SECURE HOSPITAL FILE ACCESS MONITORING SYSTEM

A MINI-PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this project titled "Secure Hospital File Access Monitoring System" is the bonafide work of:

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who carried out the project under my supervision.

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ABSTRACT

In critical sectors such as healthcare, protecting sensitive data such as patient records is paramount. This project implements a Secure Hospital File Access Monitor using system call monitoring in C, a simulated RAM log using LRU/FIFO, and a real-time graphical interface in Python.
The system logs access to files based on system calls, assigns PIDs, checks permission levels, and simulates memory behavior through FIFO and LRU strategies. This bridges real-world hospital file management with essential Operating System concepts like system call tracing and memory management, providing both practical and educational value.

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CHAPTER 1 — INTRODUCTION

With increasing cyberattacks on healthcare systems, protecting sensitive hospital data such as patient reports, prescriptions, and lab results has become more crucial than ever. Hospitals operate with a wide range of departments and devices, all of which may access critical files. Therefore, a system is required to monitor, log, and visualize these file access events in real-time, ensuring that only authorized processes are allowed to interact with sensitive data.

This project simulates a secure hospital data access system using Operating System concepts like **system call monitoring** and **memory management**. We implement a system in C that simulates system call- level monitoring of file accesses, logging every access along with the process ID (PID), file name, status (ALLOWED / DENIED), and timestamp.

Additionally, we introduce a simulated memory log using Python to reflect how the OS handles memory under constraints. We use two classic page replacement algorithms — **FIFO (First-In First-Out)** and **LRU (Least Recently Used)** — to maintain a rolling log of the last five file accesses. These logs are presented in a colourful, real-time GUI built using PyQt5 and Matplotlib.

CHAPTER 2 — SYSTEM SPECIFICATIONS

2.1 HARDWARE REQUIREMENTS

- Intel i5 or above
- 8 GB RAM
- 100 GB HDD/SSD

2.2 SOFTWARE REQUIREMENTS

- OS: Kali Linux / Ubuntu / Windows WSL
- Language: C, Python 3
- Libraries: PyQt5, matplotlib, deque
- Editor: VS Code / Terminal

CHAPTER 3 — MODULE DESCRIPTION

This module simulates a low-level system call that checks whether a process (identified by its PID) is allowed to access a particular file.
Written in C, it reads an allowed_files.txt list, attempts to open the requested file, and logs the result in access.log. Each log entry includes:

- The access status (ALLOWED / DENIED)
- Filename
- Process ID (PID)
- Timestamp

This mimics basic syscall tracing behaviour found in Linux auditing tools like auditd or ptrace.

The Python module simulates a simplified version of the Operating System's **page replacement mechanism**. It maintains the last five file accesses using either:

- **FIFO (First-In First-Out)**: Evicts the earliest accessed file.
- **LRU (Least Recently Used)**: Evicts the file that hasn't been accessed in the longest time.

These logs simulate a "RAM-like" cache and reflect how limited memory is managed efficiently in a real OS.

A user-friendly interface built using **PyQt5** and **matplotlib**, providing the following features:

- **File Access Simulation Tab**: Buttons to simulate file access requests.
- **Simulated RAM Tab**: Visualizes RAM log state based on the selected strategy (FIFO or LRU). Uses bar graphs to show the active files in memory and dynamically updates after every access.

- **Access Log Tab**: Displays real-time log entries from the access.log file, color-coded based on access type.

This module brings together all the components and provides an intuitive and visual way to understand the OS-level operations happening in the background.

CHAPTER 4 — CODE HIGHLIGHTS

SIMULATE_SYSCALL.C

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include<unistd.h>
#include<time.h>
#define LOG_FILE “access.log”
#define ALLOWED_FILES_FILE “allowed_files.txt”
int is_allowed(const char *filename) {
   FILE *fp = fopen(ALLOWED_FILES_FILE, “r”);
   if (!fp) {
      perror(“Unable to open allowed_files.txt”); return
      0;
   }
   char allowed[100];
   while (fgets(allowed, sizeof(allowed), fp)) {
      allowed[strcspn(allowed, “\n”)] = 0; // Remove newline if
      (strcmp(allowed, filename) == 0) {
         fclose(fp);
```

