJECT
 - .vscode
 - a.out
 - admin_log.txt
 - bill.txt
 - server.c
 - user.c

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

4. Exit
1

Enter the product name: p1
Enter the product cost: 200
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
3

Available Products:
1. p1 - Rs. 200.000000 - Quantity: 12
Enter the product ID you want to update: 1
Enter the new quantity: 10
Enter the new price: 1000
Product updated successfully.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
1

Enter the product name: p2
Enter the product cost: 500
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4

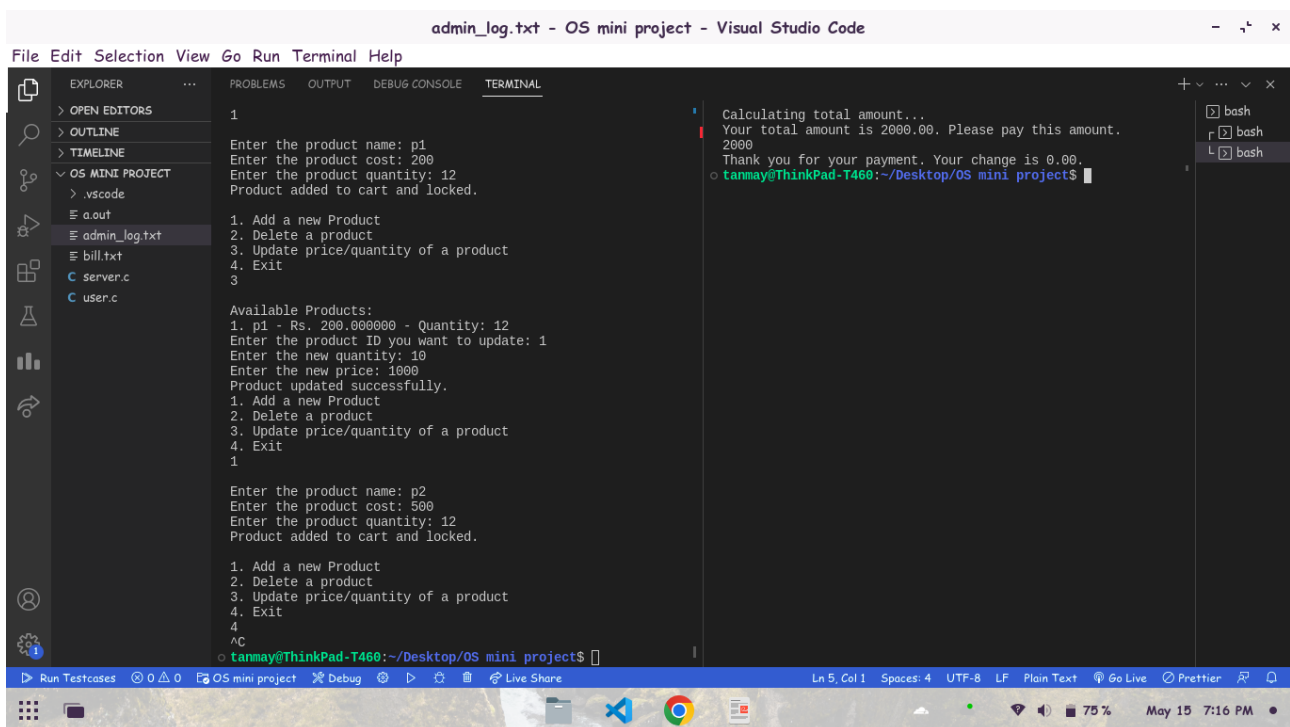
Item updated successfully
1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
2
1 p1 1000.000000 2
2 p2 500.000000 3

1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
4
Your Cart:
1. p1 - Rs. 1000.000000 (Qty: 2)
2. p2 - Rs. 500.000000 (Qty: 3)
Enter the Sr. No of the item to modify/delete (type 0 to cancel): 2
Do you want to (1) modify or (2) delete this item? 2
Item deleted from cart
1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway
2
1 p1 1000.000000 2

1. Display all the products
2. Display the Cart
3. Choose a product and quantity to add into the cart
4. Edit the cart
5. Go to payment gateway

Run Testcases 0 0 OS mini project Debug Live Share Ln 5, Col 1 Spaces: 4 UTF-8 LF Plain Text Go Live Prettier May 15 7:16 PM

Figure 6: Deleteing items from the user cart



admin_log.txt - OS mini project - Visual Studio Code

File Edit Selection View Go Run Terminal Help

EXPLORER

- OPEN EDITORS
- OUTLINE
- TIMELINE
- OS MINI PROJECT
 - .vscode
 - a.out
 - admin_log.txt
 - bill.txt
 - server.c
 - user.c

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

1

Enter the product name: p1
Enter the product cost: 200
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
3

Available Products:
1. p1 - Rs. 200.000000 - Quantity: 12
Enter the product ID you want to update: 1
Enter the new quantity: 10
Enter the new price: 1000
Product updated successfully.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
1

Enter the product name: p2
Enter the product cost: 500
Enter the product quantity: 12
Product added to cart and locked.

