Assignment 7

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- Subject: Computer Networks Lab (CS 3272)

A: Simple Web Server

In this assignment, you will develop a simple Web server in C that is capable of processing only one HTTP request at a time. Specifically, your Web server will

1. create a TCP connection socket when contacted by a client (browser)
2. receive the HTTP request from this connection
3. parse the request to determine the specific file being requested
4. get the requested file from the server's file system
5. create an HTTP response message consisting of the requested file preceded by header lines
6. send the response over the TCP connection to the requesting browser. If a browser requests a file that is not present in your server, your server should return a "404 Not Found" error message

HTML code (`./index.html`)

```html
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="UTF-8" />
        <meta http-equiv="X-UA-Compatible" content="IE=edge" />
        <meta name="viewport" content="width=device-width, initial-scale=1.0" />
        <title>Simple Web Server</title>
    </head>
    <body>
        <h1>Hello World</h1>
        <p>Bye Bye</p>
    </body>
</html>
```

Server Code

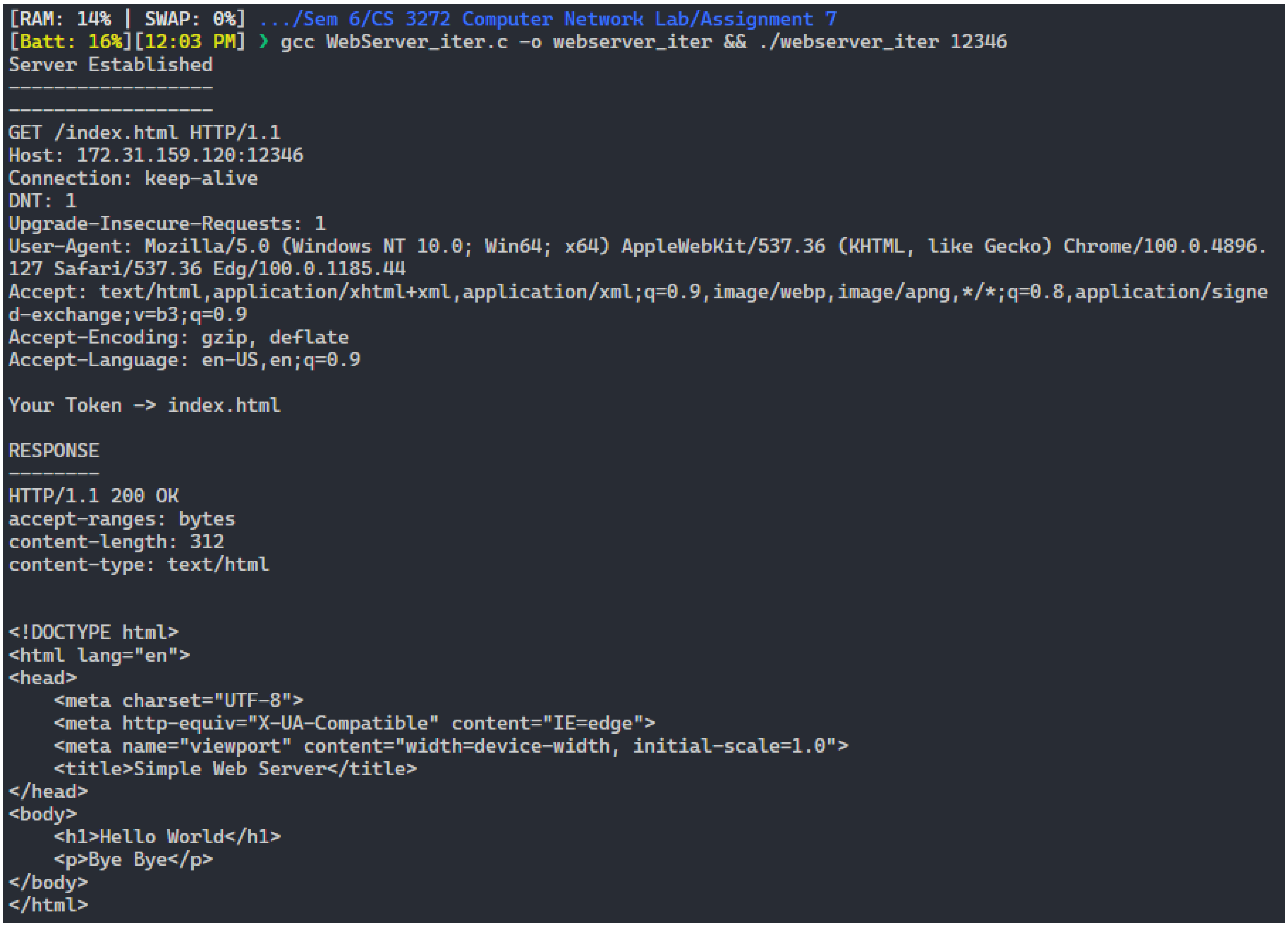
```c
// Web Server Code

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <unistd.h>

void talk(int newsockfd)
{
    char buf[1000];

    for (int i = 0; i < 1000; i++)
        buf[i] = '\0';

    recv(newsockfd, buf, 2500, 0);
    printf("Server Established\n------------------\n------------------\n%s", buf);

    char *token = strtok(buf, "/");
    token = strtok(NULL, " ");
    printf("Your Token -> %s\n", token);
    FILE *fp = fopen(token, "r");

    if (!fp)
    {
        // printf("File doesn't exist in Server Directory.\n");
        printf("\nRESPONSE\n--------\n");

        char header[1000];
        char data[1000] = "<html><head></head><body><h1>404 Not Found</h1></body></html>\r\n";

