

# Video Capture report

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Version 1

## **Introduction**

The Nanoro-M microscope is best suited to scanning static flat samples such as silicon chips.

The Nanoro-B microscope, targeting the study of biological samples, should be used at times for the study of living organisms. The very nature of life implies movement, be it growth, feeding, or reproduction, and to understand this, what could be better than to see it in action? For this, we need a form of video recording.

# Choices to be made

There are several ways of capturing video from the Nanoro-B microscope.

Either the software generates a video itself, or a recording is made of the microscope software in operation. To make a recording, there are two potential sources for the image stream: outside of the computer, from the HDMI cable, or inside the computer, the screen. Another option, pointing a camera at the computer screen is not considered due to the obvious deterioration in image quality. Capturing from the screen also provides us with options. Either we use software provided with the PC, or we install third party software.

That's a lot to take in, so let's summarize the options we need to discuss later.

| # | Recorder        | Overview                         |
|---|-----------------|----------------------------------|
| 1 | HDMI Recording  | Hardware solution                |
| 2 | Nanoro S/W      | LIG custom software              |
| 3 | Windows S/W     | Comes with the computer          |
| 4 | Third Party S/W | Requires additional installation |

There will be pros and cons with these solutions, my aim is to discuss these to better understand the choices to be made.

What are the factors that will help our choice?

| # | Factors         |  |
|---|-----------------|--|
| 1 | Video quality   | Video Format e.g. MPEG 2, MPEG 4                   |
|   |                 | Image Resizing (camera to screen, screen to video) |
|   |                 | Dimensions (width, height, frame rate)             |
| 2 | Recording speed | Dedicated hardware, graphics card, CPU             |
|   |                 | Fixed or variable                                  |
| 3 | Ease of use     | Button, Hotkeys, Menus                             |
| 4 | Compatibility   | Installed Codecs                                   |
|   |                 | Irregular Dimension Playback                       |
|   |                 | Input resolution problem                           |
| 5 | Hardware        | Potential file transfer from external recorder     |

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# Video Quality

## Format

There are numerous video formats. Since videos can contain audio and video content, and multiple streams, e.g. stereo (left and right) or multiple languages, there are often separate descriptions of the containers and the streams.

The container – roughly corresponds to the file created and its extension

Containing one or more video and audio streams. Defines which streams are present and how the streams are interleaved, etc.

The stream – roughly corresponds to the codec used for compression

For example a video stream created with a particular codec. Defines the system of compression, etc.

Some of the proprietary container formats are from well-known manufacturers

QuickTime (QT)

Apple

Audio Video Interleaved (AVI)

Microsoft

FlashVideo (FLV)

Adobe

WebM (WEBM)

Google

Moving Picture Experts Group (MPEG)

International Standards Organisation

From what I understand, any royalty payable would be on the codec, and if these are installed from reputable sources, e.g. came with Windows, then the royalty is paid by the reputable source and included in the cost of their product.

We wish to use an established format, supported by multiple manufacturers to allow the widest possible use of the video files we create. For this reason **I suggest we use MPEG-4 where possible, as the container format, and H.264 as the video stream format within that container.**

A proper discussion on codecs would be immense, but a quote from [Wikipedia on Advanced Video Coding](#) should be a persuasive argument for using H.264 where possible. There is also a section later: Compatibility, installed codecs.

*Advanced Video Coding (AVC), also referred to **as H.264 or MPEG-4 Part 10, Advanced Video Coding (MPEG-4 AVC), is a video compression standard based on block-oriented, motion-compensated coding.**[2] It is by far the most commonly used format for the recording, compression, and distribution of video content, **used by 91% of video industry developers** as of September 2019.*

See [H264 vs MPEG4 \(PDF\)](#) for more information.

The following links may be useful.

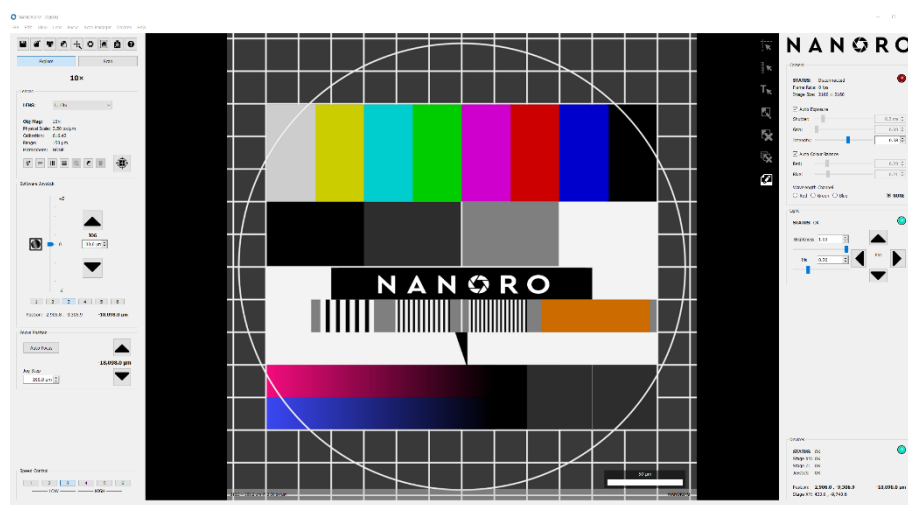
[https://en.wikipedia.org/wiki/Comparison\\_of\\_video\\_container\\_formats](https://en.wikipedia.org/wiki/Comparison_of_video_container_formats)



## Image Resizing

It is interesting to start a discussion about video quality by looking at the HDMI recorder solution. The camera on the Nanoro microscopes provide a large image, of which a square portion, 2160x2160 pixels is taken and used by the software. From this, the user selects a region of interest (ROI), occupying up to 80% of the image; 1728x1728 pixels. Although smaller than the usable camera image of 2160x2160, the image is merely trimmed. When the region of interest (ROI) is used, there is a loss of data, but no loss of image quality/resolution.

The computer screen I am using here is 2560x1440. A 1728x1728 pixel region of interest needs to be scaled down to fit within the 1440 screen height. The software also need space for the Graphic User Interface (GUI) controls.



Nanoro GUI

With the GUI and a windows task bar at the bottom of the screen, the area available for display of the microscope image is now reduced to approximately 1320x1320 pixels, and about 10% of irrelevance is added vertically, and a great deal more horizontally, if the aim is to capture the camera images, rather than operation of the GUI.

The 1440 vertical pixels from the screen are again resized into 1080 pixels, for the video recording, adding another step in the reduction of recorded image quality.

