Vietnam National University,
Ho Chi Minh City

University of Science

Faculty of Information Technology

Project 02

CSC10007 – Operating System

Ngo Nguyen The Khoa 23127065

April 11, 2025

Contents

1 Group Information

- **Subject:** Operating System.
- **Class:** 23CLC09.
- **Lecturer:** Cao Xuan Nam, Dang Hoai Thuong.
- **Team members:**

No.	Fullname	Student ID	Email
1	Ngo Nguyen The Khoa	23127065	nntkhoa23@clc.fitus.edu.vn

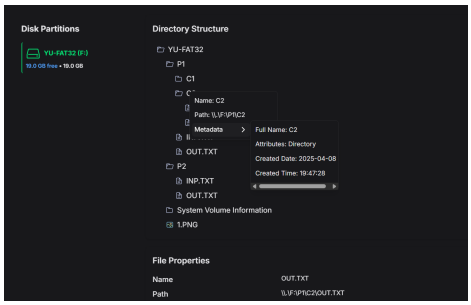
2 Project Information

- **Programming Language:** Rust, JavaScript.
- **Github Repo:**
  - The repo can be found here
  - The app installer can be downloaded here

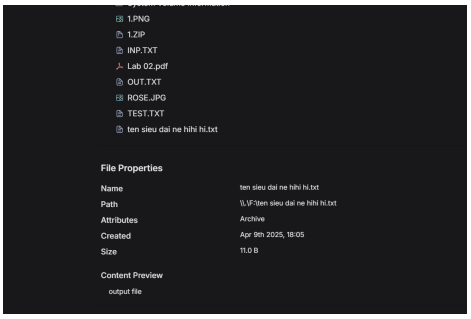
3 App Screenshots

(a) Home page

(b) About page



(c) Display directory tree with metadata on right-click



(d) Display text file

Figure 1: GUI App Screenshots

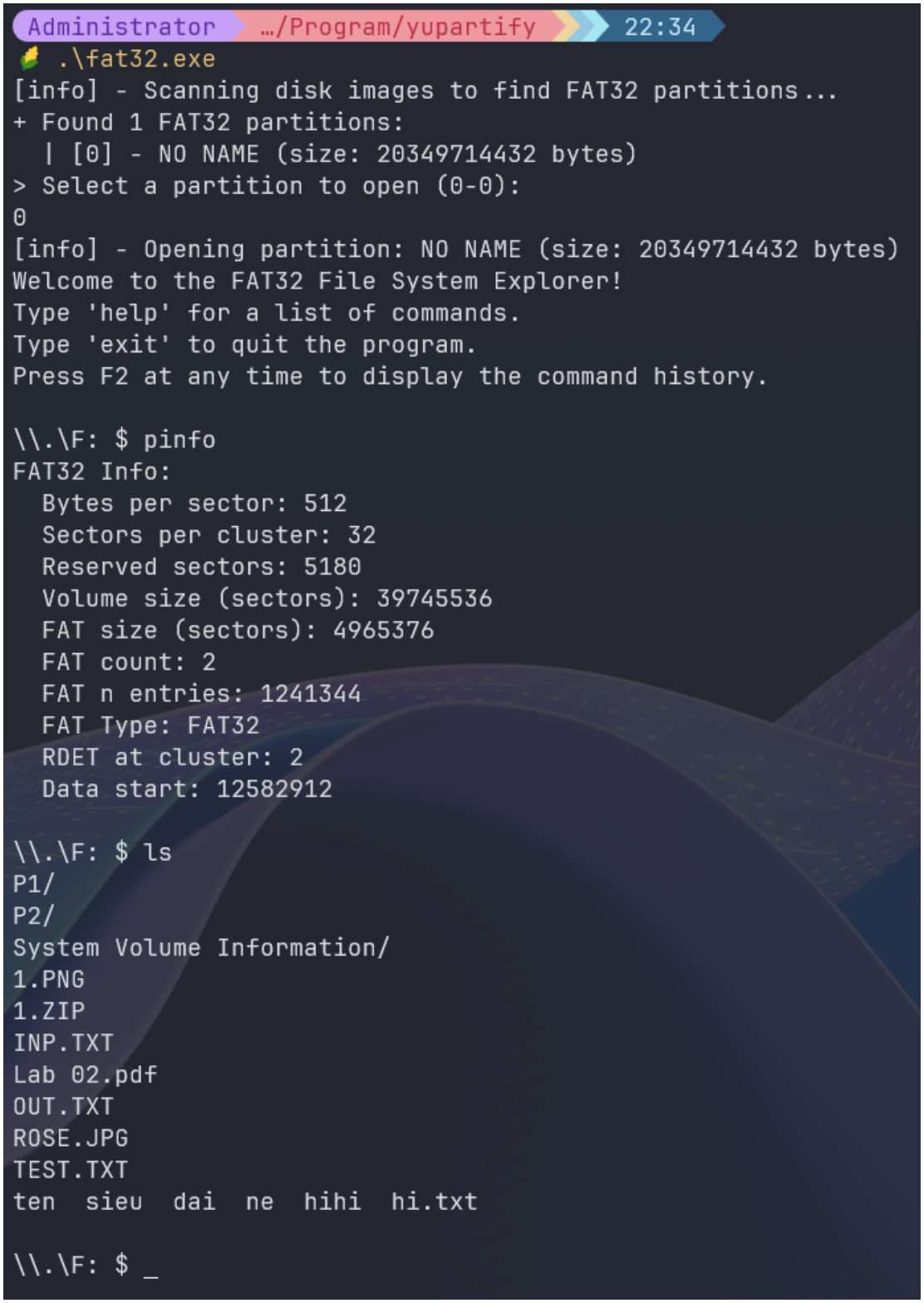


Figure 2: CLI Version

4 Project in details

4.1 Utility Function Implementations

Convert numbers from little-endian bytes

```rust
// src-tauri/src/utils/data/reader.rs
pub fn read_u16_le(bytes: &[u8]) -> u16;
pub fn read_u24_le(bytes: &[u8]) -> u32;
pub fn read_u32_le(bytes: &[u8]) -> u32;
pub fn read_u48_le(bytes: &[u8]) -> u64;
pub fn read_u64_le(bytes: &[u8]) -> u64;
```

Other helper functions

```rust
// src-tauri/src/utils/base.rs

// check if a file is a text file
pub fn is_text_file(path: &str) -> io::Result<bool>;

// calculate the size of a FAT32 partition based on the number of sectors used
pub fn calc_fat32_used_space(
    fats: &Vec<FATTable>,
    sectors_per_cluster: u64,
    bytes_per_sector: u64,
) -> u64;

// get attributes of a FAT32 file as a displayable string
pub fn format_attributes(attrs: u32) -> String;

// convert timestamp to a human-readable string
pub fn system_time_to_local_strings(time: SystemTime) -> (String, String);

// get the file metadata in a human-readable format
pub fn get_fat32_file_metadata(file: FATEntry) -> Result<FileMetadata, String>;
```

4.2 List partitions on a disk

Read MBR

```rust
// src-tauri/src/utils/data/reader.rs
pub fn read_mbr_disk(path: &str, partition_idx: Option<usize>) ->
↪  Result<Vec<PartitionRawInfo>> {
    if path.is_empty() || !path.starts_with(r"\\.\") {
        return Ok(vec![]);
    }
```

```