        sprintf(header, "HTTP/1.1 404 Not Found\naccept-ranges: bytes\ncontent-length: %ld\ncontent-type: text/html\r\n\r\n", strlen(data));
        printf("%s\n", header);
        send(newsockfd, header, strlen(header) * sizeof(char), 0);

        printf("%s\n", data);
        send(newsockfd, data, strlen(data) * sizeof(char), 0);

        close(newsockfd);
    }
    else
    {

        // printf("File exists in Server Directory\n");
        printf("\nRESPONSE\n--------\n");

        char header[1000];
        char data[10000];
        size_t charRead = fread(data, sizeof(char), 10000, fp);

        sprintf(header, "HTTP/1.1 200 OK\naccept-ranges: bytes\ncontent-length: %ld\ncontent-type: text/html\r\n\r\n", strlen(data));
        printf("%s\n", header);
        send(newsockfd, header, strlen(header) * sizeof(char), 0);

        printf("%s\n", data);
        send(newsockfd, data, charRead, 0);
        send(newsockfd, "\r\n", sizeof("\r\n"), 0);

        close(newsockfd);
    }
}

int main(int argc, char *argv[])
{
    int sockfd, newsockfd;
    int clilen;
    struct sockaddr_in cli_addr, serv_addr;

    if ((sockfd = socket(AF_INET, SOCK_STREAM, 0)) < 0)
    {
        printf("Cannot create socket\n");
        exit(0);
    }

    int port = atoi(argv[1]);
    serv_addr.sin_family = AF_INET;
    serv_addr.sin_addr.s_addr = INADDR_ANY;
    serv_addr.sin_port = htons(port);

    if (bind(sockfd, (struct sockaddr *)&serv_addr, sizeof(serv_addr)) < 0)
    {
        printf("Unable to bind local address\n");
        exit(0);
    }

    listen(sockfd, 5);
    while (1)
    {

        clilen = sizeof(cli_addr);
        newsockfd = accept(sockfd, (struct sockaddr *)&cli_addr, &clilen);

        if (newsockfd < 0)
        {
            printf("Accept error\n");
            exit(0);
        }
```

```
            talk(newsockfd);
        }
        close(sockfd);
    }
```