When the video is replayed, it could be on another screen, adding a further possibility for a reduction in the definition of the sample's features when finally viewed.

Video compression is another factor, affecting picture quality, but here I am considering just the step changes in the image size.

Let's make a list of the potential camera image resizing events.

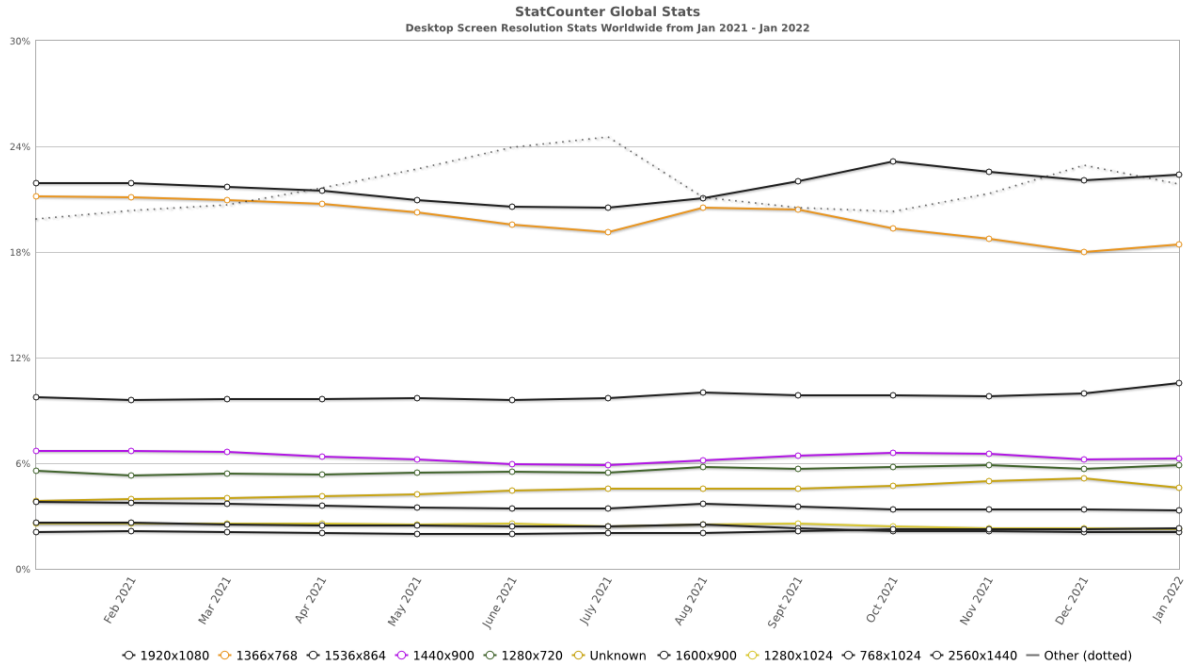
1. Camera image forced to fit as part of the application screen window: part of the desktop.
2. Desktop image potentially forced to fit into standard video size.
3. Replayed video forced to fit into replay software's screen window.

## Dimensions

### Common screen sizes

Later, in the section on Compatibility, Irregular Dimension Playback, we see that some programs – browsers in particular – appear to have problems playing back files with irregular sizes.

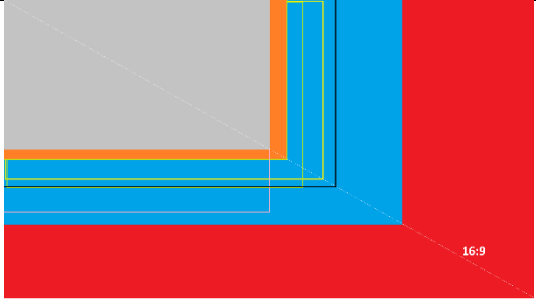
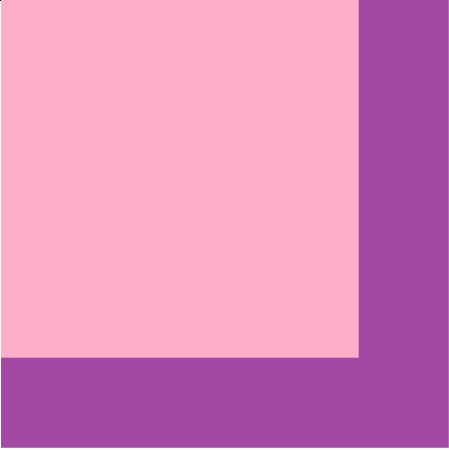
This is an advantage screen captures have over camera region of interest captures.



<https://gs.statcounter.com/screen-resolution-stats/desktop/worldwide>

From this, we can see that 1920x1080 is the most popular screen size as well as the size of full HD video.

Comparison between image sizes

|  |  |
|--|--|
|   |    |
| <p>Common screen sizes</p> <ul style="list-style-type: none"> <li>Red 2560x1440</li> <li>Blue 1920x1080 (Full HD, 1080p)</li> <li>Black 1600x900</li> <li>Pink 1280x1024</li> <li>Lime Green 1440x900</li> <li>Yellow 1536x864</li> <li>Orange 1366x768</li> </ul> | <p>Nanoro Image sizes</p> <ul style="list-style-type: none"> <li>Purple 2160x2160 (image from Nanoro camera)</li> <li>Pink 1728x1728 (maximum ROI)</li> <li>ROI is always square</li> <li>Minimum ROI is 10x10.</li> </ul> |



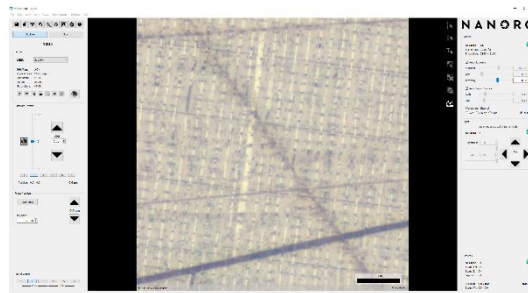
One way to produce a more standard video from the Nanoro region of interest would be to pad images to a larger size, i.e. embed the Nanoro camera ROI in a larger standard video frame size.



Illustration of square ROI embedded in a 16:9 video.

**Embedding square camera images in standard 16:9 video could be considered as an option later.**

Note that when the ROI of interest is embedded in a 16:9 video, the result is no longer very different from a screen capture.



Current Nanoro Screen View

Another option is to scale and embed the region of interest in a standard sized video.



Illustration of a square ROI scaled and embedded in a standard 16:9 video.

