**Welcome to the Aquiplicity 2025 Motion Detector!  
 (User's Manual)**

Hello there! 👋 Welcome to your guide for the Aquiplicity 2025 Motion Detector. This handy web tool helps you visualize motion or changes within a specific segment of an **MP4 video file.**

Think of it like this: You pick a starting point in your video, decide how frequently you want to check for changes after that point, and tell the tool how sensitive it should be. It then compares a sequence of frames (up to 300 samples, or fewer if the video ends) against that starting frame and highlights **any pixel** that changed **at any point** during that sequence.

It's great for quickly identifying where activity occurred in security footage, analyzing time-lapses, or spotting differences in video recordings.

Let's dive in!

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1. Getting Started: Loading Your Video

It all begins with your video file.

* Click the **"Choose File"** button located in the top-left corner of the Controls Bar.
* Select an **MP4 video file** from your computer.
* The tool will load the video's metadata (like duration and dimensions). You'll see the video duration and estimated total frames appear next to the "Start Frame" label.
* An initial frame (around frame 25) will be displayed in the main viewing area (the canvas) to confirm the video loaded correctly.
* The controls (sliders and the "Detect Motion" button) will become active.

**(See? Easy!)**

2. The Interface: What You See

Let's get familiar with the layout:

* **Marquee Bar (Top):** This scrolling text provides a quick reminder of the tool's basic function and key parameters.
* **Controls Bar (Below Marquee):** This is your main command center! Here you'll find:
  + Choose File: To load your MP4 video.
  + Detect Motion: The big green button to start the analysis.
  + Reset: A red button to clear everything and start fresh.
  + Start Frame Slider: Selects the *reference point* in your video.
  + Frame Sample Interval Slider: Sets the *gap* between frames being analyzed.
  + Difference % Threshold Slider: Controls how *sensitive* the motion detection is.
* **Thumbnail Strip (Left Panel):** *(Currently inactive)* This area is reserved for potential future features, like displaying thumbnails of extracted frames. For now, it remains empty.
* **Working Area (Main Panel):** This is where the action happens!
  + Canvas: The large central area where your video's reference frame and the motion overlay are displayed. Before loading a video or after a reset, it will be blank.
  + Progress Bar: Appears below the canvas during frame extraction and detection, showing you how far along the process is.
  + Status Bar: Text below the progress bar that provides feedback on what the tool is doing (e.g., "Loading video...", "Extracting frames...", "Detection complete..."). **Pay attention to this!**
  + Save Result Image Button: Below the status bar, allows you to save the final image shown on the canvas.

3. The Core Workflow: Detecting Motion Step-by-Step

Using the tool generally follows these steps:

1. **Load Video:** Click "Choose File" and select your MP4. Wait for the initial frame to appear and the controls to activate.
2. **Select Start Frame:** Use the "Start Frame" slider to choose the exact moment in the video you want to use as your **reference point**. This is the frame all subsequent samples will be compared against. Watch the timestamp next to the slider to help you pinpoint the time.
3. **Set Sample Interval:** Use the "Frame Sample Interval" slider. This determines how many frames the tool *skips* between each sample it takes after the start frame. (More on this below!). Notice the (Max: ...) value changes based on your Start Frame!
4. **Adjust Sensitivity:** Use the "Difference % Threshold" slider to set how much a pixel needs to change (compared to the start frame) to be considered "motion".
5. **Detect!** Click the green "Detect Motion" button.
6. **Wait:** The tool will now extract the necessary frames based on your Start Frame and Interval settings (up to 300 subsequent samples, or until the video ends). It will then compare them to the Start Frame. Watch the Progress Bar and Status Bar for updates.
7. **View Results:** Once finished, the canvas will display the Start Frame image, with any detected changes overlaid in translucent **red**.
8. **Analyze/Adjust:** Look at the results. Does it show the motion you expected?
   * *Too much red?* Increase the "Difference % Threshold".
   * *Not enough red?* Decrease the "Difference % Threshold".
   * *Want to check a different time period?* Adjust the "Start Frame" and/or "Frame Sample Interval" sliders.
   * *Need to start over?* Click "Reset".
9. **Save (Optional):** If you're happy with the result, click "Save Result Image".

