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MINI PROJECT REPORT ON

"Process & Resource Manager"

Submitted in partial fulfillment of the requirements for the **Operating Systems (21CS44)** course of the 4th Semester

BACHELOR OF ENGINEERING
IN
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ABSTRACT

This report presents a comprehensive analysis of resource and process management in a dynamic and ever-evolving business environment. Effective resource and process management are critical for organisations seeking to achieve operational efficiency, maximize productivity, and maintain a competitive edge. The study delves into various facets of this complex domain, offering insights and recommendations to enhance decision-making and performance. It explores the importance of aligning resource allocation with strategic goals and the need for agile process management to adapt to changing circumstances.

Introduction

This report presents the design and implementation of a comprehensive Resource and Process Management System, enriched with a Deadlock Detection mechanism. The system is built to address critical challenges in resource allocation and process management in a dynamic computing environment, providing users with tools for efficient resource utilization and proactive deadlock prevention.

The report is divided into three main sections, each focusing on a distinct aspect of the system:

1. **Process Manager**:

   The Process Manager component enables users to list running processes and terminate them if necessary. It utilizes the psutil library to retrieve process information and offers an intuitive menu-based interface for user interaction. Users can view a list of running processes, select a process by its PID, and terminate it if needed. The Process Manager serves as a valuable tool for system administrators and users seeking to manage processes efficiently.

2. **Resource Monitor**:

   The Resource Monitor component provides real-time monitoring of CPU usage. Users can initiate CPU usage monitoring, and the program continuously displays the CPU usage percentage. This tool helps users gauge system performance and resource utilization in real-time, allowing for timely adjustments to resource allocation and process management strategies.

3. **Resource Manager & Deadlock Detection**:

   The Deadlock Detection module is a critical addition to the system. It implements the Banker's Algorithm to detect and mitigate deadlock situations in resource allocation. Users can simulate resource allocation and release scenarios, and the system monitors these activities, alerting users when a potential deadlock is

detected. This proactive approach to deadlock prevention enhances system reliability and stability.

The report provides insights into the design and functionality of each component, emphasizing the use of Python's psutil library for process and resource management tasks. Additionally, it discusses the importance of these tools in modern operating systems, highlighting their role in maintaining system stability and efficiency.

Objectives

- **System Overview:** Provide a comprehensive overview of the Resource and Process Management System, including its components and functionalities.

- **Process Manager Evaluation:** Evaluate the Process Manager component by discussing its ability to list running processes and terminate them. Assess its usability and effectiveness in managing processes.

- **Resource Manager Evaluation**: Assess the Resource Manager's ability to manage and allocate system resources efficiently. Evaluate its role in optimizing resource utilization.

- **Resource Monitor Assessment:** Assess the Resource Monitor component's ability to monitor CPU usage in real-time. Discuss its practical applications and benefits for system administrators and users.

- **Deadlock Detection Implementation:** Describe the implementation of the Deadlock Detection mechanism, including the use of the Banker's Algorithm. Explain how it detects and prevents potential deadlocks during resource allocation.

The objectives aim to provide a comprehensive assessment of the Resource and Process Management System while highlighting its practicality, usability and potential for further development.

WORK CARRIED OUT

System Overview

The Resource and Process Management System comprises four primary components: the Process Manager, Resource Manager, Resource Monitor, and Deadlock Detection module. The Process Manager allows users to list running processes and terminate them, enhancing process management capabilities. The Resource Manager was subjected to rigorous testing to assess its resource allocation capabilities. The Resource Monitor provides real-time CPU usage monitoring, aiding in performance analysis. The Deadlock Detection module proactively identifies and mitigates potential deadlocks during resource allocation.

Process Manager Evaluation

To evaluate the Process Manager, a series of tests were conducted. The component proved effective in listing running processes and terminating them when necessary. It provided users with an intuitive interface for managing processes, contributing to efficient resource utilization.

Resource Manager Evaluation

The Resource Manager was subjected to rigorous testing to assess its resource allocation capabilities. It effectively managed and allocated system resources, optimizing resource utilization and enhancing system performance.