**Scaling is something which may be considered later too.**

Another way of treating strange ROI sizes, is simply to warn the user. For example most screen sizes are a multiple of 8, and there are 8 bits in standard computer memory bytes. This could well be a reason some programs fail to read some video files. Users could be warned or asked whether they wish to go ahead when the ROI width is a not a multiple of 8 pixels.

# Recording Speed

Dedicated hardware, graphics card, CPU

## Dedicated Hardware

An external video recorder (discussed later) uses its own dedicated hardware for video generation.

## Graphics card

An error message produced by OBS studio (also discussed later) demonstrates that it is attempting to use the computer's video card to do video compression.

## CPU

A program written to run on the as many computers as possible cannot make assumptions about the hardware present and must perform any video compression itself.

These different ways of compressing video have different impact on the execution speed of the Nanoro computer.

## Dedicated hardware

Dedicated hardware will have no performance effect on the Nanoro computer. Frames can be recorded on video faster than Nanoro receives them from the microscope.

## Graphics card

The dedicated hardware in a graphics card should offload some work from the main CPU and hence improve the performance of video generation. If this were not the case, there would be little point in having video compression hardware in a video card. Windows software appears to use hardware compression as the Xbox Game Bar can record my whole screen as video with no noticeable drop in performance.

## CPU

Video compression by the CPU takes a noticeable amount of time. This is an assumption I make – an educated guess – from observing the speed a video can be created using Open CV. With a large region of interest the recording speed is a disappointing frame every ~3 seconds. With a smaller region of interest the recording rate can be a frame per second.

While the recording speed of the OpenCV library appears disappointing it should be noted that the images used can be larger than most computer screen (see the section on image sizes) and the time lapse capability of the Nanoro video capture feature is not available with many other methods of video capture.

**A hybrid approach may be the best solution to video recording. Nanoro software for high resolution time lapse video, and another for lower resolution real time recording.**

## Fixed versus variable speed recording

[www.ted.com](http://www.ted.com) > talks > transcript

### Ramesh Raskar: Imaging at a trillion frames per second - TED



Ramesh Raskar presents **femto**-photography, a new type of imaging so fast it visualizes the world one trillion ...

TED · 26 Jul 2012

When creating a video recording of a biological process, it is necessary to understand the rate at which the process takes place to record it properly. There is a video on the internet with femtosecond recording where we can see a slow motion replay of a light travelling through a plastic bottle.

Another experiment on the viscosity of bitumen has been taking place over a period of years.

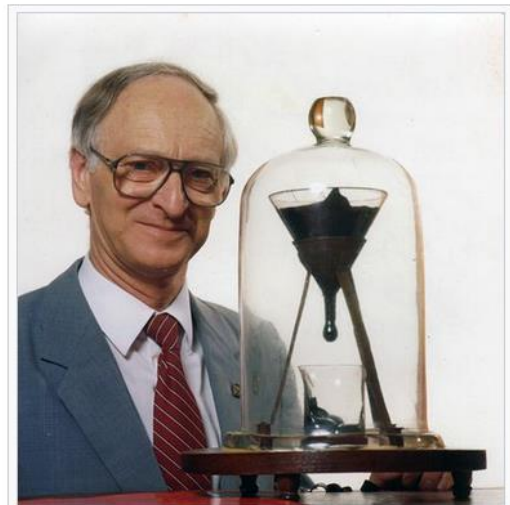
These extremes show that the duration of an experiment can vary greatly. The recording frame rate needs to be appropriate when generating a video recording. So what are typical durations of the biological events someone may wish record?

A naïve online search for how long it takes a baby to double in weight produced this quote. *“Expect your baby to double his or her birth weight by about age 5 months.”* Another search on cell division gave a rate of one division per cell per day as an example.

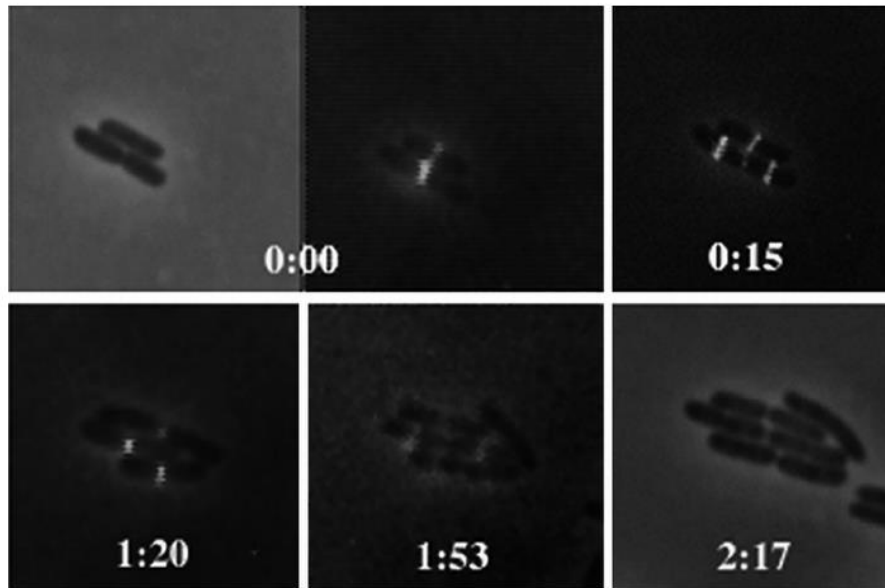
Asking our biologist, Francesco, gave me a figure of 20 minutes for the doubling rate of the widely studied *E. coli* bacteria. A published paper on the growth and division of these bacteria shows 5 still images with time stamps. It is noteworthy that the timestamps are in hours and minutes, not minutes and seconds.

**Solutions to the problem of recording video should consider whether both time-lapse and real time video generation are required.**

**For example the so called “Xbox Game Bar” feature of the Windows operating systems is designed for recording game play and does not allow the frame capture rate to be varied.**



The [University of Queensland](#) pitch drop experiment, featuring its custodian, Professor John Mainstone (taken in 1990, two years after the seventh drop and 10 years before the eighth drop fell).



Growth and division of *E. coli* microcolonies expressing FtsZ-GFP and FtsZ, showing that FtsZ rings containing FtsZ-GFP function normally. Two consecutive cell division cycles are shown, using conventional fluorescence microscopy. The first and last panels are phase-contrast images; note that the last time point lacks a fluorescence image. The other panels were obtained by a digital overlay of phase-contrast and fluorescence images at the times shown. Times are shown in hours and minutes. Note the simultaneous formation of daughter FtsZ rings and contraction of the midcell ring at 0:15 in the bottom cell and at 1:53 in two daughter cells of the original bottom cell.

