Fire Spread Detection and Simulation Application - User Guide

This tool uses AI-powered fire detection based on YOLOv5 and simulates the spread of fire over time under various environmental factors such as wind speed, temperature, and humidity.

Main Features:

1. **Fire Detection in Video/Images**: Analyze video or image frames to detect fire.
2. **Fire Spread Simulation**: Simulate the spread of fire over time, starting from a detected fire.
3. **Database Integration**: Store and retrieve fire-detected frames from a database.
4. **Configure Fire Spread Parameters**: Adjust wind direction, wind speed, temperature, and more to simulate real-world scenarios.

Installing the Application:

To install and run the application on your system, follow these steps:

1. **Clone the Repository**:

Open your terminal or command prompt and clone the GitHub repository:

```
% git clone https://github.com/ranekhuri/fire_detection.git
```

2. **Set Up a Virtual Environment (Recommended)**:

Create and activate a virtual environment to avoid dependency conflicts:

```
% python -m venv venv
```

```
% source venv/bin/activate
```

3. **Install Required Dependencies**:

Install all dependencies listed in the requirements.txt file:

```
% pip install -r requirements.txt
```

4. **Run the Application**:

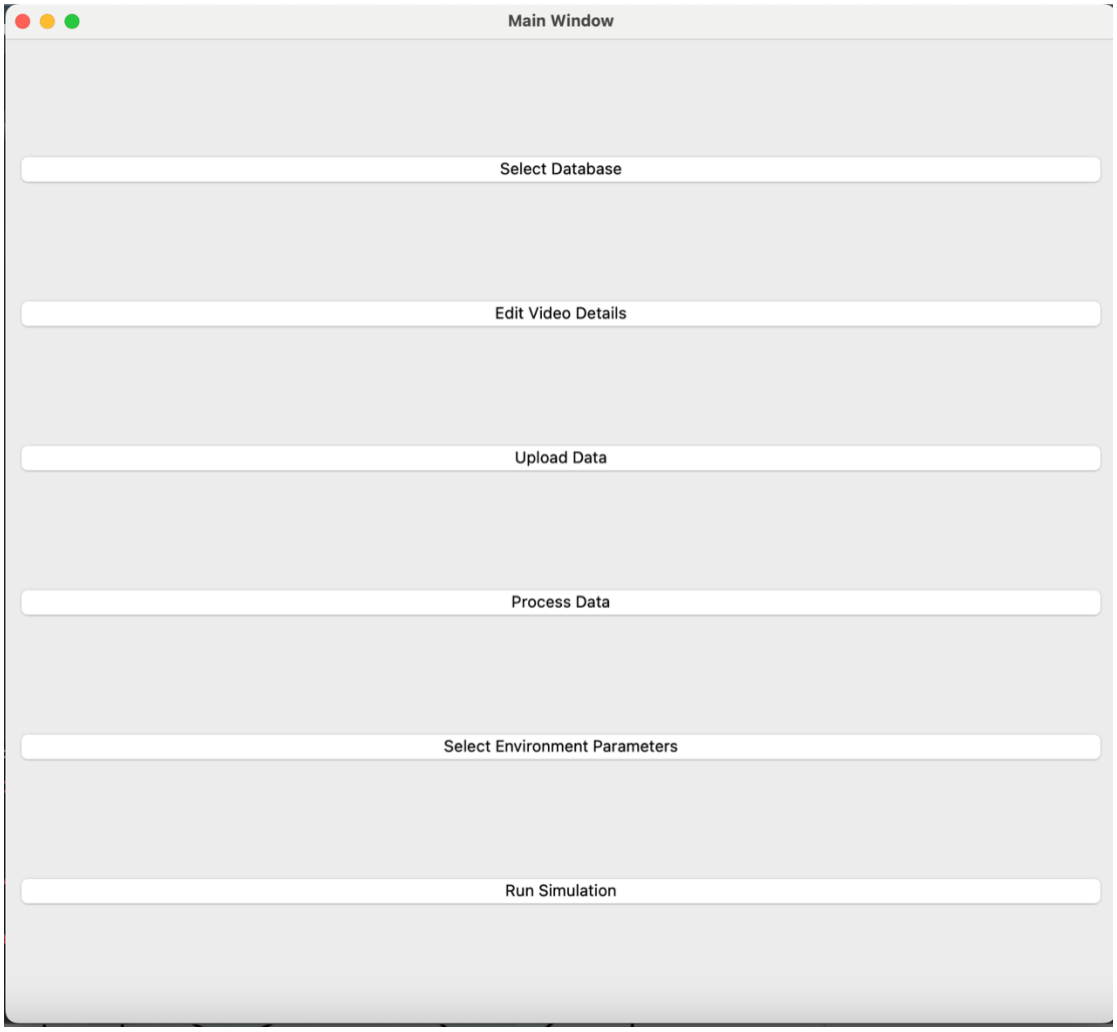
After setting up the environment and installing the dependencies, run the application:

```
% python main.py
```