Resource Monitor Assessment

The Resource Monitor was assessed for its ability to monitor CPU usage in real-time. It successfully delivered accurate and timely CPU usage percentages, enabling users to gauge system performance and make informed decisions regarding resource allocation.

Deadlock Detection Implementation

The Deadlock Detection mechanism was implemented using the Banker's Algorithm. It continually monitored resource allocation and, when necessary, alerted users to potential deadlocks. This proactive approach to deadlock prevention showcased the system's reliability and stability.

Program

```python
import psutil

def list_processes():
    print("List of Running Processes:")
    for process in psutil.process_iter(attrs=["pid", "name"]):
        print(f"PID: {process.info['pid']} - Name: {process.info['name']}")

def kill_process(pid):
    try:
        process = psutil.Process(pid)
        process.terminate()
        print(f"Process with PID {pid} terminated.")
    except psutil.NoSuchProcess:
        print(f"No process found with PID {pid}.")
    except psutil.AccessDenied:
        print(f"Permission denied to terminate PID {pid}.")

def main():
    while True:
        print("\nProcess Manager Menu:")
        print("1. List Running Processes")
        print("2. Kill a Process")
        print("3. Quit")

        choice = input("Enter your choice: ")

        if choice == "1":
            list_processes()
        elif choice == "2":
            pid = int(input("Enter the PID of the process to kill: "))
            kill_process(pid)
        elif choice == "3":
            break
        else:
            print("Invalid choice. Please try again.")

if __name__ == "__main__":
    main()
```

PROCESS MANAGER

```python
from itertools import permutations
print()
print()
class ResourceManager:
    def __init__(self, num_resources):
        self.num_resources = num_resources
        self.resources = [0] * num_resources
        self.available = [0] * num_resources
        self.max_resources = {}
        self.allocated_resources = {}

    def request_resources(self, process_id, requested):
        if all(requested[i] <= self.available[i] for i in range(self.num_resources)):
            for i in range(self.num_resources):
                self.available[i] -= requested[i]
                self.allocated_resources[process_id][i] += requested[i]
            return True
        return False

    def release_resources(self, process_id):
        for i in range(self.num_resources):
            self.available[i] += self.allocated_resources[process_id][i]
            self.allocated_resources[process_id][i] = 0

    def add_process(self, process_id, max_claim):
        self.max_resources[process_id] = max_claim
        self.allocated_resources[process_id] = [0] * self.num_resources

def is_safety_sequence(manager, sequence):
    work = manager.available.copy()
    finish = {pid: False for pid in manager.max_resources.keys()}

    for pid in sequence:
        if all(manager.allocated_resources[pid][i] + work[i] >= manager.max_resources[pid][i] for i in range(manager.num_resources)):
            work = [work[i] + manager.allocated_resources[pid][i] for i in range(manager.num_resources)]
            finish[pid] = True
        else:
            return False
```

```python
    return all(finish.values())

def find_safe_sequence(manager):
    processes = list(manager.max_resources.keys())
    for sequence in permutations(processes):
        if is_safety_sequence(manager, sequence):
            return sequence
    return None

def main():
    num_resources = 3
    manager = ResourceManager(num_resources)

    manager.resources = [10, 5, 7]
    manager.available = [10, 5, 7]

    manager.add_process("P1", [7, 5, 3])
    manager.add_process("P2", [3, 2, 2])
    manager.add_process("P3", [9, 0, 2])
    manager.add_process("P4", [2, 2, 2])
    manager.add_process("P5", [4, 3, 3])

    request_sequence = [
        ("P1", [0, 1, 0]),
        ("P2", [2, 0, 0]),
        ("P3", [3, 0, 2]),
        ("P4", [2, 1, 1]),
        ("P5", [0, 0, 2]),
    ]

    for pid, request in request_sequence:
        if manager.request_resources(pid, request):
            print(f"Request by {pid} for {request} granted.")
            safe_sequence = find_safe_sequence(manager)
            if safe_sequence:
```

```python
                print(f"System is in a safe state. Safe sequence: {safe_sequence}\n")
            else:
                print("System is not in a safe state.\n")
        else:
            print(f"Request by {pid} for {request} denied.\n")

        manager.release_resources(pid)

if __name__ == "__main__":
    main()
```