It therefore seems sensible that a biological microscope be capable of performing time-lapse photography in the same way that videos are created of clouds rolling across the sky.

# Ease of Use

## Buttons, Hot Keys and Menus

Instigation of video recording can be a simple operation even if the configuration is complicated.

In many cases, a video may be created in the same file format as a previous video. Even in the case of a new video, configuration may be a separate task from recording. Configuration for example may be done by a settings dialog, where the settings stay in place until changed later.

In cases where video recording **configuration** is stored as a separate activity to **instigating** the recording, starting and stopping recording can be as simple as pressing a so called “Hot Key”.

An example of a “Hot Key” is WINDOWSKEY-G, which toggles the Xbox Game Bar.

On a heavily used system, ease of use will be important. On a lightly used system, ease of set-up may be more important.

Most video recording software appears to follow the pattern: settings configuration, and hot-key instigation.

A particularly easy to use system is the hardware recorder discussed later, which has a single button which starts and stops recording.

**The Nanoro software requires more key presses to record, as recording is driven by a dialog box where video format must be chosen, frame rate, recording length, etc.**

# Compatibility

## Installed Codecs

It is possible to check the list of installed codecs on a windows computer.

<https://www.thewindowsclub.com/how-to-check-installed-codecs-on-windows-10>

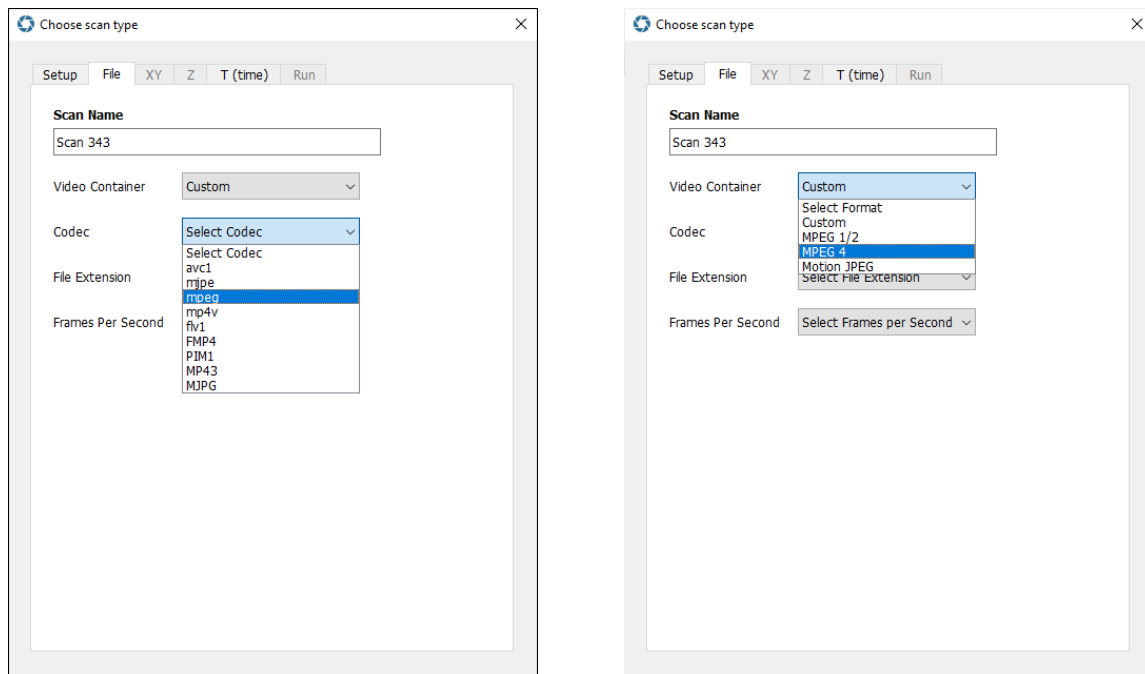
The codec used for a video stream in a video container is usually identified by a four character code. The four character code can also be said to describe the format of the video stream so multiple vendors could create a codec for 'DIVX' or 'H264' and a codec with the capability to handle H264 streams might also handle H265.

The number and variety of codecs is endless. Here are a couple of lists of "four character codes": identifiers used to distinguish one codec or compression technique from another.

[List-of-FourCC-codes-for-video-codecs](#)

<https://www.fourcc.org/codecs.php>

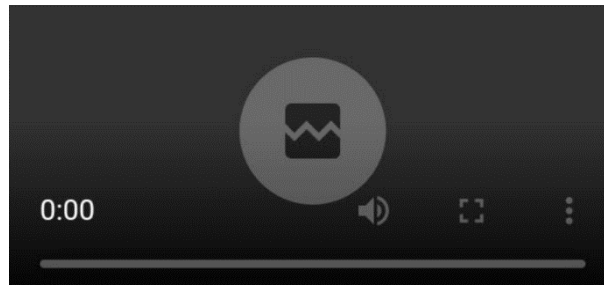
The following list (ON THE LEFT) of four character codes identifying codecs, is currently in use in Nanoro video development and reflects the currently installed codecs.



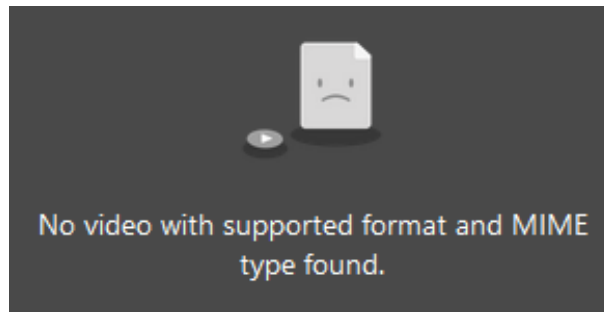
The drop down list (ON THE RIGHT) shows the list of video containers. The encouraged formats are named and fix the appropriate codec. The custom option is discouraged but allows the other codecs to be used.



