ABSTRACT:

In the realm of computer science, task scheduling is a fundamental concept that plays a critical role in the efficient execution of processes in various systems, ranging from operating systems to embedded systems. This project, titled "Task Scheduler," aims to explore and implement a priority-based task scheduling system using C++. The primary objective of this project is to design a scheduler that manages tasks based on their priority levels, ensuring that higher priority tasks are executed before lower priority ones.The task scheduler employs a linked list to manage the tasks and a hash table to facilitate quick task lookup and management. Each task is characterized by its unique ID, priority level, execution time, and name. The scheduler inserts tasks into the linked list in a manner that maintains the order based on priority, with the highest priority tasks positioned at the head of the list.This project demonstrates key data structures and algorithms concepts, including linked lists for dynamic data management and hash tables for efficient data retrieval. Additionally, it incorporates multi-threading to simulate task execution, adding a layer of realism to the scheduling process. By implementing this task scheduler, the project not only highlights the practical applications of data structures and algorithms but also provides insights into the intricacies of process management in real-world systems.

INTRODUCTION:

Task scheduling is a critical aspect of computer science, playing a vital role in the efficient execution of processes in various systems, including operating systems, real-time systems, and embedded systems. The "Task Scheduler" project aims to develop a priority-based task scheduling system using C++, which can effectively manage and execute tasks based on their priority levels. This project demonstrates the practical application of key data structures and algorithms concepts, providing insights into the complexities of process management.

The task scheduler is designed using a combination of a linked list and a hash table. Each task is represented by a structure that includes a unique task ID, priority level, execution time, and task name. The linked list is used to maintain the order of tasks based on their priority, with higher priority tasks positioned at the head of the list. The hash table facilitates quick task lookup and management, ensuring that tasks can be added, found, and removed efficiently.

One of the main features of this scheduler is its ability to insert tasks into the linked list in a manner that maintains the priority order. This ensures that tasks with higher priority are always executed before those with lower priority. The scheduler also includes functionality to execute tasks, simulating real-world task execution by incorporating multi-threading. Each task is executed for its specified duration, demonstrating the practical aspects of task scheduling.

This project not only highlights the importance of data structures such as linked lists and hash tables but also provides a hands-on approach to understanding the intricacies of task management in operating systems and real-time systems. By simulating task execution, the project adds a layer of realism, making it a valuable educational tool for students and professionals interested in system design and process management.

PROBLEM STATEMENT:

The "Task Scheduler" project aims to design and implement a priority-based task scheduling system using C++. The scheduler should manage tasks efficiently by inserting them into a linked list based on their priority levels and utilizing a hash table for quick lookup. The system must ensure that higher priority tasks are executed before lower priority ones, simulating real-world process management. The project will demonstrate the practical application of data structures and algorithms in task scheduling.

OBJECTIVE:

The "Task Scheduler" project aims to develop a priority-based task scheduling system that effectively manages and executes the following tasks crucial for autonomous vehicle operation:

1. Sensor Calibration
2. Obstacle Detection
3. Path Planning
4. Speed Control
5. Data Logging

The objective is to demonstrate the practical application of data structures and algorithms in managing complex, real-time processes essential for autonomous vehicle operation, ensuring optimal performance, safety, and reliability.

METHODOLOGY:

The "Task Scheduler" project follows a structured approach to design, implement, and test a priority-based task scheduling system. The methodology comprises the following steps:

1. **System Design**:
    - Define the task structure, including task ID, priority, execution time, and task name.
    - Design a linked list to manage tasks based on their priority levels.
    - Implement a hash table for efficient task lookup and management.
2. **Task Insertion**:
    - Develop a function to insert tasks into the linked list, maintaining the order based on priority.
    - Ensure the insertion algorithm places higher priority tasks at the head of the list.
3. **Task Execution**:
    - Implement a function to remove and execute the highest priority task from the linked list.
    - Utilize multi-threading to simulate task execution, with each task running for its specified execution time.
4. **Task Management**:
    - Create functions to add new tasks to the scheduler, ensuring no duplicate task IDs.
    - Implement a lookup function to find tasks by their ID using the hash table.
    - Ensure tasks are removed from both the linked list and hash table upon completion.
5. **Priority Handling**:

- Ensure the scheduler dynamically adjusts to changing task priorities, maintaining efficient execution order.
- Test the system's ability to handle tasks with varying execution times and priorities.