How to Use the Application:

Main Application Dashboard

The **Main Window** serves as the central hub for accessing all key features of the application. From here, users can select a database, upload data, edit video details, process fire detection data, configure environmental parameters, and run fire spread simulations.



1.**Select Database**:

- Click the **“Select Database”** button to open the database management window.
- This allows users to choose or create a database to store and manage fire detection and simulation data.
- For detailed instructions, see the “Database Selection and Management” section.

2. **Edit Video Details**:

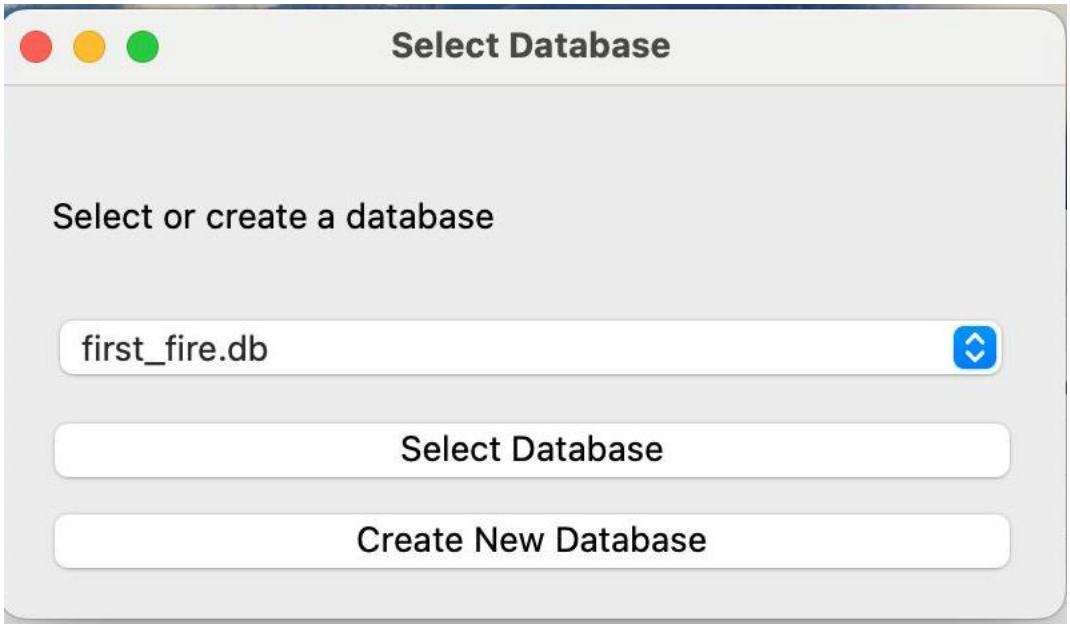
- Click the **“Edit Video Details”** button to open the video editing window.
- This feature allows users to modify metadata (e.g., timestamp, location, description) for videos that are stored in the database.

- The video editing functionality will be explained in the “Edit Video Details” section.

3. **Upload Data**:
   - Click the **“Upload Data”** button to upload images or videos containing fire detection data.
   - You can upload new media files, which will then be added to the database for further analysis.
   - This feature will be further explained in the “Uploading Data” section.
4. **Process Data**:
   - Click the **“Process Data”** button to analyze fire detection data from videos or images.
   - The system will process the selected media and detect fire, displaying the results with bounding boxes.
   - Detailed instructions are available in the “Processing Data” section.
5. **Select Environment Parameters**:
   - Click the **“Select Environment Parameters”** button to open the window for configuring environmental settings such as wind direction, wind speed, temperature, and humidity.
   - These parameters are used in the fire spread simulation to create realistic scenarios.
   - More information is available in the “Selecting Environment Parameters” section.
6. **Run Simulation**:
   - Click the **“Run Simulation”** button to initiate a fire spread simulation.
   - The simulation will predict how the fire will spread over a given period, based on the detected fire and the configured environmental factors.
   - Full details are in the “Running Fire Spread Simulation” section.

