Usage Guide

1. **Launch the Program:**
    - Run the Python script to open the GUI window.
    - Or run the .EXE file to open the GUI window.
2. **Set Up Download Parameters:**
    - **Number of Images:** Enter the number of solar images you want to download.
    - **Time Interval (minutes):** Enter the time interval between downloads in minutes (e.g., `5` minutes).
    - **Start Image Number:** Enter the starting number for the image filenames.
    - **Save Images To:** Click the "Browse" button to select the directory where you want to save the downloaded images.
3. **Select the Image Source:**
    - From the drop-down list (combobox), select the source from which you want to download images.
4. **Start Downloading Images:**
    - Click the "Start Download" button to begin downloading the images.
    - **Status Updates:** Monitor status updates indicating the progress and time until the next image download.
5. **Stop Downloading Images:**
    - Click the "Stop Download" button to halt the download process. The program will stop downloading and provide a status update.
6. **Create MP4 Video from Images:**
    - **Frames per Second (FPS):** Enter the desired FPS for the video and click "Update FPS" to apply the value.
    - Click the "Create MP4 from Images" button to compile the images into an MP4 video.
    - The video will be saved in the same directory where the images are stored, named `output.mp4`.
7. **Program Closure:**
    - Click the close button on the window (the "X" icon) to exit the program. The program will ensure any ongoing processes are stopped before closing.

Description of Image Types and Corresponding Temperatures

1. **SDO/HMI Continuum**
    - **URL:** `https://soho.nascom.nasa.gov/data/realtime/hmi_igr/1024/latest.jpg`
    - **Description:** This image represents the continuum filtergrams from the Solar Dynamics Observatory's Helioseismic and Magnetic Imager (HMI). It captures the solar disk in a wavelength sensitive to the photosphere, providing detailed images of solar features like sunspots and granulation.
    - **Temperature:** Approximately 5,500°C (photosphere)

2. **SDO/HMI Magnetogram Image**
    - **URL:** `https://soho.nascom.nasa.gov/data/realtime/hmi_mag/1024/latest.jpg`
    - **Description:** This image shows the magnetic field strength on the solar surface, also from the HMI. Magnetograms highlight areas of strong magnetic fields and are crucial for studying sunspot regions and solar magnetic activity.
    - **Temperature:** Approximately 5,500°C (photosphere)
3. **EIT 171**
    - **URL:** `https://soho.nascom.nasa.gov/data/realtime/eit_171/1024/latest.jpg`
    - **Description:** Captured in the Extreme Ultraviolet (EUV) wavelength of 171 Ångströms by the Extreme Ultraviolet Imaging Telescope (EIT) on the SOHO spacecraft. It highlights the solar corona, revealing features such as coronal loops and active regions.
    - **Temperature:** Approximately 1,000,000°C (corona)
4. **EIT 195**
    - **URL:** `https://soho.nascom.nasa.gov/data/realtime/eit_195/1024/latest.jpg`
    - **Description:** An EUV image captured at 195 Ångströms by the EIT. This wavelength provides insights into the hotter parts of the solar corona, including coronal mass ejections and large-scale structures.
    - **Temperature:** Approximately 1,500,000°C (corona)
5. **EIT 284**
    - **URL:** `https://soho.nascom.nasa.gov/data/realtime/eit_284/1024/latest.jpg`
    - **Description:** This EUV image at 284 Ångströms offers a view of the solar corona in a different wavelength, highlighting regions with high temperatures such as solar prominences and flare regions.
    - **Temperature:** Approximately 2,000,000°C (corona)
6. **EIT 304**
    - **URL:** `https://soho.nascom.nasa.gov/data/realtime/eit_304/1024/latest.jpg`
    - **Description:** Captured at 304 Ångströms, this EUV image shows the solar chromosphere and lower corona. It is especially useful for observing prominences and active regions in the sun's atmosphere.
    - **Temperature:** Approximately 10,000°C to 100,000°C (chromosphere and lower corona)
7. **SDO/AIA 193**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_0193.jpg`
    - **Description:** This image from the Atmospheric Imaging Assembly (AIA) on the SDO spacecraft at 193 Ångströms provides a detailed view of the solar corona, focusing on high-temperature plasma regions.