4. Understanding the Controls (The Nitty-Gritty)

Let's break down exactly what each control does:

* **Choose File Button:**
  + **Function:** Opens your system's file browser to select a video.
  + **Requirement:** Must be an **MP4** video file. Other formats won't work.
  + **Action:** Loads video metadata (duration, size) and displays an initial frame. Enables other controls.
* **Start Frame Slider:**
  + **Function:** Selects the *single frame* in the video that will serve as the **reference** for comparison.
  + **Display:** Shows the selected position as a percentage (%) of the total video duration and the corresponding timestamp (HH:MM:SS or MM:SS).
  + **Impact:** This is the **baseline**. The tool looks for differences *compared to this specific frame*. Changing this significantly impacts the results.
  + **Interaction:** Adjusting this slider recalculates the **maximum allowed value** for the "Frame Sample Interval" slider.
* **Frame Sample Interval Slider:**
  + **Function:** Controls the **gap** or spacing between the frames the tool analyzes *after* the Start Frame.
  + **Value Meaning:**
    - 0: Analyze **consecutive** frames (Start Frame, Start+1, Start+2, ...). Good for detailed analysis of a very short time period right after the Start Frame.
    - 1: Skip 1 frame between samples (Start Frame, Start+2, Start+4, ...).
    - N: Skip N frames between samples (Start Frame, Start+(N+1), Start+2\*(N+1), ...).
  + **Dynamic Maximum Value:** The maximum value (Max: ...) you can set depends on:
    - The selected **Start Frame**.
    - The **total duration** of the video.
    - The target number of samples (NUM\_FRAMES\_TO\_PROCESS, currently 300).  
      *Why?* The tool needs enough video time remaining after your Start Frame to take up to 300 samples with the chosen interval. If you select a Start Frame near the end, or choose a very large interval, the maximum allowed interval will decrease to prevent trying to sample frames that don't exist.
  + **Impact:** Determines the *time span* covered by the analysis after the Start Frame. A larger interval covers a longer duration but might miss very brief changes between samples.
* **Difference % Threshold Slider:**
  + **Function:** Sets the **sensitivity** of the change detection.
  + **Value Meaning:** It represents the average difference in color value (across Red, Green, Blue channels, from 0-255) required for a pixel to be flagged as changed, expressed as a percentage.
    - Low % (e.g., 5%): **More sensitive.** Smaller color changes will be marked as motion. Might pick up noise or compression artifacts.
    - High % (e.g., 50%): **Less sensitive.** Only significant color changes will be marked. Good for ignoring minor variations and focusing on large movements.
  + **Default:** Starts at 15%, a reasonable middle ground.
  + **Impact:** Directly controls how much red appears in the final overlay. Experimentation is key!
* **Detect Motion Button (Green):**
  + **Function:** Starts the main analysis process using the **current settings** of all three sliders.
  + **Process:**
    - Extracts the Start Frame.
    - Extracts up to 300 subsequent frames based on the Interval setting (or fewer if the video ends).
    - Compares *each* subsequent extracted frame to the Start Frame based on the Threshold setting.
    - Creates the red overlay map.
    - Displays the result.
  + **State:** Disabled until a video is loaded. Also disabled *during* processing.
* **Reset Button (Red):**
  + **Function:** Clears **everything** – the loaded video, the canvas display, the results, and resets all sliders to their default values.
  + **Use Case:** Use this when you want to load a completely different video or start a new analysis from scratch.
* **Save Result Image Button:**
  + **Function:** Saves the image currently displayed on the canvas (the Start Frame with the red motion overlay) as a **PNG file** named motion\_detection\_result.png.
  + **Availability:** Only works after a successful "Detect Motion" run that produced a result.