Observation

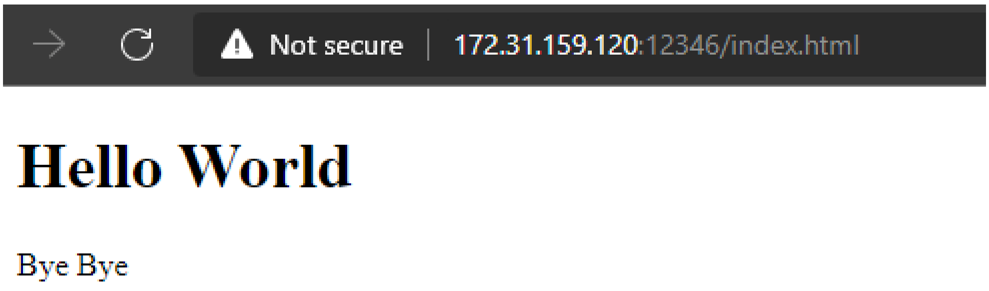
1. when valid file exists

In console (server) side we get the info of the HTTP GET request by the browser and we see that the file is present and is sent back to the browser



```
[RAM: 14% | SWAP: 0%] .../Sem 6/CS 3272 Computer Network Lab/Assignment 7
[Batt: 16%][12:03 PM] ❯ gcc WebServer_iter.c -o webserver_iter && ./webserver_iter 12346
Server Established
------------------
------------------
GET /index.html HTTP/1.1
Host: 172.31.159.120:12346
Connection: keep-alive
DNT: 1
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/100.0.4896.
127 Safari/537.36 Edg/100.0.1185.44
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8,application/signe
d-exchange;v=b3;q=0.9
Accept-Encoding: gzip, deflate
Accept-Language: en-US,en;q=0.9

Your Token -> index.html

RESPONSE
--------
HTTP/1.1 200 OK
accept-ranges: bytes
content-length: 312
content-type: text/html


<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Simple Web Server</title>
</head>
<body>
    <h1>Hello World</h1>
    <p>Bye Bye</p>
</body>
</html>
```