- **Temperature:** Approximately 1,500,000°C (corona)

8. **SDO/AIA 304**
   - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_0304.jpg`
   - **Description:** Captured at 304 Ångströms, this AIA image highlights the solar chromosphere and lower corona, showing prominences and other features in the lower layers of the solar atmosphere.
   - **Temperature:** Approximately 10,000°C to 100,000°C (chromosphere and lower corona)
9. **SDO/AIA 171**
   - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_0171.jpg`
   - **Description:** This AIA image at 171 Ångströms shows the solar corona with a focus on active regions and coronal loops, providing insights into the sun's magnetic activity.
   - **Temperature:** Approximately 1,000,000°C (corona)
10. **SDO/AIA 211**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_0211.jpg`
    - **Description:** The AIA image at 211 Ångströms highlights the hot corona and active regions, revealing structures such as coronal loops and flare regions.
    - **Temperature:** Approximately 2,000,000°C (corona)
11. **SDO/AIA 131**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_0131.jpg`
    - **Description:** This image at 131 Ångströms provides a view of the solar corona and transition region, capturing high-energy phenomena such as solar flares.
    - **Temperature:** Approximately 5,000,000°C (corona)
12. **SDO/AIA 335**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_0335.jpg`
    - **Description:** Captured at 335 Ångströms, this AIA image shows the corona in a wavelength that highlights different aspects of solar activity and structure.
    - **Temperature:** Approximately 2,000,000°C (corona)
13. **SDO/AIA 094**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_0094.jpg`
    - **Description:** This image at 94 Ångströms reveals high-temperature features of the solar corona, including active regions and coronal loops.
    - **Temperature:** Approximately 5,000,000°C (corona)
14. **SDO/AIA 1600**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_1600.jpg`
    - **Description:** An AIA image at 1600 Ångströms provides a view of the solar chromosphere and transition region, useful for observing the solar atmosphere's lower layers.
    - **Temperature:** Approximately 10,000°C to 100,000°C (chromosphere and transition region)

15. **SDO/AIA 1700**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_1700.jpg`
    - **Description:** Captured at 1700 Ångströms, this AIA image focuses on the solar chromosphere and upper photosphere, highlighting features like sunspots and solar granulation.
    - **Temperature:** Approximately 4,000°C to 5,000°C (chromosphere and upper photosphere)
16. **SDO Composite 211-193-171**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_211193171.jpg`
    - **Description:** A composite image combining data from AIA channels at 211 Ångströms, 193 Ångströms, and 171 Ångströms. It provides a comprehensive view of various layers of the solar corona and active regions.
    - **Temperature:** Ranges from approximately 1,000,000°C to 2,000,000°C (corona)
17. **SDO Composite 304-211-171**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/f_304_211_171_1024.jpg`
    - **Description:** This composite combines images from AIA channels at 304 Ångströms, 211 Ångströms, and 171 Ångströms, offering a multi-wavelength view of the solar atmosphere.
    - **Temperature:** Ranges from approximately 10,000°C to 2,000,000°C (chromosphere and corona)
18. **SDO Composite 094-335-193**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/f_094_335_193_1024.jpg`
    - **Description:** A composite image combining data from AIA channels at 094 Ångströms, 335 Ångströms, and 193 Ångströms, highlighting different aspects of the solar corona.
    - **Temperature:** Ranges from approximately 1,500,000°C to 5,000,000°C (corona)
19. **SDO HMI Magnetogram 171**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/f_HMImag_171_1024.jpg`
    - **Description:** This magnetogram image shows the magnetic field distribution on the solar surface, providing insights into magnetic activity.
    - **Temperature:** Approximately 5,500°C (photosphere)
20. **SDO HMI Continuum Blue**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_HMIBC.jpg`
    - **Description:** An HMI continuum image with a blue filter, highlighting features of the solar surface.
    - **Temperature:** Approximately 5,500°C (photosphere)
21. **SDO HMI Continuum Intensitygram**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_HMIIC.jpg`

    - **Description:** An intensitygram from the HMI showing the solar surface in a continuum image, providing detailed views of sunspots and granulation.
    - **Temperature:** Approximately 5,500°C (photosphere)
22. **SDO HMI Continuum Full Disk**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_HMIIF.jpg`
    - **Description:** A full-disk continuum image from the HMI, covering the entire solar disk and capturing solar surface features.
    - **Temperature:** Approximately 5,500°C (photosphere)
23. **SDO HMI Intensitygram**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_HMII.jpg`
    - **Description:** This intensitygram image shows the solar surface with detailed views of granulation and sunspots.
    - **Temperature:** Approximately 5,500°C (photosphere)
24. **SDO HMI Dopplergram**
    - **URL:** `https://sdo.gsfc.nasa.gov/assets/img/latest/latest_1024_HMID.jpg`
    - **Description:** A Dopplergram from the HMI, capturing the velocity of material moving on the solar surface, which helps in studying solar oscillations and flows.
    - **Temperature:** Approximately 5,500°C (photosphere)

Configuration Details

- **Number of Images:** Specifies how many images to download.
- **Time Interval:** Time between each image download in minutes.
- **Start Image Number:** The number used to start naming the images.
- **Save Images To:** Directory path where images will be saved.
- **Frames per Second (FPS):** Determines how quickly images are shown in the video. A default of 24 fps is present.