    if File::open(path).is_err() {
        return Ok(vec![]);
    }

    let mut file = File::open(path)?;
    let mut buffer = [0u8; 512];
    file.read_exact(&mut buffer)?;

    // Check boot signature
    if &buffer[0x1FE..] != [0x55, 0xAA] {
        return Err(std::io::Error::new(
            std::io::ErrorKind::InvalidData,
            "Invalid MBR boot sector",
        ));
    }

    let mut partitions = Vec::new();
    for i in 0..4 {
        // MBR disk has four partitions (16-byte entries)
        let offset = 0x1BE + i * 16;
        let entry = &buffer[offset..offset + 16];

        // ... handle partition entry
    }

    Ok(partitions)
}
```

List FAT32 partitions

```
// src-tauri/src/utils/list_partitions.rs

// list all fat32 partitions on all disks
pub fn list_fat32_paritions() -> Vec<(PartitionRawInfo, String)> {
    let mut part_list = Vec::new();

    for i in 0..32 {
        let path = format!(r"\\.\PhysicalDrive{}", i);
        match read_mbr_disk(&path, None) {
            Ok(partitions) => {
                if partitions.is_empty() && i > 0 {
                    break;
                }

                for partition in partitions.iter() {
                    if partition.raw_type.starts_with("FAT32") {
                        part_list.push((partition.clone(), path.clone()));
```

```
                    }
                }
            }
            Err(_) => {
                break;
            }
        }
    }

    part_list
}

// list all fat32 partitions on all disks with drive letter
pub fn list_fat32_paritions_by_letter() -> Vec<PartitionInfo> {
    (b'A'..=b'Z')
        .into_iter()
        .filter_map(|drive| {
            let drive_letter = format!("{}:", drive as char);
            match FAT32::open(&format!("\\\\.\\{}", drive_letter), None) {
                Ok(fat) => Some(PartitionInfo {
                    drive_letter,
                    label: fat.get_label(),
                    fs_type: fat.raw_part_info.clone().unwrap_or_default().raw_type,
                    total_size: fat.volume_size * fat.bytes_per_sector as u64,
                    free_space: fat.volume_size * fat.bytes_per_sector as u64 -
                    ↪  fat.used_space,
                }),
                _ => None,
            }
        })
        .collect()
}
```