In browser side we can see the webpage

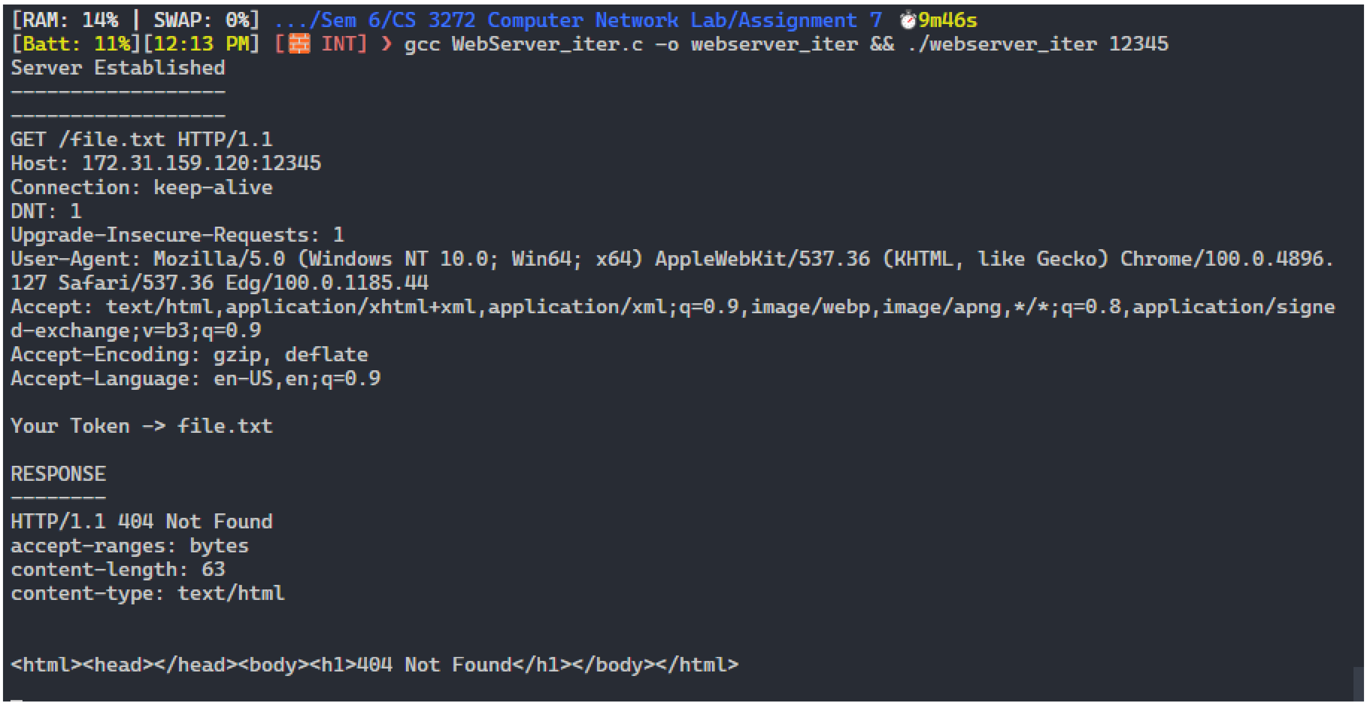


Hello World

Bye Bye

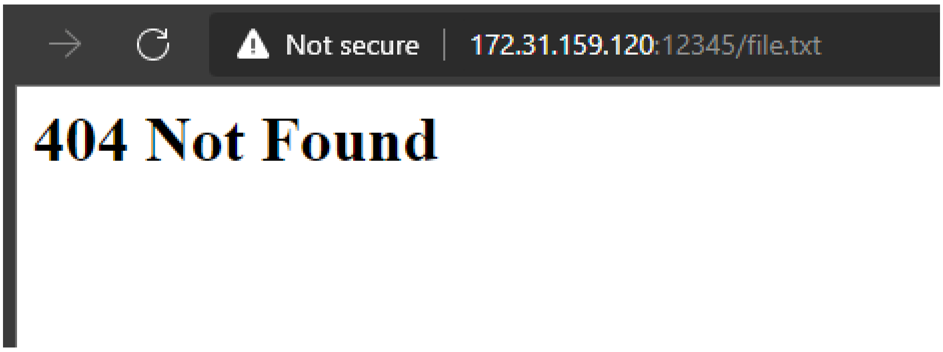
2. when file does not exist

In console (server) side we get the info of the HTTP GET request by the browser and we see that file is not present, hence the webserver is giving the "404 Not Found"



```
[RAM: 14% | SWAP: 0%] .../Sem 6/CS 3272 Computer Network Lab/Assignment 7 ⏱9m46s
[Batt: 11%][12:13 PM] [🧱 INT] ❯ gcc WebServer_iter.c -o webserver_iter && ./webserver_iter 12345
Server Established
------------------
------------------
GET /file.txt HTTP/1.1
Host: 172.31.159.120:12345
Connection: keep-alive
DNT: 1
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/100.0.4896.
127 Safari/537.36 Edg/100.0.1185.44
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8,application/signe
d-exchange;v=b3;q=0.9
Accept-Encoding: gzip, deflate
Accept-Language: en-US,en;q=0.9

Your Token -> file.txt

RESPONSE
--------
HTTP/1.1 404 Not Found
accept-ranges: bytes
content-length: 63
content-type: text/html


<html><head></head><body><h1>404 Not Found</h1></body></html>
```

In browser side, we see the webpage



404 Not Found

A: Multi-threaded Web Server

Currently, the web server handles only one HTTP request at a time. Now. implement a multithreaded server that is capable of serving multiple requests simultaneously. Using threading, first create a main thread in which your modified server listens for clients at a fixed port. When it receives a TCP connection request from a client, it will set up the TCP connection through another port and services the client request in a separate thread. There will be a separate TCP connection in a separate thread for each request/response pair.