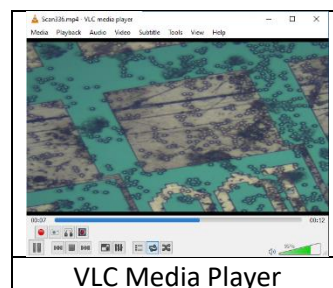
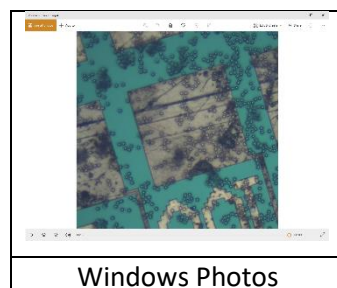
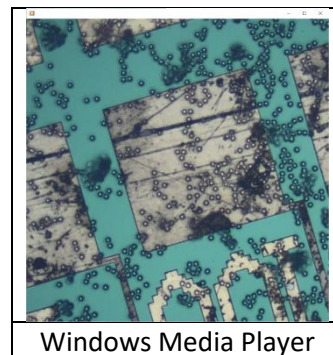
## Irregular Dimension Playback



This is part of a screen capture from the Chrome browser on my phone trying to play a video file with irregular dimensions. Similar results will be found using the Firefox browser on a PC.



The files do however play in the usual media player programs, showing that the files are correctly produced, just using less-standard dimensions.



Video players cope better than browsers



## Input resolution problem

There is a problem using the HDMI recorder shown. Not only is the output quality restricted to 1080p Full HD, but the input quality is restricted to 1080p Full HD too.



| Parameter                 | Illustration   |
|---------------------------|--|
| PowerSupply               | 12V1ADCPowerSupply   |
| HDMIsignal                | HDMI1.3supportsHDCP  |
| HDMILoopoutput            | HDMI1.3supportsHDCP  |
| HDMIInputResolution       | 720x480p(60),720x576p(50),1280x720p(50),1280x720p(60),1920x1080i(50),1920x1080i(60),1920x1080p(24),1920x1080p(25),1920x1080p(30),1920x1080p(50),1920x1080p(60) |
| HDMIOutputresolution      | 720x480p(60),720x576p(50),1280x720p(50),1280x720p(60),1920x1080i(50),1920x1080i(60),1920x1080p(24),1920x1080p(25),1920x1080p(30),1920x1080p(50),1920x1080p(60) |
| Recordingresolution       | 720x480p(60),720x576p(50),1280x720p(50),1280x720p(60),1920x1080i(50),1920x1080i(60),1920x1080p(24),1920x1080p(25),1920x1080p(30)                               |
| RecordingformatVideo :    | MP4; Audio: AACStereo  |
| RecordingqualityHighest : | 16Mbps@1080P30fps  |

What is the impact of this restriction?

## Display

Change the size of text, apps and other items

Advanced scaling settings

Display resolution

- 1920 × 1080 (Recommended)
- 1680 × 1050
- 1600 × 900
- 1440 × 900
- 1400 × 1050
- 1366 × 768
- 1360 × 768
- 1280 × 1024
- 1280 × 960

## Scale and layout

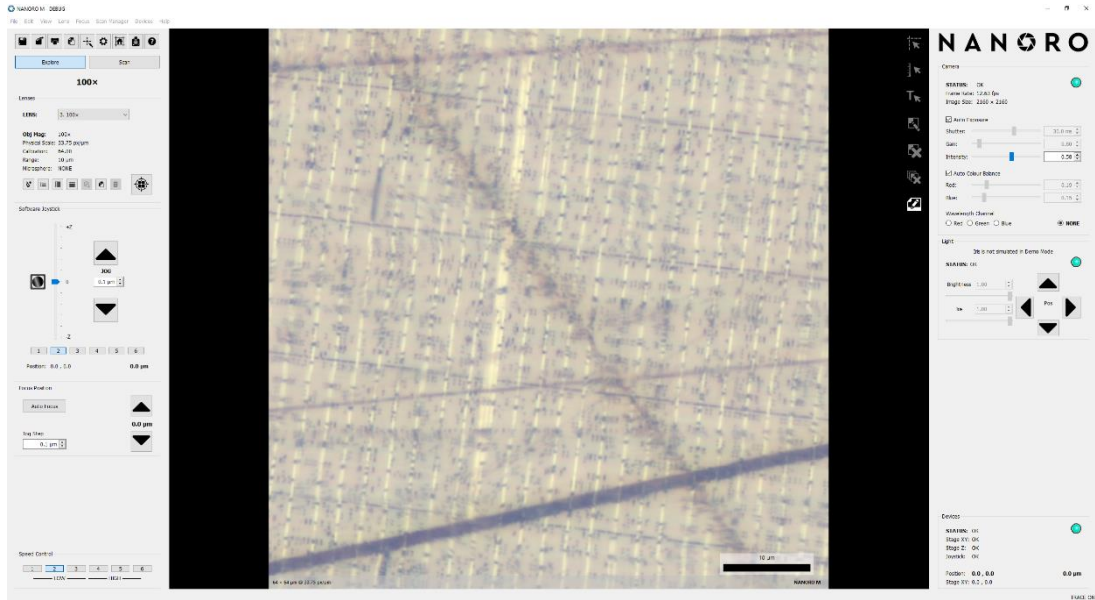
Change the size of text, apps and other items

- 2560 × 1440 (Recommended)
- 2048 × 1152
- 1920 × 1440
- 1920 × 1200
- 1920 × 1080
- 1856 × 1392
- 1792 × 1344
- 1680 × 1050
- 1600 × 1200

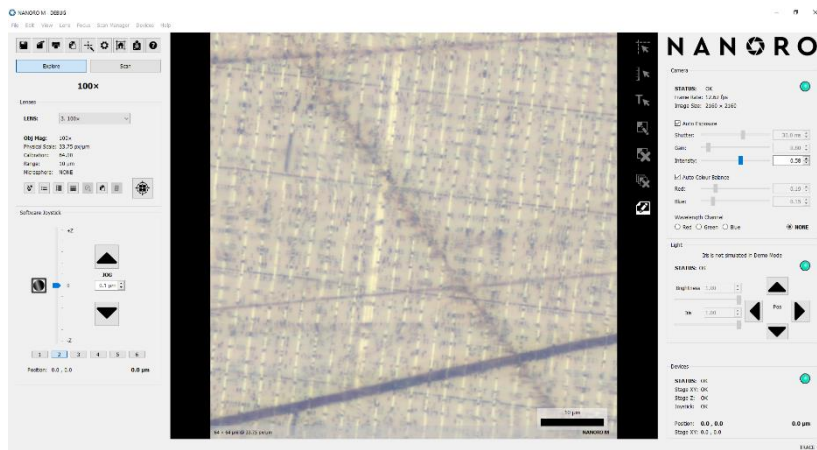
Here we see the display cannot be configured for more than 1080 pixels vertically with the recording device in place.

## Screen Comparison

The two diagrams below are drawn to the same scale



My screen (2560x1440)



Maximum resolution with HDMI recorder attached (Full HD 1920x1080)

You may notice (in the left column) that due to the reduced screen height, the autofocus panel and the speed control panel have been removed from the display due to insufficient space. There is also little free space on the right with the screen recorder attached.