4.3 Read FAT32 file system information

Read boot sector

```
// src-tauri/src/utils/data/parser.rs
pub fn parse_boot_sector(data: &[u8]) -> FAT32BootSector {
  let bytes_per_sector = read_u16_le(&data[0xB..0xD]);
  let sectors_per_cluster = data[0xD];
  let reserved_sectors = read_u16_le(&data[0x0E..0x10]);
  let volume_size = read_u32_le(&data[0x20..0x24]);
  let fat_count = data[0x10];
  let sectors_per_fat = read_u32_le(&data[0x24..0x28]);
  let root_dir_cluster = read_u32_le(&data[0x2C..0x30]);
  let fat_type = String::from_utf8_lossy(&data[0x52..0x52 + 8])
      .trim()
```

```
        .to_string();

    let fat_size = sectors_per_fat as u64 * bytes_per_sector as u64;
    let data_start = (reserved_sectors as u64 + fat_count as u64 * sectors_per_fat as
    ↪  u64)
        * bytes_per_sector as u64;

    FAT32BootSector {
        bytes_per_sector,
        sectors_per_cluster,
        reserved_sectors,
        volume_size,
        fat_count,
        sectors_per_fat,
        root_dir_cluster,
        fat_size,
        fat_type,
        data_start,
    }
}
```

Read FAT table

```
// src-tauri/src/models/fat_fs.rs
impl FATTable {
    pub fn new(data: Vec<u8>) -> Self;
    pub fn is_in_bounds(&self, cluster: u32) -> bool;
    pub fn get_cluster_chain(&self, start: u32) -> Vec<u32>;
}

// src-tauri/src/utils/data/reader.rs
pub fn read_fat_table(
    file: &mut File,
    fat_count: u8,
    fat_size: u64,
    fat_start: u64,
) -> std::io::Result<Vec<FATTable>> {
    let mut raw_fats = vec![0u8; fat_size as usize];
    let mut fats = vec![];

    file.seek(SeekFrom::Start(fat_start))?;
    for _ in 0..fat_count {
        file.read_exact(&mut raw_fats)?;
        fats.push(FATTable::new(raw_fats.clone()));
    }

    Ok(fats)
```

```
}
```

Read RDET

```
// src-tauri/src/models/fat_fs.rs
#[derive(Debug, Clone)]
pub struct FATEntry {
    pub path: String,
    pub name: String,
    pub short_name: String,
    pub extension: String,
    pub attributes: FATAttributes,
    pub created: SystemTime,
    pub modified: SystemTime,
    pub accessed: SystemTime,
    pub cluster: u32,
    pub size: u32,
    pub is_deleted: bool,
    pub is_directory: bool,
}

impl FATEntry {
    pub fn is_active(&self) -> bool;
    pub fn is_valid(&self, name: &str) -> bool;
}

impl DET {
    pub fn new(data: Vec<u8>, path: &str) -> Self;
    pub fn find_entry(&self, name: &str) -> Option<FATEntry>;
    pub fn get_active_entries(&self) -> Vec<FATEntry>;
}

#[derive(Debug)]
pub struct FATClusterManager {
    pub data_start: u64,
    pub sectors_per_cluster: u64,
    pub bytes_per_sector: u64,
}

impl FATClusterManager {
    pub fn get_cluster_size(&self) -> u64;
    pub fn get_cluster_offset(&self, cluster: u64) -> u64;
    pub fn read_cluster_data(&mut self, file: &mut File, cluster: u32) ->
    ↪ Result<Vec<u8>>;
    pub fn read_all_cluster_data(&mut self, file: &mut File, chain: Vec<u32>) ->
    ↪ Result<Vec<u8>>;
}

```

```rust
impl FAT32 {
    pub fn open(path: &str, raw_part_info: Option<PartitionRawInfo>) -> Result<Self> {
        // ...
        let mut all_det = HashMap::new();
        all_det.insert(
            root_dir_cluster,
            DET::new(
                cluster_manager.read_all_cluster_data(
                    &mut file,
                    fats[0].get_cluster_chain(root_dir_cluster),
                )?,
                &path,
            ),
        );
        // ...
    }
}
```