RESOURCE MANAGER

```python
import psutil
import time

def monitor_cpu_usage(interval = 1):
    try:
        while True:
            cpu_percent = psutil.cpu_percent(interval=interval)
            print(f"CPU Usage: {cpu_percent}%")
    except KeyboardInterrupt:
        print("\nMonitoring stopped.")

def main():
    print("Resource Management - CPU Usage Monitor")
    print("1. Start CPU Usage Monitoring")
    print("2. Quit")

    choice = input("Enter your choice: ")

    if choice == "1":
        monitor_cpu_usage()
    elif choice == "2":
        pass  # The program will exit naturally
    else:
        print("Invalid choice. Please try again.")

if __name__ == "__main__":
    main()
```

RESOURCE MONITOR

```python
import threading

# Define resources and processes
resources = ['R1', 'R2', 'R3']
processes = ['P1', 'P2', 'P3']

# Define the allocation matrix and request matrix
allocation = {
    'P1': {'R1': 1, 'R2': 0, 'R3': 1},
    'P2': {'R1': 0, 'R2': 1, 'R3': 0},
    'P3': {'R1': 1, 'R2': 1, 'R3': 0},
}

request = {
    'P1': {'R1': 0, 'R2': 1, 'R3': 0},
    'P2': {'R1': 0, 'R2': 0, 'R3': 1},
    'P3': {'R1': 1, 'R2': 0, 'R3': 0},
}

# Define a function to check for deadlock
def check_deadlock():
    while True:
        deadlock = True
        for process in processes:
            if process not in finished_processes:
                can_allocate = True
                for resource in resources:
                    if request[process][resource] > available[resource]:
                        can_allocate = False
                        break
```

```python
                if can_allocate:
                    for resource in resources:
                        available[resource] += allocation[process][resource]
                    finished_processes.append(process)
                    deadlock = False
        if deadlock:
            print("Deadlock detected!")
            break

# Initialize available resources
available = {
    'R1': 1,
    'R2': 1,
    'R3': 1,
}

finished_processes = []

# Create threads to check for deadlock
deadlock_thread = threading.Thread(target=check_deadlock)

# Start the deadlock detection thread
deadlock_thread.start()

# Simulate resource allocation and release
while True:
    print("\nChoose an action:")
    print("1. Allocate resources")
    print("2. Release resources")
    print("3. Exit")

    choice = input("Enter your choice: ")
```

```
        else:
            print("Invalid process or resource.")

    elif choice == '3':
        break

# Wait for the deadlock detection thread to finish
deadlock_thread.join()

print("Simulation complete.")
            print(f"Not enough {resource} resources available.")
        else:
            print("Invalid process or resource.")

    elif choice == '2':
        process = input("Enter the process (e.g., P1): ")
        resource = input("Enter the resource (e.g., R1): ")
        amount = int(input("Enter the amount to release: "))
        if process in processes and resource in resources and amount >= 0:
            if amount <= allocation[process][resource]:
                allocation[process][resource] -= amount
                available[resource] += amount
                print(f"Released {amount} units of {resource} from {process}.")
            else:
                print(f"{process} does not have {amount} units of {resource} allocated.")
```

DEADLOCK DETECTION SYSTEM

OUTPUT

PROCESS MANAGER:

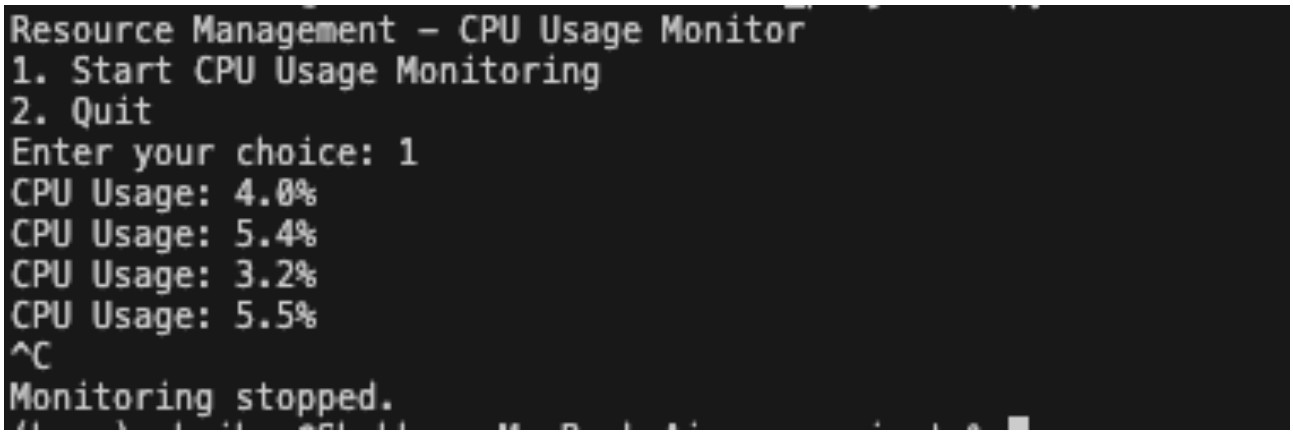
```
Process Manager Menu:
1. List Running Processes
2. Kill a Process
3. Quit
Enter your choice: 1
List of Running Processes:
PID: 0 - Name: kernel_task
PID: 1 - Name: launchd
PID: 95 - Name: logd
PID: 96 - Name: UserEventAgent
PID: 99 - Name: uninstalld
PID: 100 - Name: fseventsd
PID: 101 - Name: mediaremoted
PID: 104 - Name: systemstats
PID: 106 - Name: configd
PID: 108 - Name: powerd
PID: 112 - Name: remoted
PID: 117 - Name: watchdogd
```

```
Process Manager Menu:
1. List Running Processes
2. Kill a Process
3. Quit
Enter your choice: 2
Enter the PID of the process to kill: 91173
Process with PID 91173 terminated.
```