Database Selection and Management

The **Select Database** window allows users to select an existing database or create a new one to store fire detection frames, videos, and simulation data.



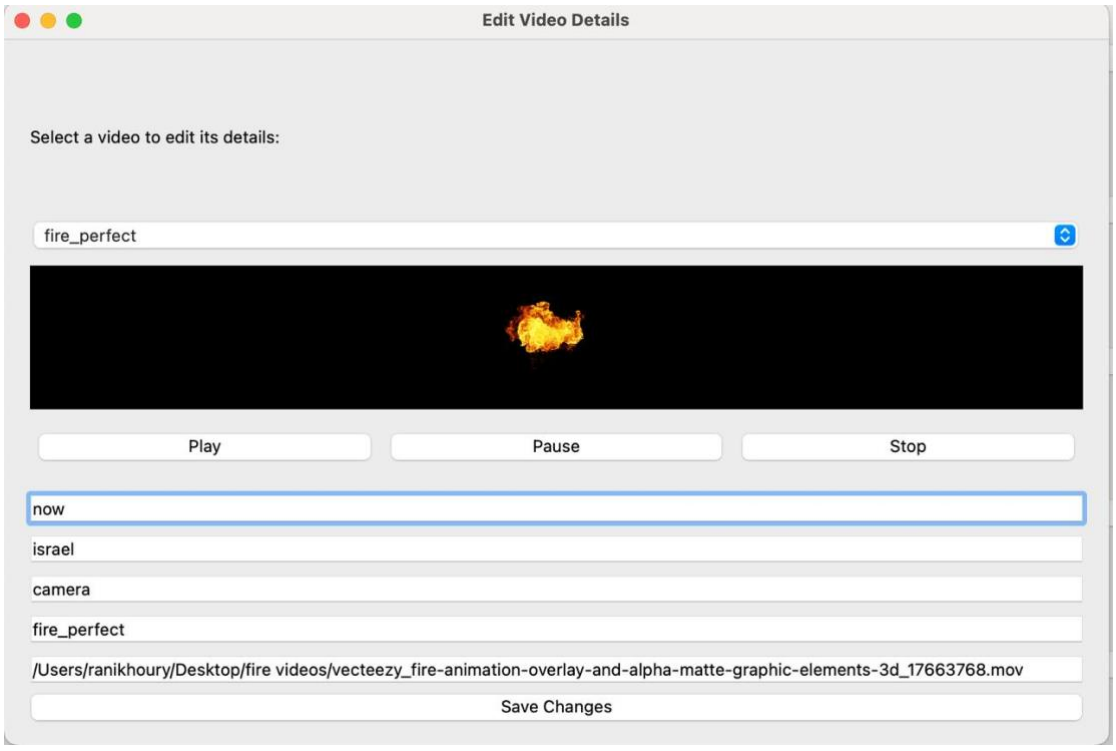
How to Use:

1. **Select an Existing Database**:
   - Upon opening the window, a **dropdown list** is displayed with available databases (e.g., first_fire.db, second_fire.db).
   - Select the desired database from the list.
   - Click the **"Select Database"** button to connect to the selected database.
   - A confirmation message will appear indicating that the database has been successfully connected.
2. **Create a New Database**:
   - If you wish to create a new database, click the **"Create New Database"** button.
   - A prompt will appear asking for the new database name.

- Enter the name for the new database (e.g., my_fire_data).
- The new database will automatically be created (with a .db extension if not provided) and connected.
- A confirmation message will indicate the successful creation and connection to the new database.
- The newly created database will also be added to the dropdown list for future use.

Editing Video Details

The **Edit Video Details** window allows users to modify metadata associated with a video stored in the database. This includes editing timestamps, locations, sources, descriptions, and video paths. Additionally, users can preview and control video playback within the application.