6. **Task Types**:
    - Integrate specific tasks such as Sensor Calibration, Obstacle Detection, Path Planning, Speed Control, and Data Logging.
    - Assign appropriate priorities to each task type to reflect their importance in autonomous vehicle operation.
7. **Testing and Validation**:
    - Conduct extensive testing to validate the correctness and efficiency of the task scheduler.
    - Simulate real-world scenarios to ensure the scheduler can handle dynamic task environments.
    - Monitor and log performance metrics to identify areas for optimization.
8. **Documentation**:
    - Document the design, implementation, and testing process.
    - Provide detailed instructions for using and extending the task scheduler system.

By following this methodology, the project aims to create a robust and efficient task scheduling system that can effectively manage and execute tasks critical to autonomous vehicle operation.

FLOWCHART:

1. **Start**
    - Begin the process.
2. **Initialize System**
    - Initialize the linked list and hash table.
3. **Display Menu**
    - Present the user with options:
        1. Add Task
        2. Execute Tasks
        3. Exit
4. **User Choice Decision**

- If the user chooses "Add Task":
    1. Go to "Add Task"
- If the user chooses "Execute Tasks":
    1. Go to "Execute Tasks"
- If the user chooses "Exit":
    1. Go to "End"

5. **Add Task**
    - Prompt user to enter task details (ID, priority, execution time, name).
    - Check if task ID already exists in the hash table.
        - If yes, display error message and return to "Display Menu".
        - If no, create new task and insert it into the linked list based on priority.
    - Add task to hash table.
    - Return to "Display Menu".
6. **Execute Tasks**
    - While the linked list is not empty:
        - Remove the highest priority task from the linked list.
        - Remove the task from the hash table.
        - Display task execution details.
        - Simulate task execution using sleep for the task's execution time.
    - Return to "Display Menu".
7. **End**
    - Terminate the process.

Here is a simplified textual flowchart format:

[Start] --> [Initialize System] --> [Display Menu] --> [User Choice Decision]

[User Choice Decision] -->|Add Task| [Add Task] --> [Display Menu]

[User Choice Decision] -->|Execute Tasks| [Execute Tasks] --> [Display Menu]

[User Choice Decision] -->|Exit| [End]

CODE:

```
#include <iostream>
#include <thread>
#include <chrono>
#include <unordered_map>

// Task structure
struct Task {
    int taskID;
    int priority;
    int executionTime;
    std::string taskName;
    Task* next;

    Task(int id, int pri, int execTime, std::string name)
        : taskID(id), priority(pri), executionTime(execTime), taskName(name), next(nullptr) {}
};

// Linked list to manage tasks
class LinkedList {
public:
    Task* head;

    LinkedList() : head(nullptr) {}

    // Insert task into the list based on priority
    void insert(Task* newTask) {
        if (!head || head->priority < newTask->priority) {
            newTask->next = head;
            head = newTask;
        } else {
            Task* current = head;
            while (current->next && current->next->priority >= newTask->priority) {
                current = current->next;
            }
            newTask->next = current->next;
            current->next = newTask;
        }
    }

    // Remove and return the highest priority task
    Task* remove() {
        if (!head) return nullptr;
        Task* temp = head;
        head = head->next;
        return temp;
    }

    // Check if the list is empty
    bool isEmpty() {
        return head == nullptr;
    }
};

// Scheduler class to manage tasks
class Scheduler {
private:
    LinkedList taskList;
    std::unordered_map<int, Task*> taskMap; // Hash table to store tasks by ID

public:
    // Add task to the scheduler
    void addTask(int id, int priority, int executionTime, const std::string& name) {
        if (taskMap.find(id) != taskMap.end()) {
            std::cout << "Task with ID " << id << " already exists.\n";
            return;
        }

        Task* newTask = new Task(id, priority, executionTime, name);
        taskList.insert(newTask);
        taskMap[id] = newTask; // Add to hash table
    }

    // Execute tasks based on priority
    void executeTasks() {
        while (!taskList.isEmpty()) {
            Task* currentTask = taskList.remove();
            taskMap.erase(currentTask->taskID); // Remove from hash table
            std::cout << "Executing Task ID: " << currentTask->taskID
                      << " | Name: " << currentTask->taskName
                      << " | Priority: " << currentTask->priority
                      << " | Execution Time: " << currentTask->executionTime << " seconds." << std::endl;

            std::this_thread::sleep_for(std::chrono::seconds(currentTask->executionTime));
            delete currentTask;
        }
    }

    // Find task by ID
    Task* findTask(int id) {
        if (taskMap.find(id) != taskMap.end()) {
            return taskMap[id];
        }
        return nullptr;
    }
};

// Main function
int main() {
    Scheduler scheduler;
    int choice;

    do {
        std::cout << "1. Add Task\n2. Execute Tasks\n3. Exit\nEnter your choice: ";
        std::cin >> choice;
        if (choice == 1) {
            int id, priority, executionTime;
            std::string name;

            std::cout << "Enter Task ID: ";
            std::cin >> id;
            std::cout << "Enter Task Priority: ";
            std::cin >> priority;
            std::cout << "Enter Task Execution Time (in seconds): ";
            std::cin >> executionTime;
            std::cout << "Enter Task Name: ";
            std::cin.ignore(); // To ignore the newline character left in the input buffer
            std::getline(std::cin, name);

            scheduler.addTask(id, priority, executionTime, name);
        } else if (choice == 2) {
            scheduler.executeTasks();
        }

    } while (choice != 3);

    return 0;
}
```