HTML code (`./index.html`)

```
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="UTF-8" />
        <meta http-equiv="X-UA-Compatible" content="IE=edge" />
        <meta name="viewport" content="width=device-width, initial-scale=1.0" />
        <title>Simple Web Server</title>
    </head>
    <body>
        <h1>Hello World</h1>
        <p>Bye Bye</p>
    </body>
</html>
```

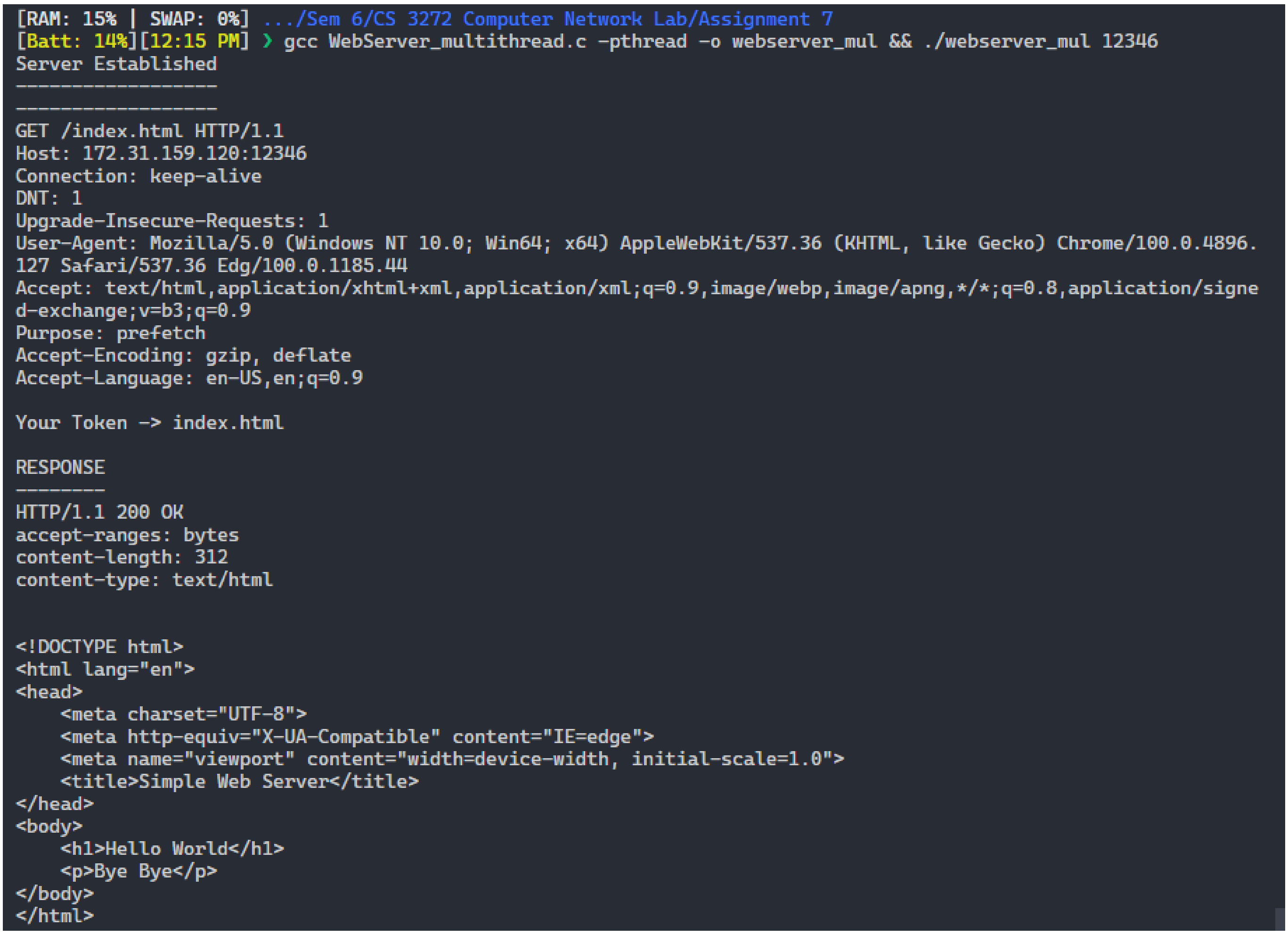
Server Code

```
// Web Server Code

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <unistd.h>
#include <pthread.h>

void *talk(void *newsockfd_ptr)
{
    int newsockfd = *((int *)newsockfd_ptr);
    char buf[1000];

    for (int i = 0; i < 1000; i++)
        buf[i] = '\0';

    recv(newsockfd, buf, 2500, 0);
    printf("Server Established\n------------------\n------------------\n%s", buf);

    char *token = strtok(buf, "/");
    token = strtok(NULL, " ");
    printf("Your Token -> %s\n", token);
    FILE *fp = fopen(token, "r");

    if (!fp)
    {
        // printf("File doesn't exist in Server Directory.\n");
        printf("\nRESPONSE\n--------\n");

        char header[1000];
        char data[1000] = "<html><head></head><body><h1>404 Not Found</h1></body></html>\r\n";

        sprintf(header, "HTTP/1.1 404 Not Found\naccept-ranges: bytes\ncontent-length: %ld\ncontent-type: text/html\r\n\r\n", strlen(data));
        printf("%s\n", header);
        send(newsockfd, header, strlen(header) * sizeof(char), 0);

        printf("%s\n", data);
        send(newsockfd, data, strlen(data) * sizeof(char), 0);

        close(newsockfd);
    }
    else
    {

        // printf("File exists in Server Directory\n");