How to Use:

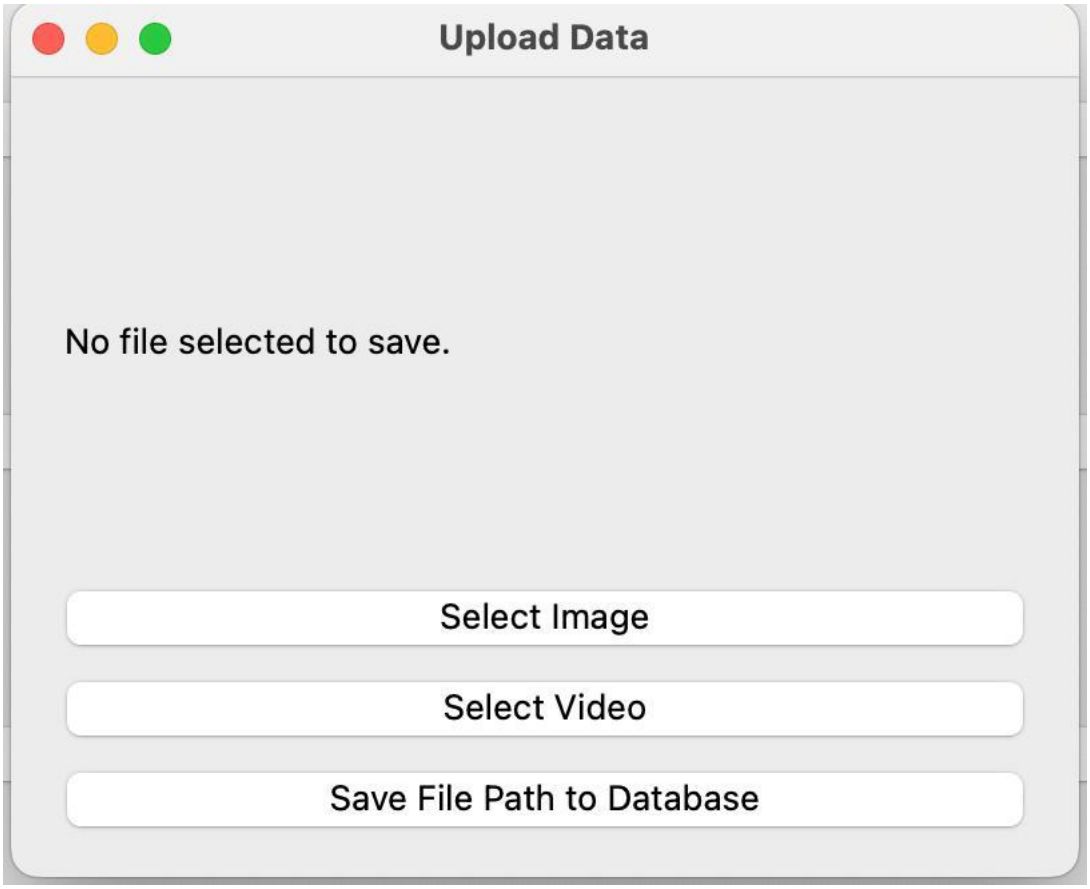
1. **Select a Video**:

- When the window opens, a **dropdown list** is displayed with all videos stored in the database.
- Select a video from the dropdown to load its details.

2. **Video Playback**:
   - After selecting a video, a video player will appear that allows you to preview the selected video.
   - Use the following controls:
     - **Play**: Starts video playback.
     - **Pause**: Pauses the video at the current frame.
     - **Stop**: Stops playback and resets the video to the beginning.
3. **Edit Video Details**:
   - Once a video is selected, its associated details (timestamp, location, source, description, and video path) are loaded into the text fields.
   - Edit any of these details by typing in the relevant text fields:
     - **Timestamp**: The date and time the video was captured.
     - **Location**: The location where the video was recorded.
     - **Source**: The origin of the video (e.g., camera, user upload).
     - **Description**: A brief description of the video.
     - **Video Path**: The file path of the video on the local machine.
4. **Save Changes**:
   - After editing the details, click the **"Save Changes"** button to update the video information in the database.
   - A confirmation message will appear once the changes have been successfully saved.

Uploading Data (Images and Videos)

The **Upload Data** window allows users to upload images or videos containing fire detection data. Once uploaded, the file paths are stored in the selected database for future processing and simulations.