```
            return 1;
        }
    }
    fclose(fp);
    return 0;
}
void log_access(const char *filename, int allowed) {
    FILE *log = fopen(LOG_FILE, “a”);
    if (!log) {
        perror(“Unable to open access.log”);
        return;
    }
    time_t now = time(NULL);
    char *timestamp = ctime(&now);
    timestamp[strcspn(timestamp, “\n”)] = 0;
    pid_t pid = getpid();
    fprintf(log, “[%s] PID: %d - %s - %s\n”, timestamp, pid, filename,
allowed ? “ALLOWED” : “DENIED”);
    fclose(log);
}
int main(int argc, char *argv[]) { if
    (argc != 2) {
        printf(“Usage: ./simulate_syscall <filename>\n”);
```

```
    return 1;
  }
  const char *filename = argv[1];
  int allowed = is_allowed(filename);
  log_access(filename, allowed);
  if (allowed) {
    printf("Access granted to file: %s\n", filename);
  } else {
    printf("Access denied to file: %s\n", filename);
  }
  return 0;
}
```

- Uses getpid(), ctime(), and file permission checking
- Logs access as ALLOWED or DENIED

GUI_MONITOR.PY

```
import sys import
os
import subprocess
from collections import deque
from datetime import datetime
```

```
from PyQt5.QtWidgets import (
   Qapplication, Qwidget, QVBoxLayout, Qlabel, QpushButton, QtextEdit,
   QcomboBox, QHBoxLayout, QtabWidget
)
from PyQt5.QtCore import Qt
from PyQt5.QtGui import QtextCharFormat, QtextCursor, Qcolor
import matplotlib.pyplot as plt
from matplotlib.backends.backend_qt5agg import FigureCanvasQTAgg as
FigureCanvas


# Config
MEMORY_LOG_LIMIT = 5
ACCESS_LOG_FILE = “access.log”
FILES = [
   “record1.txt”, “record2.txt”, “secret_config.txt”, “patient_report.txt”,
   “unauthorized_notes.txt”, “confidential.txt”
]


class MemoryLog:
   def _init_(self, strategy=’FIFO’):
      self.log = deque()
      self.strategy = strategy
```

```
    def access(self, filename): if
        filename in self.log:
            if self.strategy == ‘LRU’:
                self.log.remove(filename)
                self.log.append(filename)
        else:
            if len(self.log) >= MEMORY_LOG_LIMIT:
                self.log.popleft()
            self.log.append(filename)

    def get_log(self):
        return list(self.log)

class GraphCanvas(FigureCanvas): def
    init_(self, parent=None):
        self.fig, self.ax = plt.subplots(figsize=(4, 3))
        super()._init_(self.fig)

    def update_graph(self, memory_list):
        self.ax.clear()
        colors = [‘green’ if ‘record’ in f or ‘secret’ in f else ‘red’ for f in
memory_list]
```

```
        self.ax.bar(range(len(memory_list)), [1]*len(memory_list),
tick_label=memory_list, color=colors)

        self.ax.set_itle("* RAM Access Simulation (LRU/FIFO)")

        self.draw()


class MainWindow(Qwidget):

   def _init_(self):

        super().__init__()

        self.setWindowTitle("Secure File Access Monitor with RAM
Simulation")

        self.setGeometry(100, 100, 800, 600)

        self.memory_strategy = 'FIFO'

        self.memory_log = MemoryLog(self.memory_strategy)

        layout = QVBoxLayout()

        self.tabs = QtabWidget()

        self.log_tab = Qwidget()

        self.memory_tab = Qwidget()

        self.tabs.addTab(self.log_tab, "Access Logs")

        self.tabs.addTab(self.memory_tab, "Simulated RAM")