# Hardware

## Potential file transfer from external recorder

The very next section discusses an external hardware video recorder.

Files are recorded onto a USB device on the recorder. To do anything useful with the recording, the files need to be transferred elsewhere. This may be an inconvenience. The inconvenience might be reduced by simply having two USB devices and swapping them when necessary.

# Licencing

## What is free?

Free is usually interpreted two ways when referring to licences.

Free as in free beer

There is no cost.

Free as in free speech

Open source. Users may modify the software themselves.

### [ShareX](#)

ShareX is a free and open-source screenshot and screencast program for Microsoft Windows. It is published under **the GNU General Public License**. The project's source code is hosted on GitHub

### [OBS Studio](#)

Free and open source software for video recording and live streaming.

### [VLC](#)

Short answer: there are none.

<http://www.gnu.org/licenses/old-licenses/gpl-2.0.html>

# HDMI Recording

There are a great many video capture devices available on the market due to “gamers” playing on their PlayStations, Xboxes and Ninendos, and wishing to stream and discuss their experiences online. The output of the capture devices are usually USB streams, working as if they are USB cameras and therefore compatible with a variety of video streaming software, e.g. OBS (Open Broadcast software), a program we shall discuss later.

These so called Video Capture devices would be better called video conversion devices, as they convert an HDMI signal into a USB video signal. The devices rarely have a true recording function.

**Beware before purchasing any cheap HDMI video recorder!**

HMDI recorders do exist. This appears to be one.



[TreasLin Recorder](#)

It records 1080p video. Also known as Full HD (High Definition) video. See [Wikipedia 1080p](#).

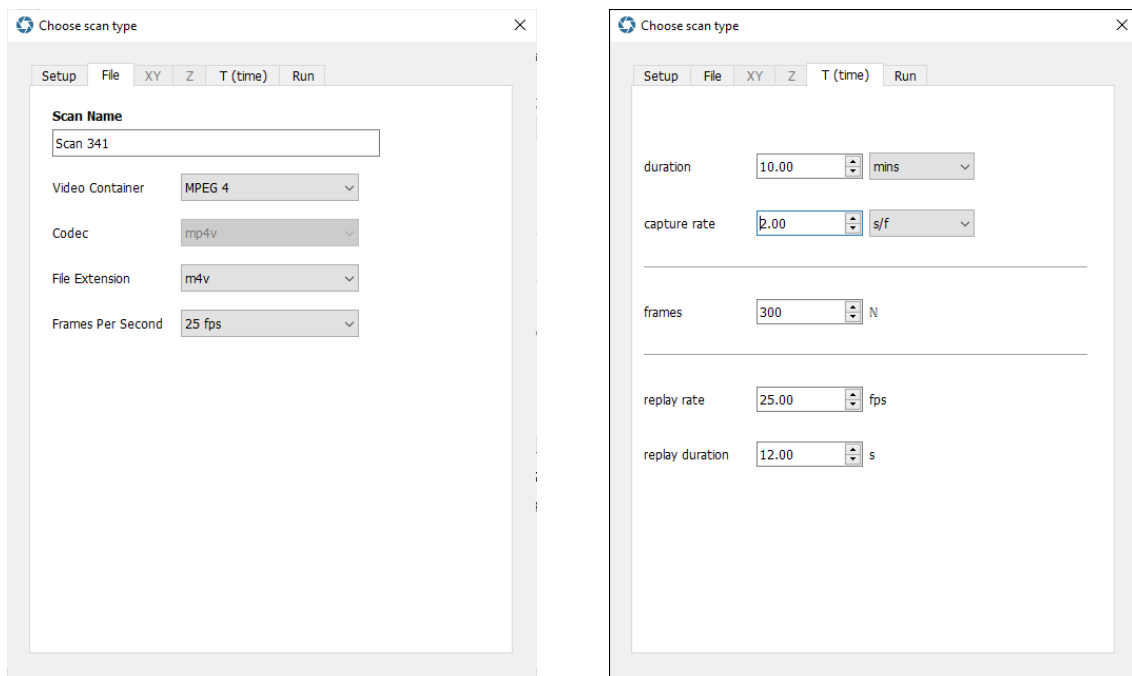
# Nanoro Software

The Nanoro software has access to the full camera image, 2160x2160.

It uses a region of interest (ROI) which is up to 80% of this, i.e. up to 1728x1728.

If Nanoro software creates a video from this region of interest, the width x height of the generated video can be 1728x1728, reflecting the full quality of the camera, albeit then subject to video compression.

This is better quality than would be obtained by screen capturing re-sized images at the screen resolution, or even re-sizing those images into a standard 16:9 video format compressing the image vertically and padding the sides. (See my discussion on video quality.)



