COMPUTER ENGINEERING WORKSHOP

S.E. (CIS) OEL REPORT

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CONTENTS

CHAPTER 1

PROBLEM DESCRIPTION

To construct an integrated environmental monitoring system in C, covering a range of fundamental concepts and practical applications. The project involves interacting with a free API that provides real-time environmental data. The system's core functionalities include data retrieval, processing and reporting.

CHAPTER 2

METHODOLOGY

1. **API Integration**:

- This project interacted with a free API-open-meteo.com to retrieve real-time weather data which included **temperature**, **windspeed** and a boolean variable **is_day** to indicate if it is day or night.
- API endpoints are constructed dynamically to include parameters such as latitude, longitude, and weather variables.

2. **Dynamic Memory Management**:

- malloc and realloc is used to handle JSON responses of varying sizes.
- Efficient memory handling employed to minimize overhead during data parsing and storage, also to optimize data manipulation and enhance efficiency

3. **Data Retrieval and Parsing**:

- Weather data is fetched using the libcurl library.
- JSON responses are parsed using the cJSON library to extract relevant weather metrics for the cities: Karachi, Lahore, Islamabad, Quetta, and Peshawar.

4. **File Operations**:

- **Raw Data**: This project collected data for 5 major cities of Pakistan(which includes Karachi, Lahore, Islamabad, Quetta and Peshawar), and stored them in a text file. All fetched weather variables (i.e temperature, windspeed, is_day) for each city are saved in raw_data.txt.
- **Processed Data**: The average windspeed across the five cities is calculatd and stored the in processed_data.txt.

5. **Automation Using Shell Scripts**:

- Scripts are created to automate repetitive tasks such as compiling the program, running it periodically, and cleaning up files.
- cron jobs are used for scheduling periodic data retrieval.

6. **Real-Time Alerts**:

- Zenity is used to trigger alerts when windspeed or temperature exceeds a critical threshold.

7. **Code Modularity**:

- Codebase is organized into modular components using header files for improved readability and maintainability.
- Fetching, parsing, and processing logic is separated into distinct functions.

8. **Compilation and Execution**:

- A Makefile is used to streamline compilation and execution, including commands like make run for user convenience.
- Link against libcurl and cJSON libraries.

The program used the following files:

- weather_data.c
  - Functions included are:
    - send_alert → sends the user a popup showing the anomaly value
    - check_thresholds → checks against a set threshold values for normal operations
    - write_callback → append the incoming data into a memory buffer (MemoryChunk) and dynamically reallocates memory to accommodate the growing size of the data as more chunks are received
    - fetch_weather_data → fetches the weather data from the API
    - write_raw_data → appends data to raw data file
    - write_processed_data → appends data to processed data file
    - calculate_average_windspeed →calculates average windspeed for all 5 cities
    - main
- weather_data.h → declares the functions and structure used to hold weather data to modularize and enhance code readability
- fetch_weather.sh → helps automate the process of fetching weather data
- process_data.sh → processes the raw weather data and calculates the average wind speed
- Makefile → helps automate the compilation and running of the program
- raw_data.txt → stores all the weather data for each city, inclusing temperature, wind_speed and is_day
- processed_data.txt → stores the average windspeed calculated from the data of the five cities

CHAPTER 3

RESULTS

Raw data file:

raw_data.txt

```
City: Karachi, Wind Speed: 0.40, Temperature: 26.00, Is Day: 1
City: Lahore, Wind Speed: 2.30, Temperature: 17.60, Is Day: 1
City: Islamabad, Wind Speed: 1.30, Temperature: 16.40, Is Day: 1
City: Quetta, Wind Speed: 6.60, Temperature: 12.00, Is Day: 1
City: Peshawar, Wind Speed: 0.50, Temperature: 14.00, Is Day: 1
City: Karachi, Wind Speed: 10.80, Temperature: 31.10, Is Day: 1
City: Lahore, Wind Speed: 3.60, Temperature: 24.60, Is Day: 1
City: Islamabad, Wind Speed: 7.30, Temperature: 21.30, Is Day: 1
City: Quetta, Wind Speed: 8.10, Temperature: 18.60, Is Day: 1
City: Peshawar, Wind Speed: 4.20, Temperature: 20.50, Is Day: 1
City: Karachi, Wind Speed: 11.20, Temperature: 31.20, Is Day: 1
City: Lahore, Wind Speed: 3.30, Temperature: 24.90, Is Day: 1
City: Islamabad, Wind Speed: 6.80, Temperature: 21.50, Is Day: 1
City: Quetta, Wind Speed: 9.70, Temperature: 18.90, Is Day: 1
City: Peshawar, Wind Speed: 3.90, Temperature: 20.90, Is Day: 1
City: Karachi, Wind Speed: 12.60, Temperature: 29.00, Is Day: 1
City: Lahore, Wind Speed: 3.00, Temperature: 22.10, Is Day: 0
City: Islamabad, Wind Speed: 0.80, Temperature: 19.10, Is Day: 0
City: Quetta, Wind Speed: 12.60, Temperature: 17.20, Is Day: 1
City: Peshawar, Wind Speed: 5.40, Temperature: 17.50, Is Day: 0
City: Karachi, Wind Speed: 12.20, Temperature: 28.50, Is Day: 0
City: Lahore, Wind Speed: 3.30, Temperature: 21.60, Is Day: 0
City: Islamabad, Wind Speed: 0.00, Temperature: 18.80, Is Day: 0
City: Quetta, Wind Speed: 11.00, Temperature: 16.90, Is Day: 0
City: Peshawar, Wind Speed: 5.40, Temperature: 17.00, Is Day: 0
City: Karachi, Wind Speed: 12.20, Temperature: 28.50, Is Day: 0
City: Lahore, Wind Speed: 3.30, Temperature: 21.60, Is Day: 0
City: Islamabad, Wind Speed: 0.00, Temperature: 18.80, Is Day: 0
City: Quetta, Wind Speed: 11.00, Temperature: 16.90, Is Day: 0
City: Peshawar, Wind Speed: 5.40, Temperature: 17.00, Is Day: 0
```

Processed data file:

processed_data.txt

```
Average Wind Speed: 2.84
Average Wind Speed: 2.22
Average Wind Speed: 6.80
Average Wind Speed: 6.98
Average Wind Speed: 6.88
Average Wind Speed: 6.32
```