        # Tab 1 – Log

        log_layout = QVBoxLayout()

        self.log_display = QtextEdit()
```

```
        self.log_display.setReadOnly(True)
        btn_layout = QHBoxLayout()
        for f in FILES:
            btn = QpushButton(f"Access {f}")
            btn.clicked.connect(lambda checked, file=f: self.run_syscall(file))
            btn_layout.addWidget(btn)

        self.refresh_btn = QpushButon("  Refresh Logs")
        self.refresh_btn.clicked.connect(self.load_logs)
        btn_layout.addWidget(self.refresh_btn)
        log_layout.addLayout(btn_layout)
        log_layout.addWidget(self.log_display)
        self.log_tab.setLayout(log_layout)

        # Tab 2 – RAM
        memory_layout = QVBoxLayout()
        self.strategy_dropdown = QcomboBox()
        self.strategy_dropdown.addItems(["FIFO", "LRU"])

self.strategy_dropdown.currentTextChanged.connect(self.change_strate gy)
        self.memory_display = QtextEdit()
        self.memory_display.setReadOnly(True)
```

```
    self.canvas = GraphCanvas(self)
    memory_layout.addWidget(Qlabel(“Choose Memory Strategy:”))
    memory_layout.addWidget(self.strategy_dropdown)
    memory_layout.addWidget(self.memory_display)
    memory_layout.addWidget(self.canvas)
    self.memory_tab.setLayout(memory_layout)
    layout.addWidget(self.tabs)
    self.setLayout(layout)
    self.load_logs()
    self.update_memory_display()

def change_strategy(self, strategy):
    self.memory_strategy = strategy self.memory_log
    = MemoryLog(strategy) self.load_logs()

def run_syscall(self, filename):
    if not os.path.exists(“./simulate_syscall”): self.log_display.append(“+
       simulate_syscall binary not found.”) return
    subprocess.call([“./simulate_syscall”, filename])
    self.memory_log.access(filename)
```

```
    self.load_logs()
    self.update_memory_display()

def load_logs(self):
    self.log_display.clear()
    if not
        os.path.exists(ACCESS_LOG_FILE):
        return
    with open(ACCESS_LOG_FILE, “r”) as f:
        for line in f:
            self.append_colored_line(line.strip())