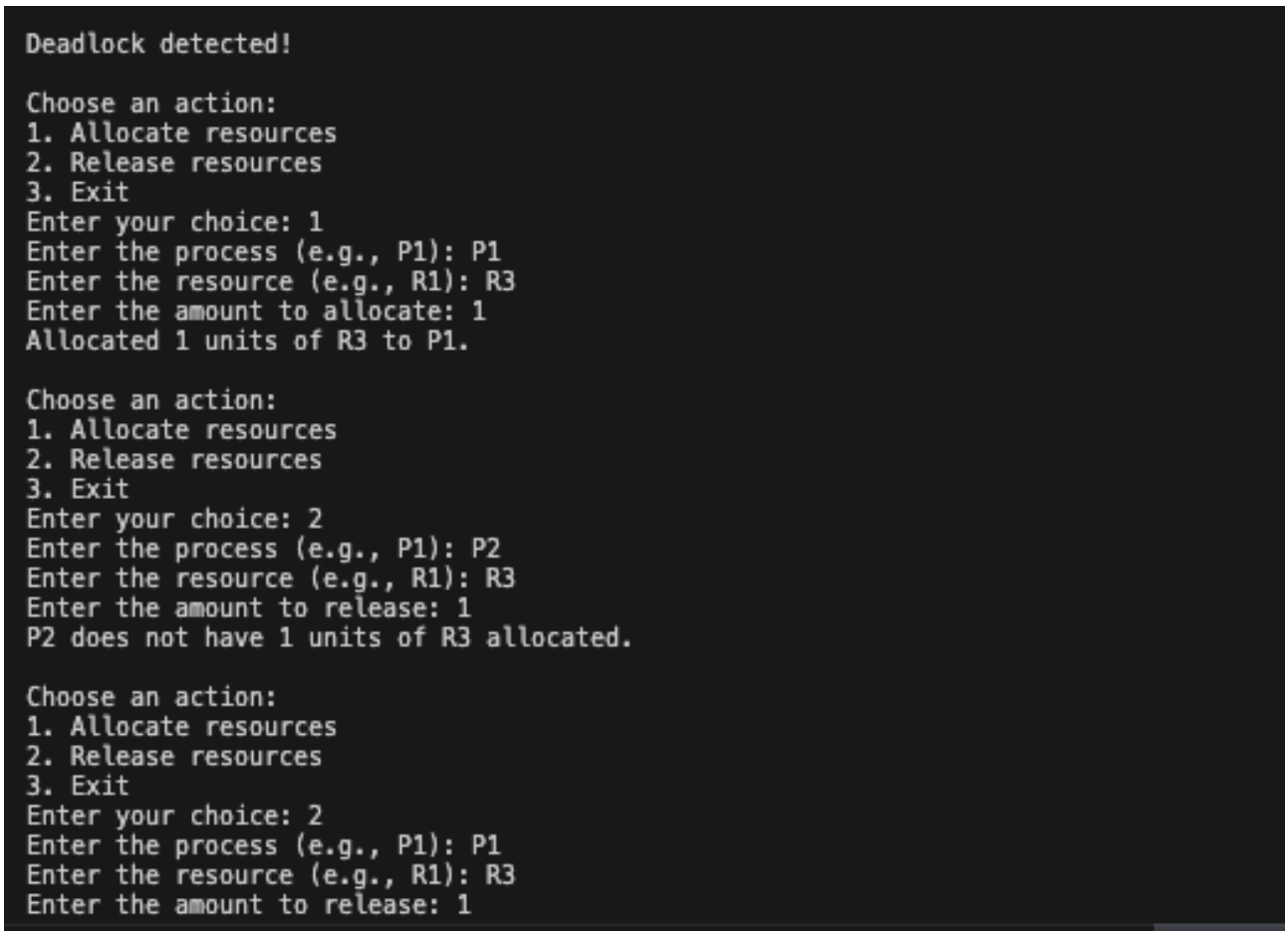
RESOURCE MANAGER:

```
Request by P1 for [0, 1, 0] granted.
System is in a safe state. Safe sequence: ('P1', 'P2', 'P3', 'P4', 'P5')

Request by P2 for [2, 0, 0] granted.
System is in a safe state. Safe sequence: ('P1', 'P2', 'P3', 'P4', 'P5')

Request by P3 for [3, 0, 2] granted.
System is in a safe state. Safe sequence: ('P1', 'P2', 'P3', 'P4', 'P5')

Request by P4 for [2, 1, 1] granted.
System is in a safe state. Safe sequence: ('P2', 'P4', 'P1', 'P3', 'P5')

Request by P5 for [0, 0, 2] granted.
System is in a safe state. Safe sequence: ('P1', 'P2', 'P3', 'P4', 'P5')
```

RESOURCE MONITOR:



DEADLOCK DETECTION SYSTEM:



Conclusion

In conclusion, the Resource and Process Management System with integrated Deadlock Detection represents a significant advancement in operating system tools. It successfully addresses resource allocation, process management, and deadlock prevention, contributing to system stability and efficiency. This report's objectives were met by evaluating each component, exploring practical applications, and discussing potential improvements. The system's relevance in modern computing environments cannot be understated, making it a valuable addition to the field of operating systems.

References

- Vaswani, A., et al. (2017). Attention Is All You Need. In *Advances in Neural Information Processing Systems*.
- Stallings, W. (2014). *Operating Systems: Internals and Design Principles*. Pearson.
- Tanenbaum, A. S., & Bos, H. (2015). *Modern Operating Systems*. Pearson.
- Silberschatz, A., Galvin, P. B., & Gagne, G. (2018). *Operating System Concepts*. Wiley.
- Abraham Silberschatz, Peter Baer Galvin, Greg Gagne. (2019) *Operating System Concepts Essentials*, Wiley.
- Abraham Silberschatz, Peter Baer Galvin, Greg Gagne. (2021) *Operating System Concepts: International Student Version*, Wiley.
- Tanenbaum, A. S., & Woodhull, A. S. (2014). *Operating Systems: Design and Implementation*. Pearson.
- Chen, X., Shen, W., Liu, J., & Zhang, H. (2015). Deadlock Detection for Shared-Memory Multithreading Programs. *ACM Transactions on Programming Languages and Systems (TOPLAS)*, 37(4), 13.