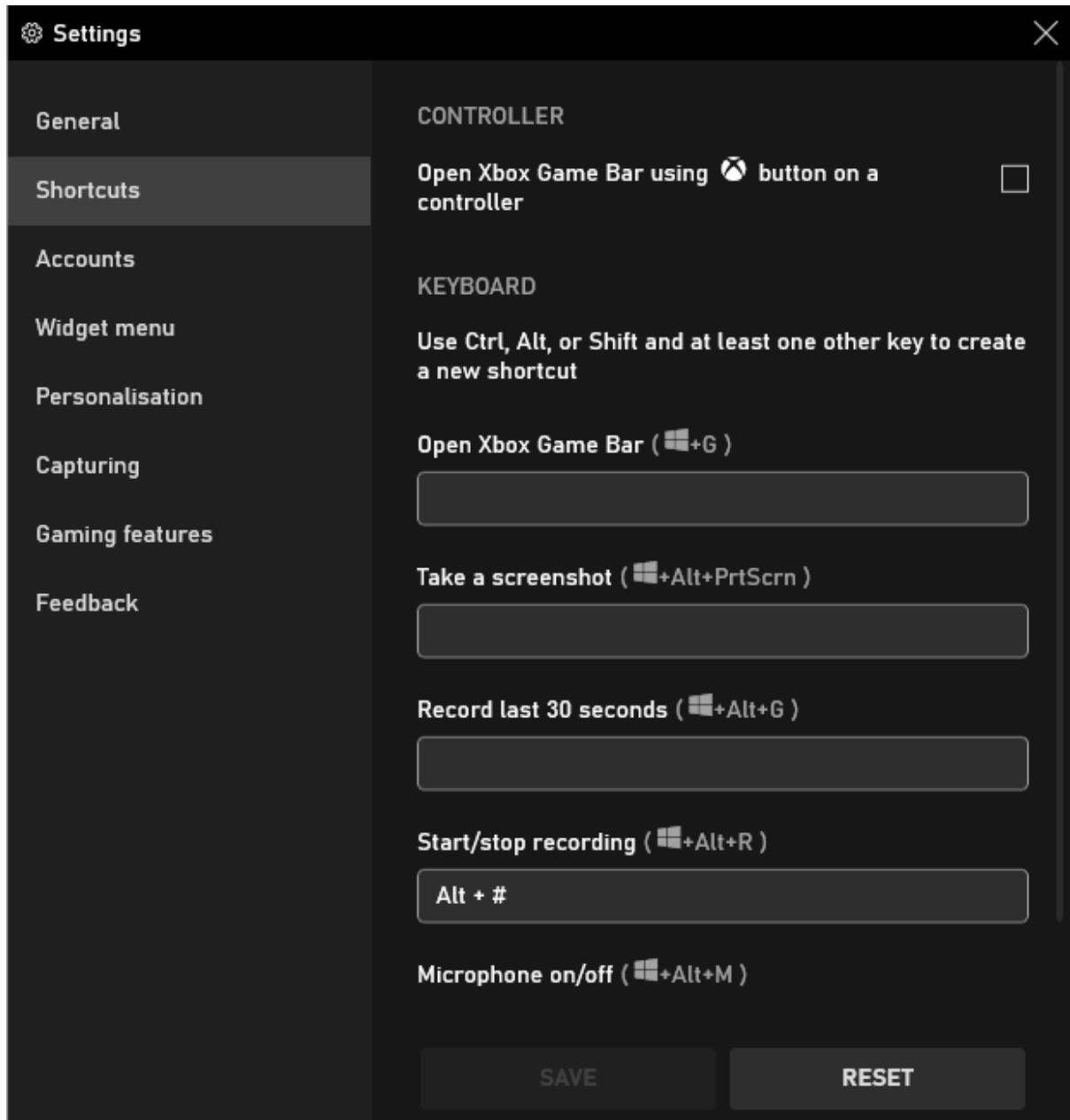
*Nanoro-B time-lapse video configuration*

The images above show the Nanoro-B user interface (in development) with settings to record an MP4 video. A frame would be captured every two seconds for 10 minutes, making a total of 300 frames. Played back at a rate of 25 frames per second, giving a replay time of 12 seconds.

**The capabilities of Nanoro software will be time lapse recording from the camera.**

# Windows S/W

Xbox Game Bar



The capabilities of the Xbox Game Bar are real time video capture of the whole screen.

# Third Party Software

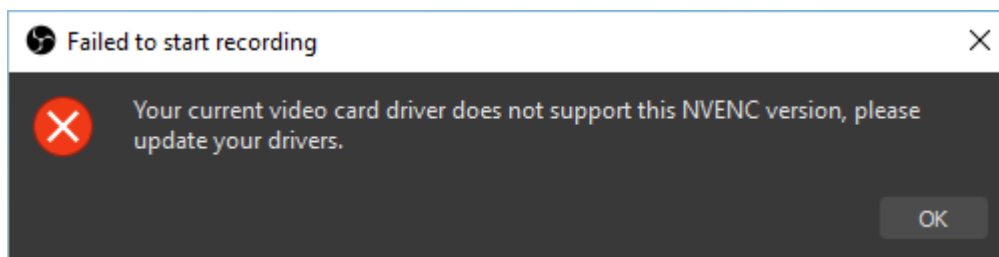
I have looked at a few free -- as in free beer, no cost, and as in free speech, open source – programs to capture video. Namely ShareX, OBS (Open Broadcast Software) Studio, and VLC Media Player. The name VLC comes from a previous name VideoLAN Client.

There are many programs, free and otherwise which could be considered. I have a little familiarity with VLC and ShareX, and OBS Studio appears to be widely recommended.

## OBS (Open Broadcast Software) Studio

The best software in the world is of no use if it doesn't run on our hardware.

This is the result of my attempt to run OBS studio.



With more effort this problem might be overcome. There is a warning here though. Solutions built into windows need to work as Microsoft's reputation is at stake. Microsoft has no obligation to third party software. Indeed, it is in Microsoft's interests if competitor software is less reliable. Even working software third party software is vulnerable to a windows update.

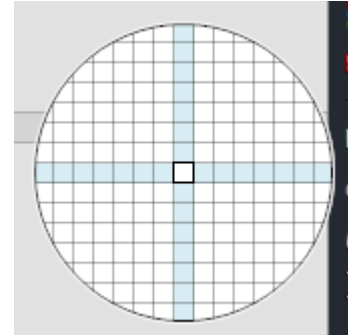
The main reason to use third party software is if it can provide additional desired features

1. File format
2. Resolution (width x height)
3. Frame capture rate
4. Multiple layers (eg to add captions)

## ShareX

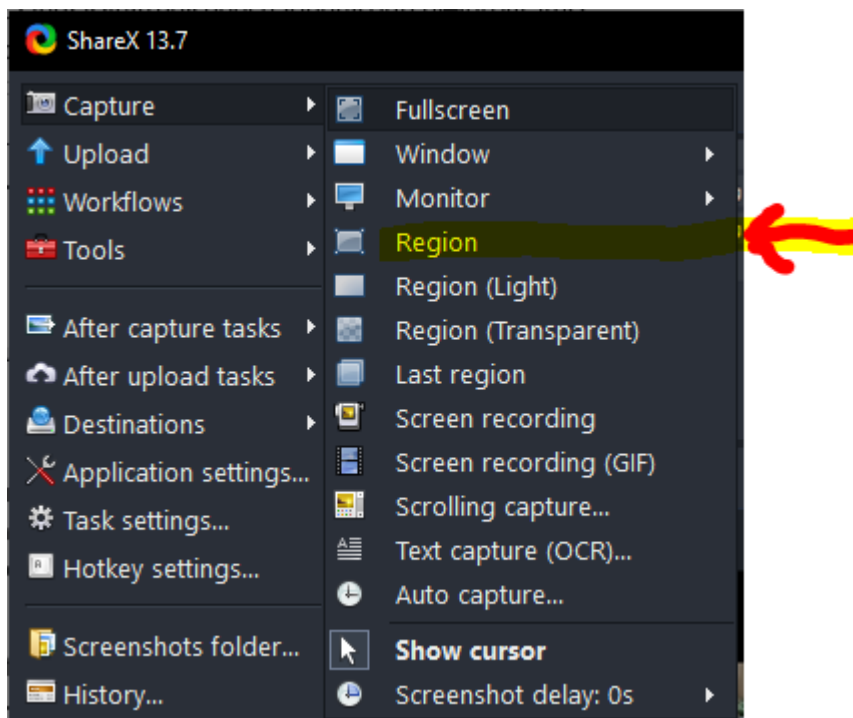
I downloaded ShareX in November 2021 after a request to produce a video demonstration which included the NM900 software.