Error Handling

- **Invalid Input Errors:** Ensure all input fields contain valid numeric values. Enter positive numbers where required.
- **Image Source Errors:** Verify that a valid image source is selected from the dropdown menu.
- **Directory Issues:** Check that the selected directory exists and is writable.

Detailed Description of How the Program Works

Overview

The Solar Image Downloader & MP4 Creator is a Python application designed to automate the process of downloading solar images from various online sources and compiling them into a video. The program features a graphical user interface (GUI) that allows users to specify parameters for image downloading and video creation.

Components

1. **Graphical User Interface (GUI):**
    - **Purpose:** Provides an interactive way for users to set parameters and control the download and video creation process.
    - **Libraries Used:** `tkinter` for GUI development.
2. **Image Downloading:**
    - **Purpose:** Fetches solar images from selected online sources at specified intervals.
    - **Libraries Used:** `requests` for making HTTP requests, `PIL` (Pillow) for handling image data.
3. **MP4 Video Creation:**
    - **Purpose:** Compiles downloaded images into an MP4 video with specified frames per second (FPS).
    - **Libraries Used:** `opencv-python` for video processing.

How It Works

1. **Initialization:**
    - The program starts by initializing global variables and setting up the GUI window using `tkinter`. It provides fields for user input and buttons to start, stop, and configure actions.
2. **User Input Configuration:**
    - **Number of Images:** Users specify how many images they want to download.
    - **Time Interval:** Users set the time interval between downloads in minutes.
    - **Start Image Number:** Users define the starting number for naming the downloaded images.
    - **Save Directory:** Users select the directory where images will be saved.
    - **Image Source:** Users select the solar image source from a predefined list.
3. **Starting the Download Process:**
    - When the user clicks the "Start Download" button, the `start_download` function is triggered. This function:
        - Validates user input to ensure all values are positive and correct.
        - Creates the target directory if it doesn’t exist.
        - Fetches images from the selected source URL at the specified intervals.
        - Saves each image with a filename that includes the current date and an incrementing number.
        - Provides status updates in the GUI and handles exceptions for errors such as network issues.
4. **Stopping the Download Process:**

    - If the user clicks the "Stop Download" button, the `stop_download` function sets a global flag to stop the downloading loop. The program halts the download process and updates the status.
5. **Creating the MP4 Video:**
    - After downloading the images, the user can compile them into an MP4 video by clicking the "Create MP4 from Images" button. This process involves:
        - Reading all JPEG images from the specified directory.
        - Sorting the images based on their filenames to ensure correct order.
        - Creating a video file using `opencv-python`, with each image added as a frame at the specified FPS.
        - Saving the video in the same directory as the images with the name `output.mp4`.
        - Providing feedback to the user about the video creation status.
6. **Handling GUI Events:**
    - The program responds to various GUI events, such as closing the window, updating FPS, and browsing directories. It ensures that any ongoing processes are properly managed and stopped if necessary.
7. **Error Handling:**
    - The program includes robust error handling to manage issues such as invalid input, network errors, and file handling problems. It provides informative messages to guide users in resolving issues.
8. **Program Closure:**
    - When the user closes the window, the `on_closing` function is called to ensure that any ongoing download processes are stopped, and the program exits gracefully.

FAQ

Q: How do I change the image source?
A: Use the dropdown menu to select a different image source.

Q: What should I do if the download fails?
A: Check your internet connection and ensure the image source URL is correct. Restart the program if needed.

Changelog

Version 1.0 (October 2023):

- Initial release with image downloading and MP4 creation features.

Version 2.0 (August 2024):

- Release with minor improvements in code execution and additional image sources.

Version 3.0 (September 2024):

- Includes threading so the download and movie making processes can execute simultaneously.
- Countdown timer between image downloads.

Acknowledgments

- **Author:** Thomas M. Van Pelt
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- **Libraries Used:**
  - `requests` for HTTP requests
  - `PIL` (Pillow) for image handling
  - `opencv-python` for video creation
  - `tkinter` for GUI development

License Information

Feel free to include this comprehensive documentation in your project's readme file or any accompanying documentation!