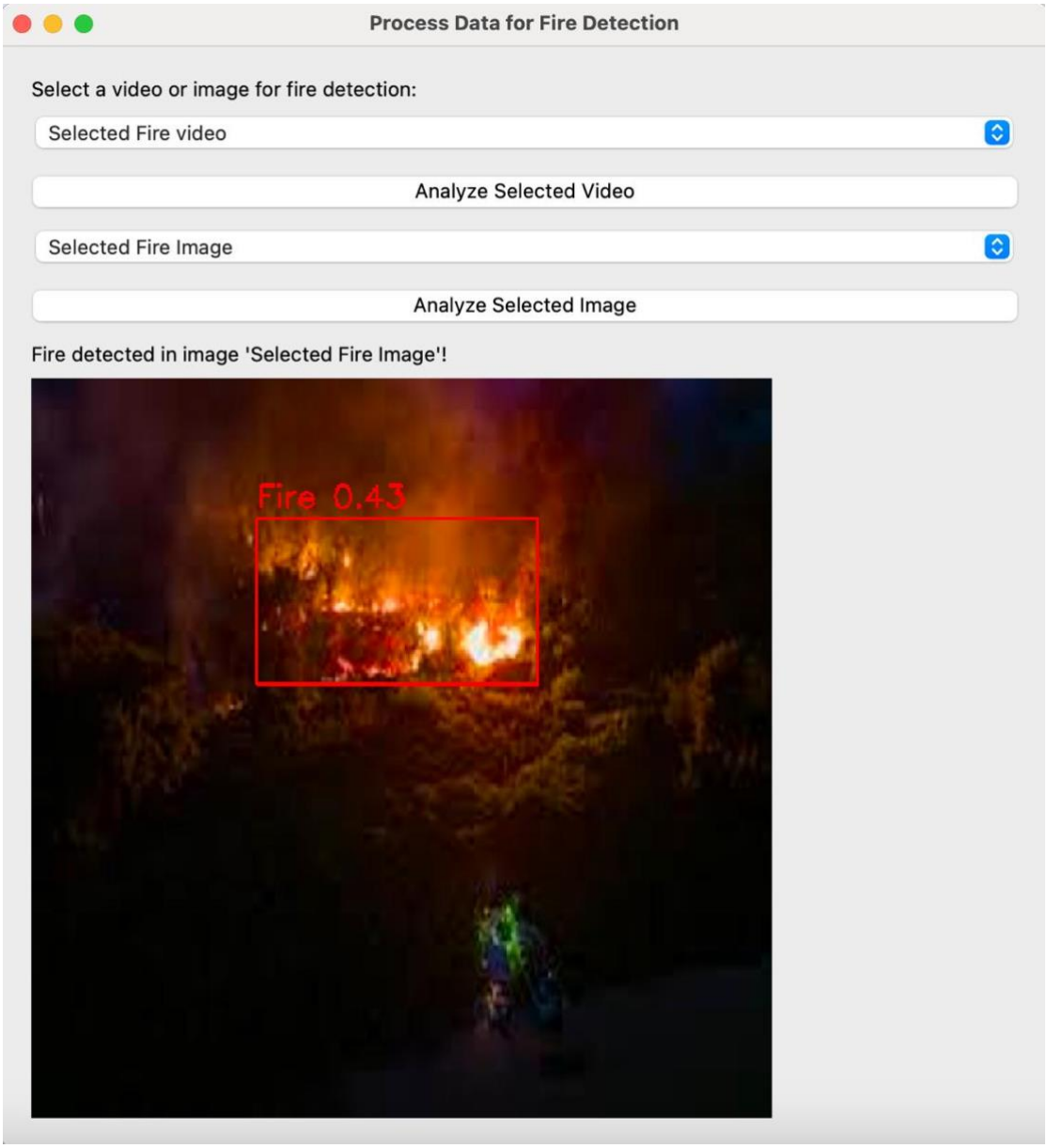
How to Use:

1. **Select an Image**:
   - Click the **"Select Image"** button to open a file dialog.
   - Browse your computer and select an image file in one of the supported formats: .png, .jpg, .jpeg, .bmp.
   - Once selected, the file path will be displayed under the **"Selected Image"** label.
2. **Select a Video**:
   - Click the **"Select Video"** button to open a file dialog.
   - Browse your computer and select a video file in one of the supported formats: .mp4, .avi, .mov, .mkv.
   - Once selected, the file path will be displayed under the **"Selected Video"** label.
3. **Save File Path to Database**:

- After selecting an image or video, click the **“Save File Path to Database”** button.
- If the file is an image, it will be saved to the **Images** table in the database.
- If the file is a video, it will be saved to the **Videos** table in the database along with default metadata (e.g., timestamp, location, source, description).
- A message will confirm that the file path has been successfully saved to the database.