        printf("\nRESPONSE\n--------\n");

        char header[1000];
        char data[10000];
        size_t charRead = fread(data, sizeof(char), 10000, fp);

        sprintf(header, "HTTP/1.1 200 OK\naccept-ranges: bytes\ncontent-length: %ld\ncontent-type: text/html\r\n\r\n", strlen(data));
        printf("%s\n", header);
        send(newsockfd, header, strlen(header) * sizeof(char), 0);

        printf("%s\n", data);
        send(newsockfd, data, charRead, 0);
        send(newsockfd, "\r\n", sizeof("\r\n"), 0);

        close(newsockfd);
    }
    return NULL;
}

int main(int argc, char *argv[])
{
    int sockfd, newsockfd;
    int clilen;
    struct sockaddr_in cli_addr, serv_addr;

    if ((sockfd = socket(AF_INET, SOCK_STREAM, 0)) < 0)
    {
        printf("Cannot create socket\n");
        exit(0);
    }

    int port = atoi(argv[1]);
    serv_addr.sin_family = AF_INET;
    serv_addr.sin_addr.s_addr = INADDR_ANY;
    serv_addr.sin_port = htons(port);

    if (bind(sockfd, (struct sockaddr *)&serv_addr, sizeof(serv_addr)) < 0)
    {
        printf("Unable to bind local address\n");
        exit(0);
    }

    listen(sockfd, 5);
    while (1)
    {

        clilen = sizeof(cli_addr);
        newsockfd = accept(sockfd, (struct sockaddr *)&cli_addr, &clilen);

        if (newsockfd < 0)
        {
            printf("Accept error\n");
            exit(0);
        }
        // talk(newsockfd);
        pthread_t thread;
        pthread_attr_t attr;
        pthread_attr_init(&attr);
        if (pthread_create(&thread, &attr, talk, &newsockfd) != 0)
        {
            fprintf(stderr, "error: pthread_create error");
        }
    }
    close(sockfd);
}
```