5. Understanding the Output: What Does the Red Mean?

The final image you see on the canvas after clicking "Detect Motion" consists of two layers:

1. **Base Layer:** This is simply the **Start Frame** you selected with the slider.
2. **Overlay Layer:** The translucent **red** areas highlight pixels where a change was detected.

**Crucially:** A pixel is marked red if its color value differed from the corresponding pixel in the **Start Frame** by more than the **Threshold %** in **ANY** of the subsequently sampled frames (up to 300 samples, respecting the Interval).

It **doesn't** show *when* the change occurred, only *that* a change happened at that pixel location *at some point* during the sampled sequence compared to the beginning (the Start Frame).

6. Tips and Tricks for Best Results

* **Target Your Start Frame:** Choose a Start Frame just *before* the period of activity you're interested in. This makes it the clean "before" state.
* **Interval Strategy:**
  + For **fast, brief events** right after the Start Frame: Use a **low interval (0-5)**. This samples densely over a shorter time.
  + To scan for **any change over a longer period**: Use a **higher interval**. Calculate roughly: Time Covered ≈ 300 \* (Interval + 1) / 30 seconds (assuming 30fps). A higher interval means you might miss very short events that happen entirely *between* samples.
* **Threshold Tuning:** Start with the default (15%).
  + If you see red speckles everywhere (noise), **increase** the threshold.
  + If obvious motion isn't being detected, **decrease** the threshold. Video quality and lighting affect this a lot.
* **Performance:** Frame extraction, especially with a low interval (many frames) or on large/long videos, can take time and use significant browser resources. Be patient! Watch the status bar. Closing other demanding browser tabs might help.
* **Interpreting Faint Red:** The overlay has some transparency (OVERLAY\_ALPHA = 0.3 or 30%). Even a fully "changed" pixel will appear as translucent red, allowing you to see the underlying Start Frame detail.

7. Best Practices

* **Know Your Goal:** Are you looking for *any* change, or changes within a specific few seconds? Adjust your Interval accordingly.
* **Start Simple:** Test with a short video or a small interval first to understand how the controls affect the outcome before processing very long segments.
* **Reset Between Analyses:** If you're analyzing different parts of the same video or switching videos, use the "Reset" button to ensure you're starting with a clean slate and default settings.
* **Check the Status:** The Status Bar gives crucial feedback on errors or progress.
* **Save Useful Results:** Don't forget to click "Save Result Image" if the detection reveals something important.

8. Troubleshooting & Known Limitations

* **Video Won't Load:**
  + Ensure it's a valid **MP4** file. Some .mp4 files might use internal codecs the browser doesn't support. Try re-encoding the video if possible.
  + Check the Status Bar for error messages.
  + Very large files might struggle.
* **Detection Takes a Very Long Time:**
  + This is expected for long videos or low intervals (extracting many frames).
  + Your computer's performance and browser impact speed.
* **"Extraction Failed" or Few Frames Extracted:**
  + This usually means the combination of your **Start Frame** and **Frame Sample Interval** tried to sample beyond the actual end of the video.
  + Try selecting an earlier Start Frame or reducing the Interval. Check the Status Bar message.
* **Timestamps/Frame Counts are Estimates:** The tool assumes a frame rate (around 30 FPS) to calculate timestamps and total frames. This might not perfectly match the video's actual frame rate, leading to slight inaccuracies.
* **Red Noise/Speckles:** Video compression can cause minor pixel variations between frames. Increase the **Difference % Threshold** to ignore these.
* **Thumbnail Strip:** As mentioned, this panel on the left is not currently functional.
* **Single Reference Point:** Remember, all changes are detected relative to the *single Start Frame* you select. It doesn't compare frame 5 to frame 6, frame 6 to frame 7, etc. It compares frame 5 to frame Start, frame 6 to frame Start, frame 7 to frame Start...

That's it! You're now equipped to use the Aquiplicity 2025 Motion Detector. Experiment with the controls, observe the results, and happy detecting!