def append_colored_line(self, line):
    fmt = QtextCharFormat()
    if “ALLOWED” in line:
        fmt.setForeground(Qcolor(“green”))
    elif “DENIED” in line:
        fmt.setForeground(Qcolor(“red”))
    else:
        fmt.setForeground(Qcolor(“black”))
    cursor  =  self.log_display.textCursor()
    cursor.movePosition(QtextCursor.End)
    cursor.insertText(line + “\n”, fmt)
```

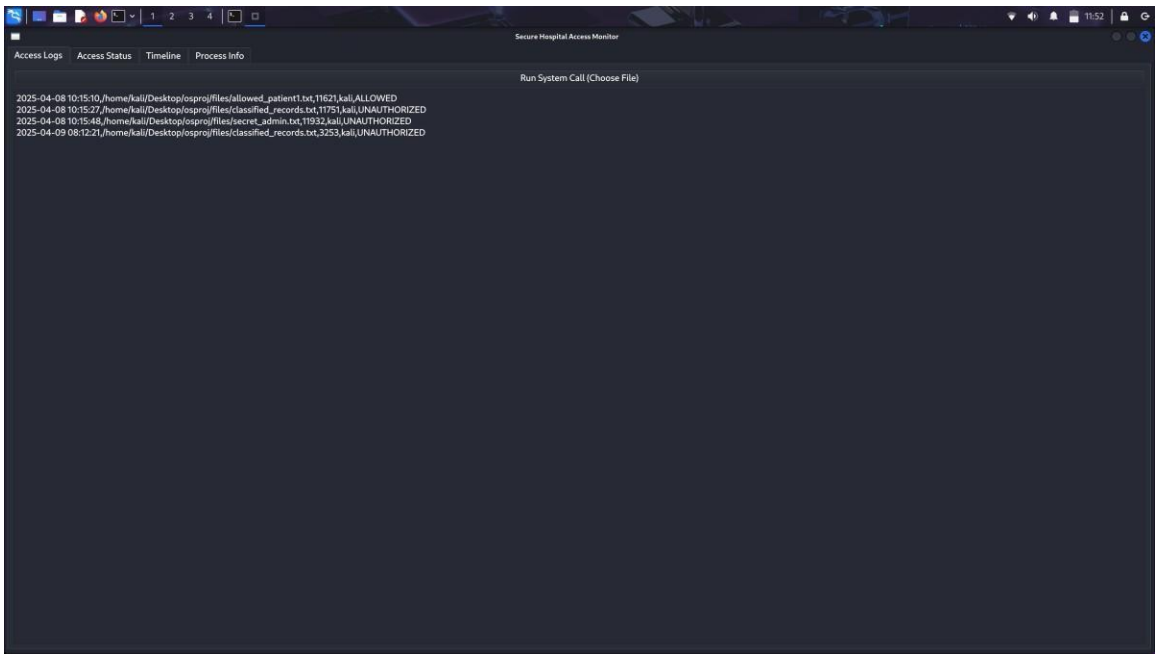
```
        self.log_display.setTextCursor(cursor)
        self.log_display.ensureCursorVisible()
    def update_memory_display(self):
        self.memory_display.clear()  mem_log
        = self.memory_log.get_log()
        self.memory_display.append("Last 5 File Accesses
({}):\n".format(self.memory_strategy))
        for I, f in enumerate(mem_log): self.memory_display.append(f"{i+1}.
            {f}")
        self.canvas.update_graph(mem_log) if
name_____== "_main_":
    app = Qapplication(sys.argv)
    win = MainWindow()
    win.show() sys.exit(app.exec_())
```

- Uses PyQt5 for GUI
- Shows logs, triggers system calls
- Displays simulated RAM based on LRU/FIFO
- Uses matplotlib for visual memory graph

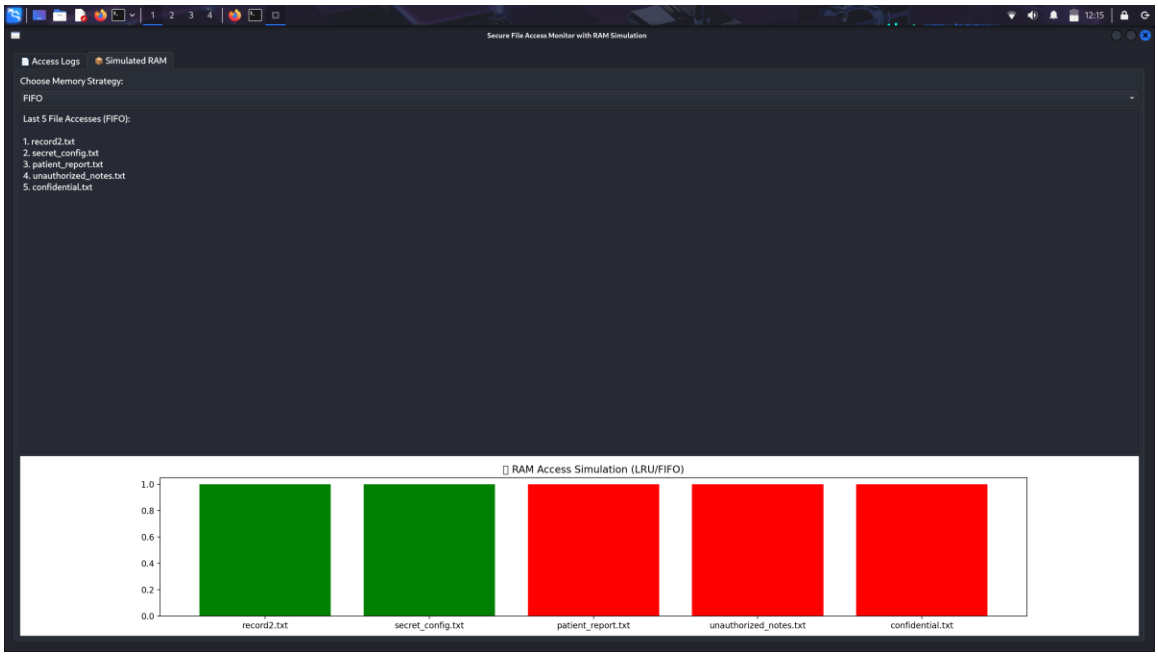
CHAPTER 5 — SCREENSHOTS AND OUTPUT

This section includes screenshots from the working GUI system, demonstrating access logging, memory visualization, and system interaction.

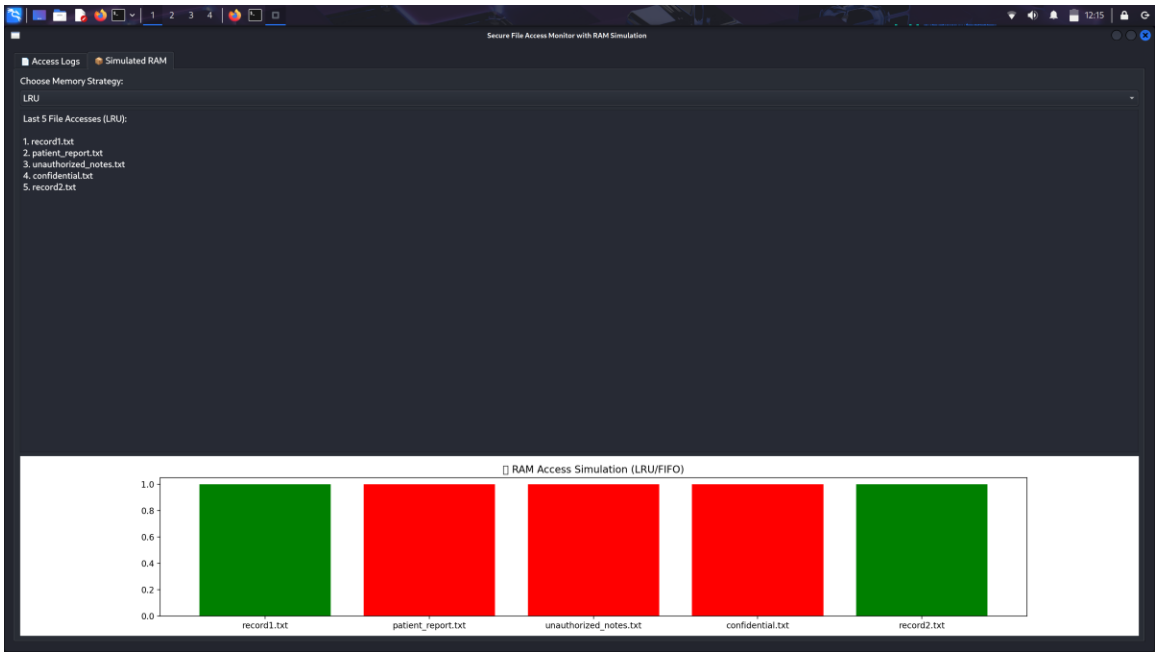
Screenshot placeholders:



- GUI File Access Page



- RAM Log Panel (FIFO)



- RAM Log Panel (LRU)

CHAPTER 6 — CONCLUSION AND FUTURE ENHANCEMENT

This project successfully demonstrates how fundamental Operating System concepts such as system calls, process identification, and page replacement algorithms (LRU/FIFO) can be applied to a real-world cybersecurity scenario like hospital data protection.
By simulating system calls in C, the system efficiently monitors access to sensitive patient files, logging essential details such as file name, access status, timestamp, and process ID (PID). This serves as a lightweight intrusion detection mechanism, mimicking how real-world OS-level auditing tools work in critical environments.

The Python-based GUI enhances the user experience by providing:

- A visual representation of file access behavior.
- A simulated RAM model using FIFO and LRU algorithms.
- Real-time updates and clear indicators of authorized vs unauthorized file activity.

The integration of system call monitoring with memory management algorithms through a responsive GUI showcases not only the theoretical knowledge of operating systems but also its practical relevance in a security-focused domain like healthcare.

In essence, this project bridges the gap between academic learning and industrial needs by demonstrating how core OS functionalities can be applied in building secure, real-time monitoring systems. It opens up further opportunities for enhancement using tools like eBPF, real-time alerts, role-based access control, and backend storage for long-term access audit logs.

CHAPTER 7 – REFERENCES

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- https://doc.qt.io/qtforpython/
- https://www.learn-c.org/
- https://matplotlib.org/stable/gallery/index.html