ShareX has a bizarre and initially confusing cursor used to select the area of the screen to capture. The cross hairs and circle show a magnified view of the pixels being chosen as the limits of the selected area, this allowing very precise control of the area selection, but at the expense of being more user friendly.



This shows great attention to detail, but a feature of ShareX in general is that it's designed for capabilities rather than user friendliness. It doesn't have a professional look and feel, despite working well.

ShareX allows a portion of the screen to be captured.



It also has an automatic capture feature which can be used to capture images repeated at a regular interval. While these could be used to create a time lapse video, the feature isn't offered directly.

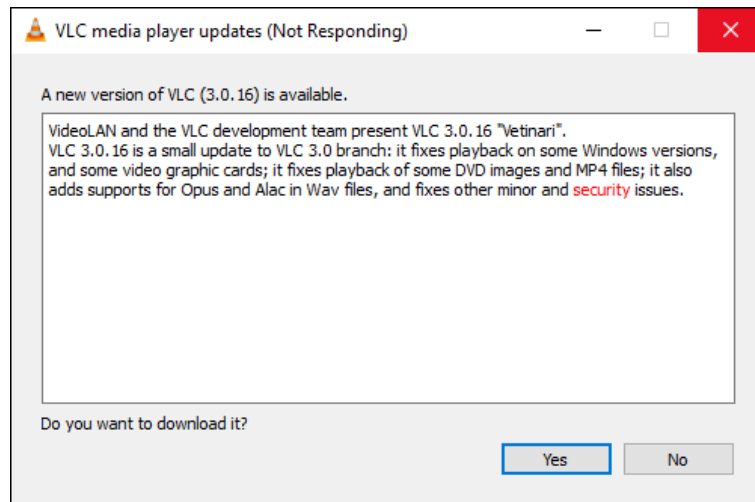
**The capabilities of ShareX are real time video capture of a selected portion of the screen.**



## VLC Media Player

VLC Media Player is best described by existing online descriptions, for example its Wikipedia page. [https://en.wikipedia.org/wiki/VLC\\_media\\_player](https://en.wikipedia.org/wiki/VLC_media_player).

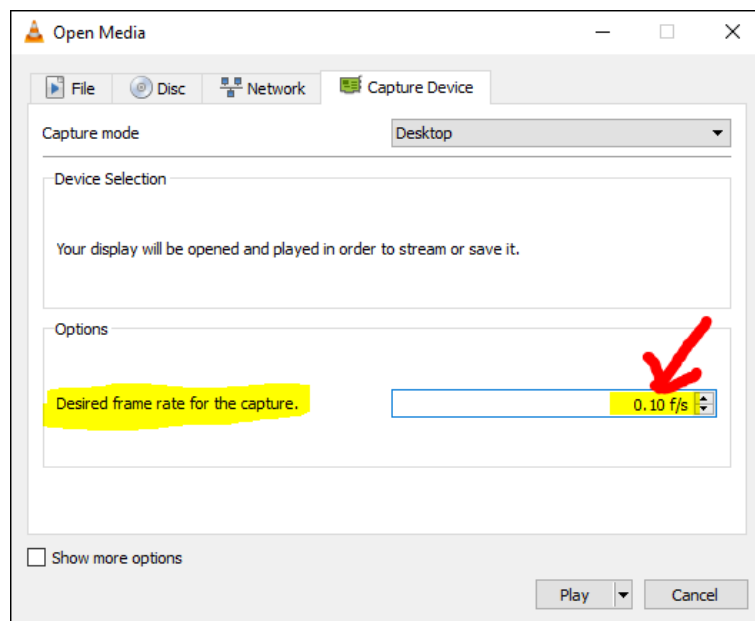
I am familiar with the program as a video player. It's look and feel is professional, and it plays video file well. However its recording capabilities were disappointing. The record button is not enabled by default and knowledge of how to enable recording is required. This is not a problem as its something we could install.



VLC media player frequently crashed during recording.

The software lacked the capability of capturing a portion of the screen.

It did however seem to have the capability to vary the frame capture rate.



**The capabilities of VLC Media Player are variable speed video capture of the screen.**

# Useful Notes

Editing / Post production

<https://obsproject.com/wiki/Post-Production-Tools-you-can-use>

VLC: How to Capture With VLC

<https://smallbusiness.chron.com/capture-vlc-45892.html>

VLC: The Recording Button With VLC

<https://www.techwalla.com/articles/the-recording-button-with-vlc>

By Seamus Islwyn

In addition to playing a wide variety of video file types, the free VLC media player can record anything it can play. You can use VLC to record video from a DVD to your hard drive, capture streaming video from the Internet and record a screen capture video of your computer's desktop. Only use VLC to record non-copy-protected video that you have permission to record.

VLC: How to disable on screen file name

<https://www.itsupportguides.com/knowledge-base/tech-tips-tricks/vlc-media-player-how-to-disable-on-screen-file-name/>

Xbox Game Bar: How to capture With the Xbox Game Bar

Use Xbox Game Bar to capture game clips and screenshots on Windows | Xbox Support

<https://support.xbox.com/en-GB/help/friends-social-activity/share-socialize/record-game-clips-game-bar-windows-10>

## Blu-ray Disc format

From [https://en.wikipedia.org/wiki/1080p#Blu-ray\\_Disc](https://en.wikipedia.org/wiki/1080p#Blu-ray_Disc) ...

*Blu-ray Discs are able to hold 1080p HD content, and most movies released on Blu-ray Disc produce a full 1080p HD picture when the player is connected to a 1080p HDTV via an HDMI cable.*

# Conclusion

The Nanoro video software will be useful for its features lacking in much video recording software

1. Area selection
2. Low frame capture rate for time lapse recording
3. Full resolution (up to 1728x1728 pixels)
4. Image from the camera without resizing

The Xbox Game Bar can be used for full screen full speed screen video capture.

An external screen recorder is not a good idea due to it lowering the screen size to 1920x1080. Better recorders may come to market and be considered.

ShareX should be considered if full speed recording of a selected screen area is required.

OBS Studio and VLC Media player is unreliable for recording.