Observation

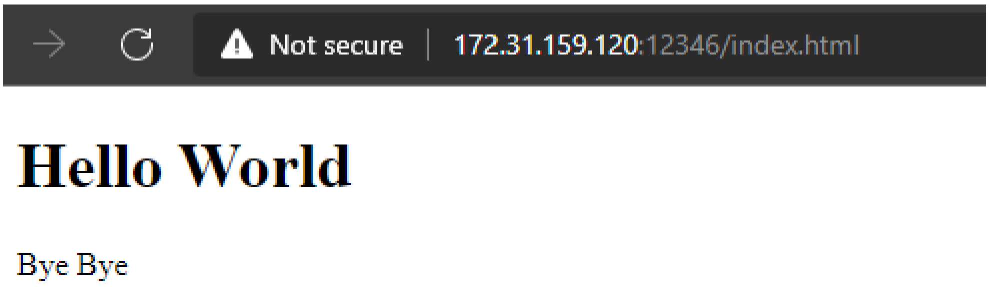
1. when valid file exists

In console (server) side we get the info of the HTTP GET request by the browser and we see that the file is present and is sent back to the browser



```
[RAM: 15% | SWAP: 0%] .../Sem 6/CS 3272 Computer Network Lab/Assignment 7
[Batt: 14%][12:15 PM] ❯ gcc WebServer_multithread.c -pthread -o webserver_mul && ./webserver_mul 12346
Server Established
------------------
------------------
GET /index.html HTTP/1.1
Host: 172.31.159.120:12346
Connection: keep-alive
DNT: 1
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/100.0.4896.
127 Safari/537.36 Edg/100.0.1185.44
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8,application/signe
d-exchange;v=b3;q=0.9
Purpose: prefetch
Accept-Encoding: gzip, deflate
Accept-Language: en-US,en;q=0.9

Your Token -> index.html

RESPONSE
--------
HTTP/1.1 200 OK
accept-ranges: bytes
content-length: 312
content-type: text/html


<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Simple Web Server</title>
</head>
<body>
    <h1>Hello World</h1>
    <p>Bye Bye</p>
</body>
</html>
```