Processing Data for Fire Detection

The **Process Data for Fire Detection** window allows users to analyze selected videos or images for fire detection using the trained YOLOv5 model. It can process media files stored in the database and provide real-time fire detection results.



How to Use:

1. **Select a Video for Fire Detection**:
   - In the **Select a video or image for fire detection** section, click the dropdown menu to select a video stored in the database.
   - The dropdown will display all videos available, showing their descriptions.
   - Once a video is selected, click the **"Analyze Selected Video"** button to start the fire detection analysis.
2. **Analyze the Selected Video**:

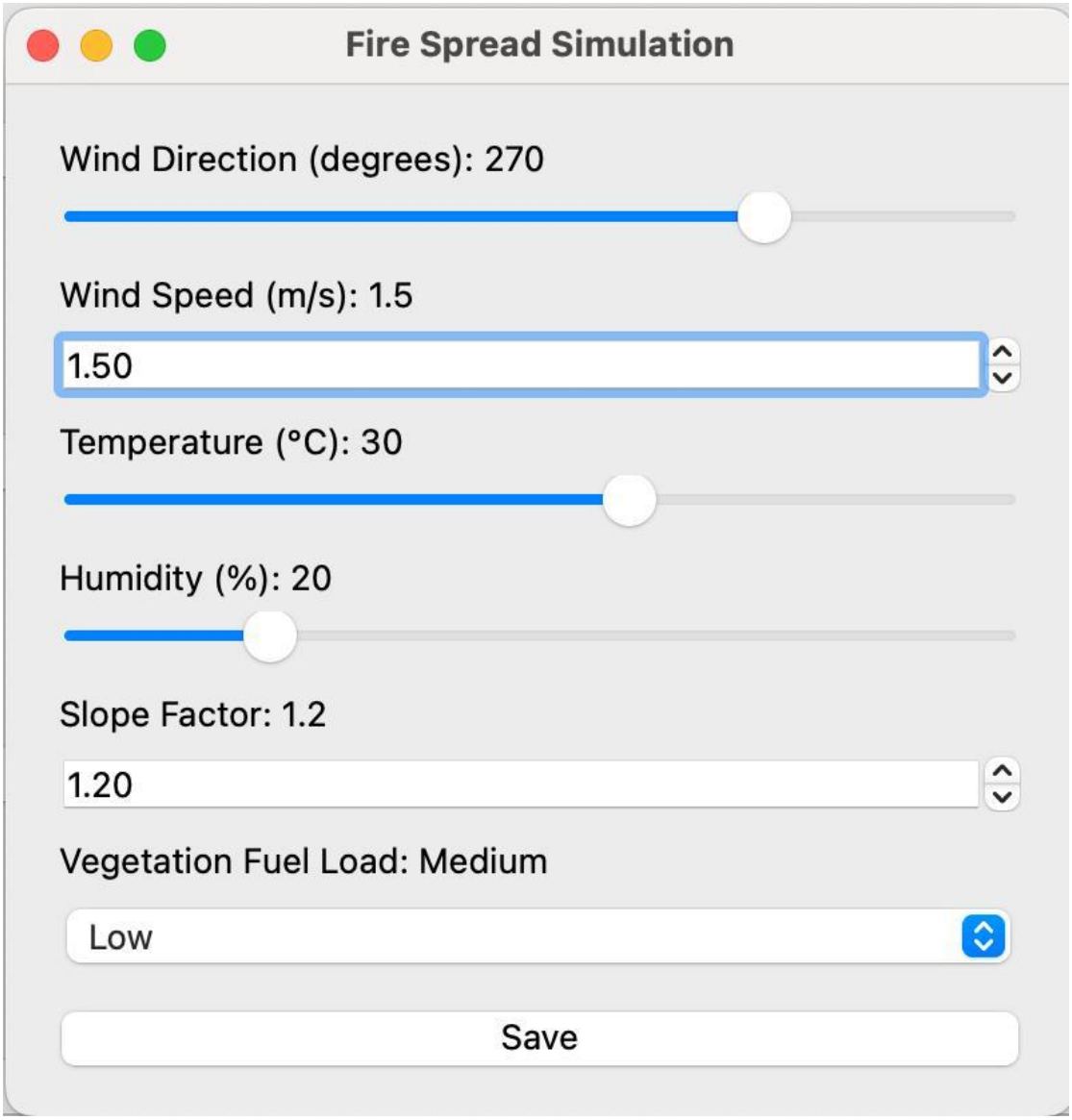
- After clicking **“Analyze Selected Video”**, the application will begin analyzing the video using a pre-trained fire detection model.
- The system processes video frames and searches for fire in each frame.
- If fire is detected, the application will display the video frame with a bounding box around the detected fire.
- The results will be displayed in the **“Fire Detection Result”** section, showing whether fire was detected or not.