Read file content

```rust
// src-tauri/src/models/fat_fs.rs
#[derive(Debug)]
pub struct FATClusterManager {
    pub data_start: u64,
    pub sectors_per_cluster: u64,
    pub bytes_per_sector: u64,
}

impl FATClusterManager {
    pub fn get_cluster_size(&self) -> u64 {
        self.sectors_per_cluster * self.bytes_per_sector
    }

    pub fn get_cluster_offset(&self, cluster: u64) -> u64 {
        self.data_start + (cluster - 2) * self.get_cluster_size()
    }

    pub fn read_cluster_data(&mut self, file: &mut File, cluster: u32) ->
    ↪ Result<Vec<u8>> {
        let mut buffer = vec![0u8; self.get_cluster_size() as usize];
        file.seek(SeekFrom::Start(self.get_cluster_offset(cluster as u64)))?;
        file.read_exact(&mut buffer)?;
        Ok(buffer)
    }

    pub fn read_all_cluster_data(&mut self, file: &mut File, chain: Vec<u32>) ->
    ↪ Result<Vec<u8>> {
        if chain.is_empty() {
```

```
            return Ok(vec![]);
        }

        let mut data = Vec::new();
        for cluster in chain {
            data.extend(self.read_cluster_data(file, cluster)?);
        }

        Ok(data)
    }
}

impl FAT32FileSystem for FAT32 {
  // ...
  fn read_file(&mut self, path: &str, parse_text: Option<bool>) -> Result<(Vec<u8>,
  ↪  String)> {
    let entry = self.fetch_file(path);
    if entry.is_err() {
        return Err(entry.unwrap_err());
    }

    let entry = entry.unwrap();
    if !entry.is_active() {
        return Ok((vec![], String::new()));
    }

    let parse_text = parse_text.unwrap_or(false);

    let chain = self.structure.fats[0].get_cluster_chain(entry.cluster);
    let mut content = Vec::with_capacity(entry.size as usize);
    for cluster in chain {
        let data = self
            .structure
            .cluster_manager
            .read_cluster_data(&mut self.file, cluster)?;

        let limit = entry.size.min(data.len() as u32) as usize;
        content.extend_from_slice(&data[0..limit]);
    }

    let parsed_content = parse_file_content(&content);

    Ok((
        content,
        if parse_text {
            parsed_content
        } else {
            String::new()
        },
```

```
    ))
  }
  // ...
}
```

4.4 Use with GUI

Read directory tree

```
// src-tauri/models/fat_fs.rs
pub trait FAT32FileSystem: FileSystem {
    fn cd(&mut self, path: &str) -> Result<()>;

    fn list_rdir(&mut self) -> Result<Vec<FATEntry>>;
    fn list_dir(&mut self, path: &str) -> Result<Vec<FATEntry>>;

    fn fetch_file(&mut self, path: &str) -> Result<FATEntry>;
    fn fetch_metadata(&mut self, path: &str) -> Result<(FileMetadata,
    ↪  Option<FATEntry>)>;

    fn read_file(&mut self, path: &str, parse_text: Option<bool>) -> Result<(Vec<u8>,
    ↪  String)>;

    fn read_immediate_children(&mut self, path: &str) -> Result<DirectoryNode>;
    fn build_shallow_node(&mut self, path: &str) -> Result<DirectoryNode>;
}


// src-tauri/src/lib.rs
#[tauri::command]
fn get_children(path: String) -> Result<DirectoryNode, String> {
    let cur_drive = get_store_value("working_drive");
    if cur_drive.is_none() {
        return Err("No current drive found in store".to_string());
    }

    let cur_drive = cur_drive.unwrap();
    let part = format!("\\\\.\\{}", cur_drive["label"].as_str().unwrap());
    match FAT32::open(&part, None) {
        Ok(mut f) => match f.read_immediate_children(&path) {
            Ok(children) => Ok(children),
            Err(_) => Err("Error reading children".to_string()),
        },
        Err(_) => Err("Error opening FAT32".to_string()),
    }
}
```

Read file content

```rust
// src-tauri/src/lib.rs
#[tauri::command]
fn read_text_file(path: String) -> Result<String, String> {
    let cur_drive = get_store_value("working_drive");
    if cur_drive.is_none() {
        return Err("No current drive found in store".to_string());
    }

    let cur_drive = cur_drive.unwrap();
    let part = format!("\\\\.\\{}", cur_drive["label"].as_str().unwrap());
    match FAT32::open(&part, None) {
        Ok(mut f) => match f.read_file(&path, Some(true)) {
            Ok((_, content)) => Ok(content),
            Err(_) => Err("Error reading file".to_string()),
        },
        Err(_) => Err("Error opening FAT32".to_string()),
    }
}
```

5 References

1. nuxtor: Tauri + Nuxt starter template for the GUI.
2. DeepSeek, ChatGPT: AI Agents help to implement the FAT32 file system and write helper functions.
3. FAT32 explorer: Take inspiration from this Python implementation ver of FAT32 file system.