ADVANTAGES:

- Efficient Task Prioritization and Management
- Real-Time Task Execution Capabilities
- Scalable Handling of Numerous Tasks
- Flexible Adaptation to Different Tasks
- Optimal Utilization of System Resources
- Quick Task Lookup and Retrieval
- Dynamic Adjustments to Task Priorities
- Modular and Clear System Design

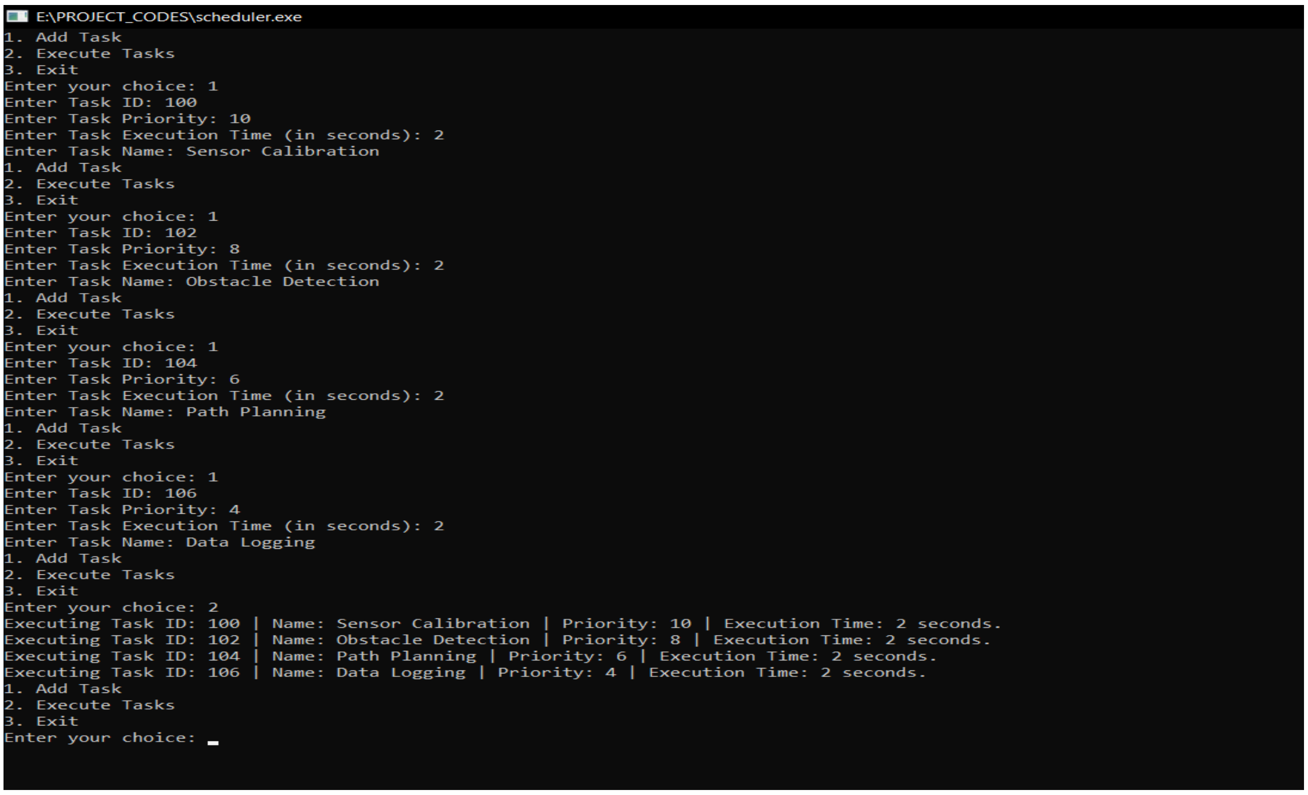
DISADVANTAGES:

- Limited to Priority-Based Scheduling Only
- Overhead in Task Management Operations
- Assumes Fixed Task Execution Time
- No Support for Task Dependencies
- Potential Resource Contention Issues

APPLICATIONS:

- Autonomous Vehicle Task Management
- Real-Time Operating Systems Task Scheduling
- Embedded Systems Process Management
- IoT Device Task Coordination
- Industrial Automation Task Execution
- Smart Home Systems Task Optimization
- Cloud Computing Task Scheduling
- Robotic Process Automation (RPA)
- Network Traffic Management in Routers
- Time-Critical Healthcare System Management

OUTPUT:



```
E:\PROJECT_CODES\scheduler.exe
1. Add Task
2. Execute Tasks
3. Exit
Enter your choice: 1
Enter Task ID: 100
Enter Task Priority: 10
Enter Task Execution Time (in seconds): 2
Enter Task Name: Sensor Calibration
1. Add Task
2. Execute Tasks
3. Exit
Enter your choice: 1
Enter Task ID: 102
Enter Task Priority: 8
Enter Task Execution Time (in seconds): 2
Enter Task Name: Obstacle Detection
1. Add Task
2. Execute Tasks
3. Exit
Enter your choice: 1
Enter Task ID: 104
Enter Task Priority: 6
Enter Task Execution Time (in seconds): 2
Enter Task Name: Path Planning
1. Add Task
2. Execute Tasks
3. Exit
Enter your choice: 1
Enter Task ID: 106
Enter Task Priority: 4
Enter Task Execution Time (in seconds): 2
Enter Task Name: Data Logging
1. Add Task
2. Execute Tasks
3. Exit
Enter your choice: 2
Executing Task ID: 100 | Name: Sensor Calibration | Priority: 10 | Execution Time: 2 seconds.
Executing Task ID: 102 | Name: Obstacle Detection | Priority: 8 | Execution Time: 2 seconds.
Executing Task ID: 104 | Name: Path Planning | Priority: 6 | Execution Time: 2 seconds.
Executing Task ID: 106 | Name: Data Logging | Priority: 4 | Execution Time: 2 seconds.
1. Add Task
2. Execute Tasks
3. Exit
Enter your choice: _
```

CONCLUSION:

In conclusion, the "Task Scheduler" project demonstrates the implementation of a priority-based task scheduling system for efficiently managing and executing real-time tasks. By utilizing data structures such as linked lists and hash tables, the system ensures optimal task execution based on their priority and execution time. The project successfully integrates tasks like sensor calibration, obstacle detection, path planning, speed control, and data logging, simulating real-world applications such as autonomous vehicles.The task scheduler not only emphasizes efficient resource utilization and real-time processing but also provides flexibility for handling various types of tasks in embedded and real-time systems. While there are limitations like overhead in task management and a lack of task dependency handling, the project serves as a valuable tool for understanding scheduling algorithms, task prioritization, and resource optimization.Overall, this project highlights the importance of task scheduling in modern systems and its practical applications in fields such as robotics, IoT, and real-time operating systems, providing a strong foundation for further advancements in task management and scheduling techniques.

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