3. **Select an Image for Fire Detection**:
   - In the same section, you can also select an image from the database by clicking the image dropdown menu.
   - After selecting an image, click the **“Analyze Selected Image”** button to start analyzing the image for fire detection.
4. **Analyze the Selected Image**:
   - Once you click **“Analyze Selected Image”**, the application will analyze the image using the same fire detection model.
   - If fire is detected, the image will be displayed with bounding boxes around the fire regions, and a success message will appear in the **“Fire Detection Result”** section.
5. **Viewing Fire Detection Results**:
   - After the analysis is complete (for both videos and images), the result will be displayed on the right side of the window.
   - If fire is detected, the frame or image will be shown with a bounding box highlighting the fire. If no fire is detected, the frame/image will still be displayed, but without bounding boxes.

Selecting Environment Parameters for Fire Spread Simulation

The **Select Environment Parameters** window allows users to configure various environmental factors that influence the fire spread simulation,

such as wind direction, wind speed, temperature, humidity, slope, and vegetation type.



How to Use:

1. **Set Wind Direction**:
   - Use the **Wind Direction** slider to set the wind direction in degrees. The default is 270°.
   - The slider ranges from 0° (East) to 360°.
   - The selected wind direction is shown in the label above the slider.
2. **Set Wind Speed**:

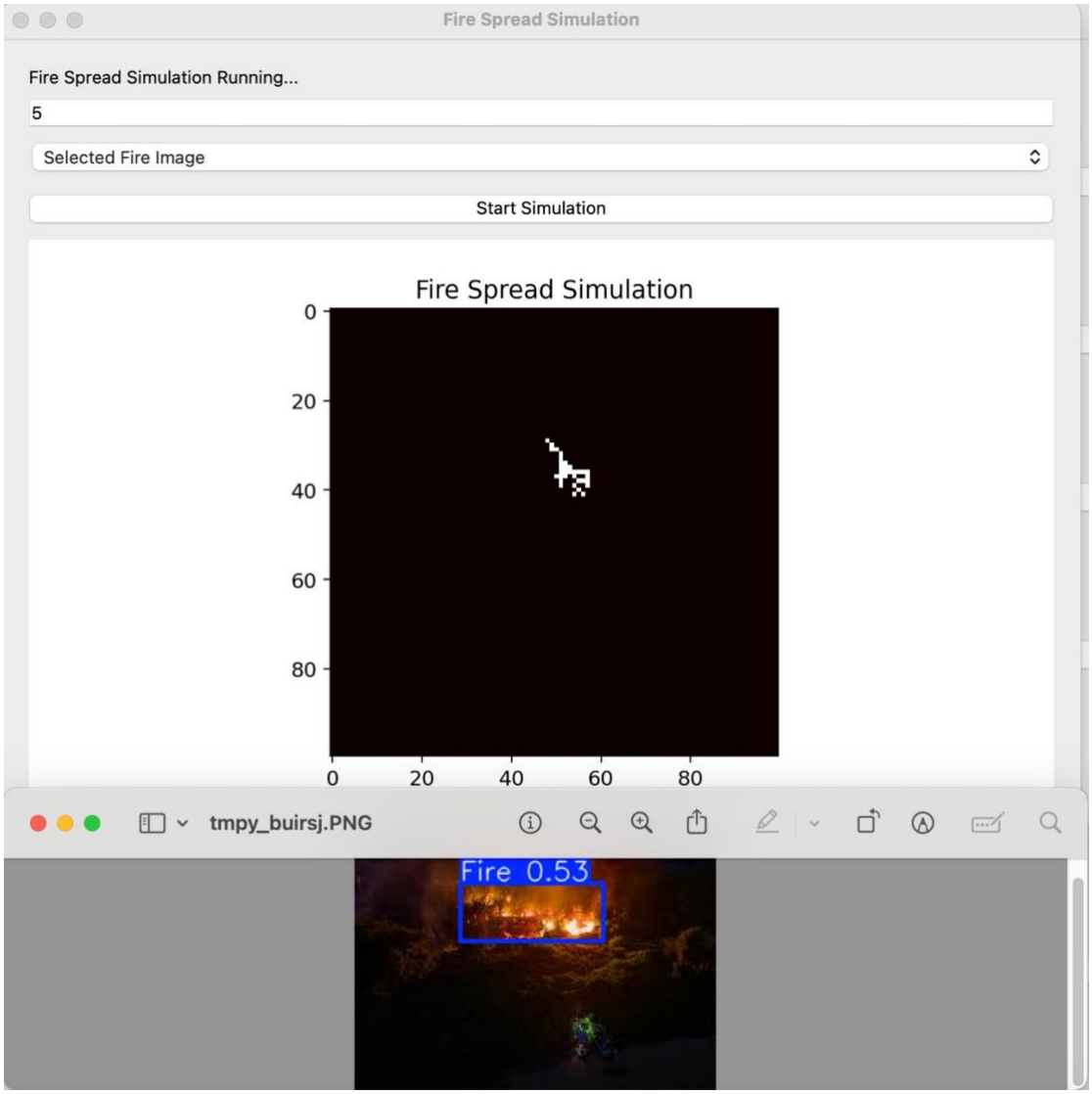
- Use the **Wind Speed** spinbox to set the wind speed in meters per second (m/s). The default is 1.5 m/s.
- You can adjust the speed between 0 and 10 m/s, with a precision of 0.1 m/s.
- The chosen wind speed is displayed in the label above the spinbox.