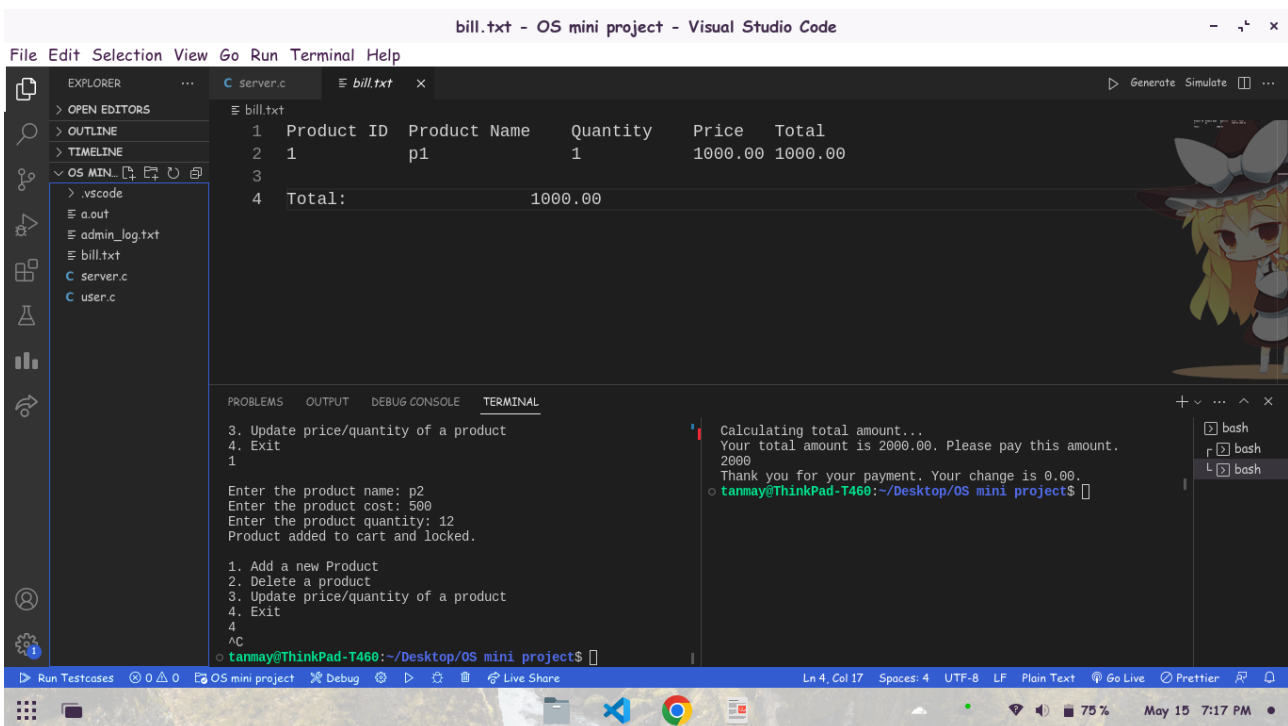
1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4

Calculating total amount...
Your total amount is 2000.00. Please pay this amount.
2000
Thank you for your payment. Your change is 0.00.

tanmay@ThinkPad-T460:~/Desktop/OS mini project\$

Run Testcases 0 0 OS mini project Debug Live Share Ln 5, Col 1 Spaces: 4 UTF-8 LF Plain Text Go Live Prettier May 15 7:16 PM

Figure 7: Going to payment gateway and entering the final bill amount



The screenshot shows the Visual Studio Code interface with a project named "OS mini project". The file explorer on the left shows files: .vscode, a.out, admin_log.txt, bill.txt, server.c, and user.c. The main editor displays the content of bill.txt, which is a table with 5 columns: Product ID, Product Name, Quantity, Price, and Total. The table contains one row for product 'p1' with a quantity of 1 and a price of 1000.00, resulting in a total of 1000.00. Below the table, the program prompts the user to enter the product name, cost, and quantity, and then displays the total amount and change.

Product ID	Product Name	Quantity	Price	Total
1	p1	1	1000.00	1000.00
Total:		1000.00		

```
3. Update price/quantity of a product
4. Exit
1

Enter the product name: p2
Enter the product cost: 500
Enter the product quantity: 12
Product added to cart and locked.

1. Add a new Product
2. Delete a product
3. Update price/quantity of a product
4. Exit
4
^C
tanmay@ThinkPad-T460:~/Desktop/OS mini project$
```

The terminal output shows the program's execution flow, including the calculation of the total amount (2000.00) and the change (0.00). The terminal also shows the user's input for the product name, cost, and quantity.

Figure 8: Generating the final bill