In browser side, we see the webpage

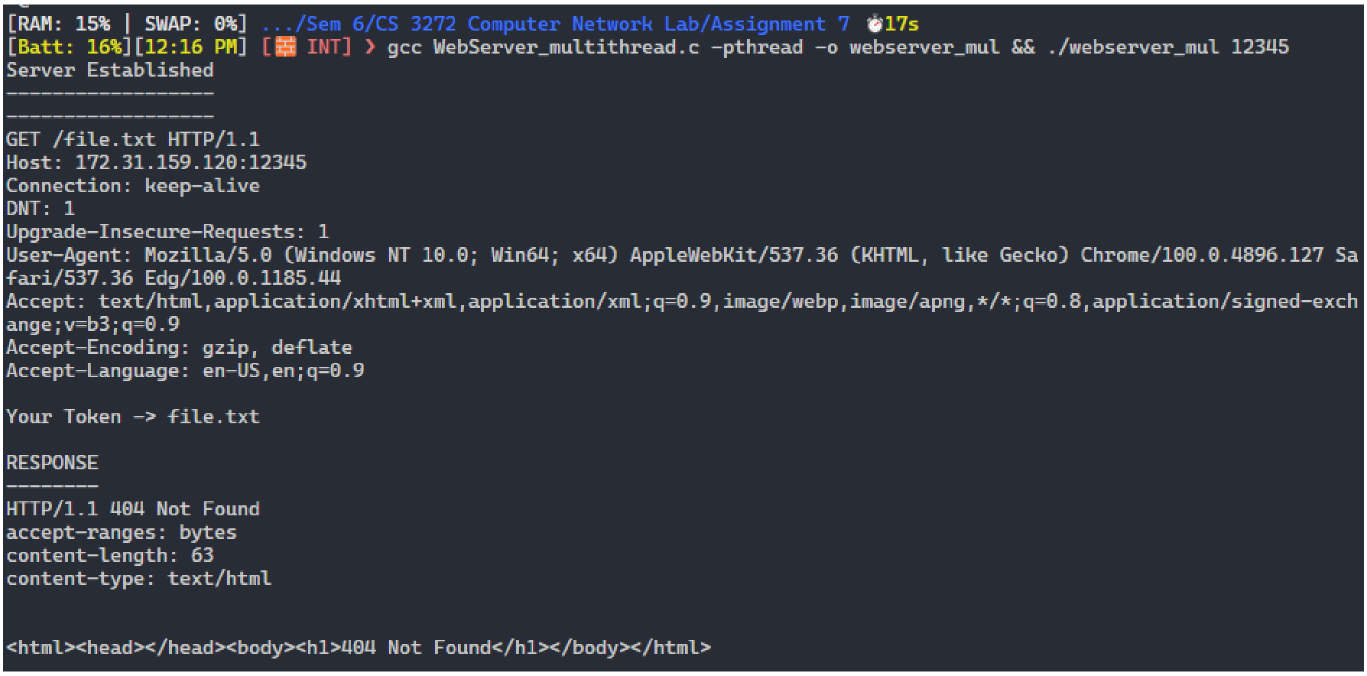


Hello World

Bye Bye

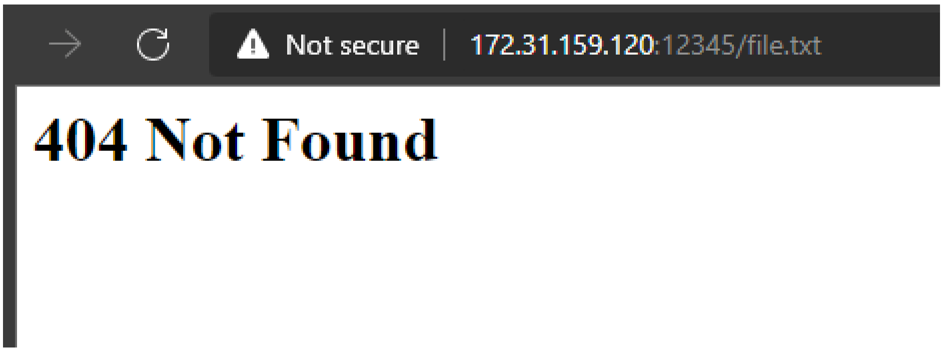
2. when file does not exist (`http://172.24.63.172:12348/file.txt`)

In console (server) side we get the info of the HTTP GET request by the browser and we see that file is not present, hence the webserver is giving the "404 Not Found"



```
[RAM: 15% | SWAP: 0%] .../Sem 6/CS 3272 Computer Network Lab/Assignment 7  ⏱17s
[Batt: 16%][12:16 PM] [▦ INT] ❯ gcc WebServer_multithread.c -pthread -o webserver_mul && ./webserver_mul 12345
Server Established
------------------
------------------
GET /file.txt HTTP/1.1
Host: 172.31.159.120:12345
Connection: keep-alive
DNT: 1
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/100.0.4896.127 Sa
fari/537.36 Edg/100.0.1185.44
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8,application/signed-exch
ange;v=b3;q=0.9
Accept-Encoding: gzip, deflate
Accept-Language: en-US,en;q=0.9

Your Token -> file.txt

RESPONSE
--------
HTTP/1.1 404 Not Found
accept-ranges: bytes
content-length: 63
content-type: text/html


<html><head></head><body><h1>404 Not Found</h1></body></html>
```

In browser side, we see the webpage



404 Not Found