3. **Set Temperature**:
   - Adjust the **Temperature** slider to set the temperature in degrees Celsius (°C). The default is 30°C.
   - The temperature ranges from 0°C to 50°C.
   - The current temperature is displayed in the label above the slider.
4. **Set Humidity**:
   - Use the **Humidity** slider to set the relative humidity percentage. The default is 20%.
   - The slider allows values from 0% to 100%.
   - The selected humidity is displayed in the label above the slider.
5. **Set Slope Factor**:
   - Use the **Slope Factor** spinbox to set the slope of the terrain. The default is 1.2.
   - The slope factor ranges from 1.0 to 5.0, with a precision of 0.1.
   - The current slope factor is shown in the label above the spinbox.
6. **Select Vegetation Type**:
   - Select the vegetation type using the **Vegetation Fuel Load** dropdown menu.
   - You can choose between **Low**, **Medium**, and **High** fuel loads, with **Medium** being the default.
   - The chosen vegetation type is displayed in the label above the dropdown.
7. **Save the Parameters**:
   - After adjusting all environmental parameters, click the **Save** button to store these settings for use in the fire spread simulation.

- A message will appear displaying the selected parameters, which will be used in the simulation.

Running Fire Spread Simulation

The **Fire Spread Simulation** window allows users to simulate how a fire will spread over time based on environmental parameters and a starting fire-detected frame. The simulation visualizes the predicted spread of fire across a grid using configurable factors like wind speed, temperature, and humidity.



How to Use:

1. **Set Simulation Time**:
    - In the **“Enter simulation time in minutes”** input field, type the desired duration for the simulation. The duration must be entered as an integer (e.g., “5” for 5 minutes).
    - The simulation will predict where the fire will spread after this period.
2. **Select Fire-Detected Frame**:
    - From the **“Fire-detected frame”** dropdown menu, select a frame previously stored in the database.
    - The dropdown will display a list of available frames, each with a description.
3. **Start Simulation**:
    - Once you have set the simulation time and selected a frame, click the **“Start Simulation”** button to begin the fire spread simulation.
    - The application will use the selected frame as the starting point for the fire, along with environmental parameters like wind direction, wind speed, temperature, and vegetation.
4. **Visualize the Fire Spread**:
    - The simulation results are displayed on a **100x100 grid**, where each cell represents a portion of the simulated area (e.g., 5x5 meters).
    - The grid will show the fire’s predicted spread after the given time.
    - The visualization is updated in real-time as the simulation processes the spread over the calculated steps.
5. **Simulation Factors**:
    - The fire spread simulation incorporates environmental factors that you have previously set in the **Select Environment Parameters** window, including:
        - **Wind Direction**
        - **Wind Speed**

- **Temperature**
- **Humidity**
- **Slope**
- **Vegetation Fuel Load**

A Note of Thanks

We sincerely appreciate your use of our application. Your support and feedback play a crucial role in helping us enhance and develop more valuable tools. We hope this application serves your needs and aids you !in your work. Thank you