The Touptek Toupcam Microscope Camera

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The Toupcam LCMOS14000KPA is one of a series of microscope cameras. It uses an Aptima sensor that is 6.451x4.603 millimetres so that the aspect ratio is 1.4:1. (Essentially $\sqrt{2}$.) The pixels are square, and measure 1.4μ. It will produce 2.7 FPC at 4096x3288, 10@2048x1644, and 35 at 1024x822. Exposures vary from 0.4ms to 2 seconds.

Touptek produces several other similar microscope cameras with different resolutions and data transfer methods. This version utilises USB 2.0. The CMOS sensors generally are similar in size to this one, though resolution varies.

During the era of 16mm motion pictures, the frame image format was 10.26x7.49mm, an aspect ratio of 1.37:1.

When this camera is directly placed on a microscope system that is designed for 16mm motion picture format a problem soon becomes apparent: the CMOS sensor is about 62% the linear size of the analogous photographic film. This is equivalent to magnifying the image by a factor of 1.6.

To help solve this problem, the cameras generally come with a reducing adaptor that fits into 23.2mm, 30mm, and 30.5mm eyepiece holders. The standard reducing adaptor changes the image scale by a factor of 0.5, so that the camera can take in a larger field of view. Other reducing adapts are available, they seem to go down to about 0.3.

The reducing adaptor must be placed at a fairly precise distance from the objectives or else several serious problems will occur. First of all, the objectives will loose all parfocality. Secondly, serious spherical aberration is introduced along with problems that seem to be due to chromatic difference of magnification. Thirdly, the focus point of the camera will not correspond to the focus point through the oculars.

When this reducing adaptor was placed on the Wild M20, M21, and M40 photo adaptor, the adaptor was fairly close to the correct distance. Problems immediately reared their ugly heads with the Leitz Orthoplan system. In the end the solution turned out to be to make a special adaptor for the Leitz photo port using a lathe. When the position of the reducing adaptor is adjusted such that the camera and microscope are simultaneously focused using a 10X objective the system seems to be fine. The camera mounted on the Orthoplan photo port using this adaptor is shown below:
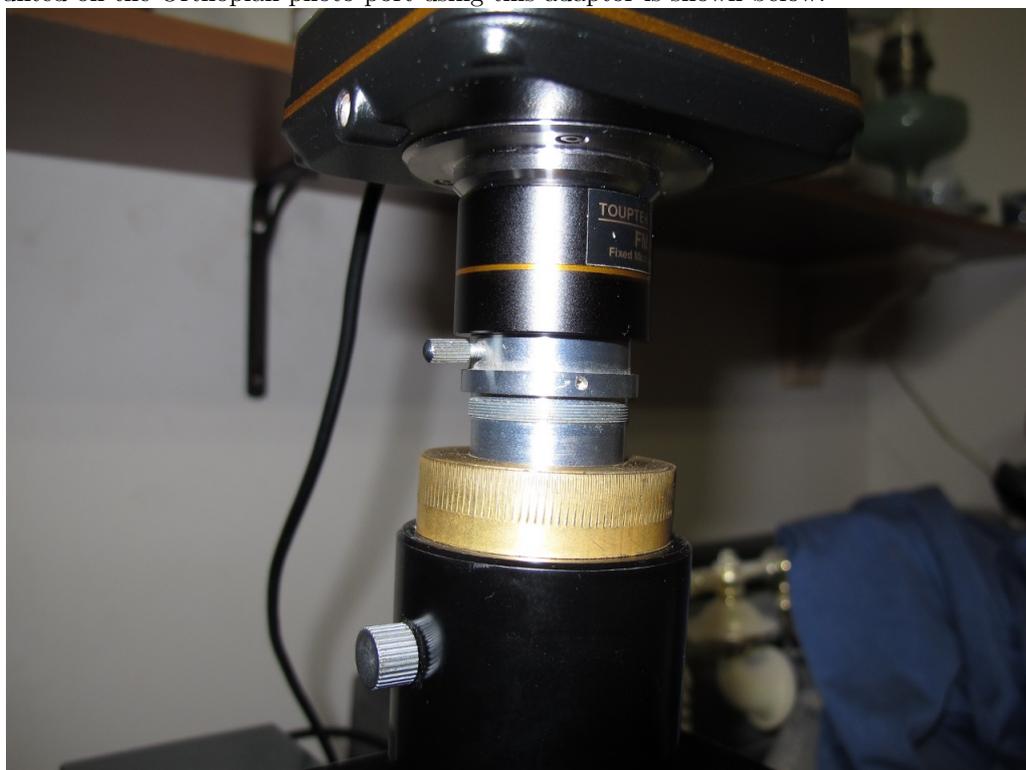
Generic C mount image reduction lens systems seem very difficult to locate, but fortunately the provided system works fine as long as one can find a way to get it at the right distance from the

objectives!

The fact that the aspect ratio is almost exactly $\sqrt{2}$ means that images from it can be printed on A series (A4, etc.) pages without any cropping.

The camera is supplied with a CDROM that has programs for Windows, OsX, and most Linux systems. The company even provides software components to write programs to access the device. Furthermore there are third party software systems.

The Windows program is rather elaborate, and there is a large manual to describe the features of program. The Linux version is straight forward, and basically it has the ability to adjust images similar to ordinary cameras and then download them. The Linux versions seem designed for laboratory situations where the images produced by the camera would be subjected to ordinary image processing programs.

The company's web site seems to provide updated software at frequent intervals. There seems no danger of one having this device become orphaned. It is a very good idea to download the programs from the web site to get the latest versions.

There is a program for Linux called "Touplite" that is available from the web site. Many users may find that this program is superior to the versions that attempt to create a data processing program along with a program to drive the camera. Users tend to be already well acquainted with other image processing systems, and it makes no sense to have to learn to use another.

The Linux programs are provided in a peculiar format. There is a "tar.gz" program that can be downloaded. When this program is "de-tarred" it produces an extremely large install script that incorporates all the files that it installs. In spite of this rather unorthodox way to distribute files, the install programs all seem to work perfectly.

The software provides a grey scale (monochrome, black and white) mode. This is a particularly good feature for use with phase contrast objectives. The phase effect is generally optimised for 546 nm (green). Green illumination can be obtained by using either a green filter in the optical system or using LED illumination with a green LED. There are standard software packages that also permit separation of the three images that are recorded in colour images.

Furthermore, stained images when stained with just one colour tend to show details much better in monochrome images. Strongly coloured slides need to be used with the colour saturation set to a fairly low value or the image may be obscured too much colour contrast. Compare the two images below. One is from a slide of sectioned and stained skin in colour mode and the other in grey scale mode. Note how many details are much more visible on the grey scale mode than in the colour one.
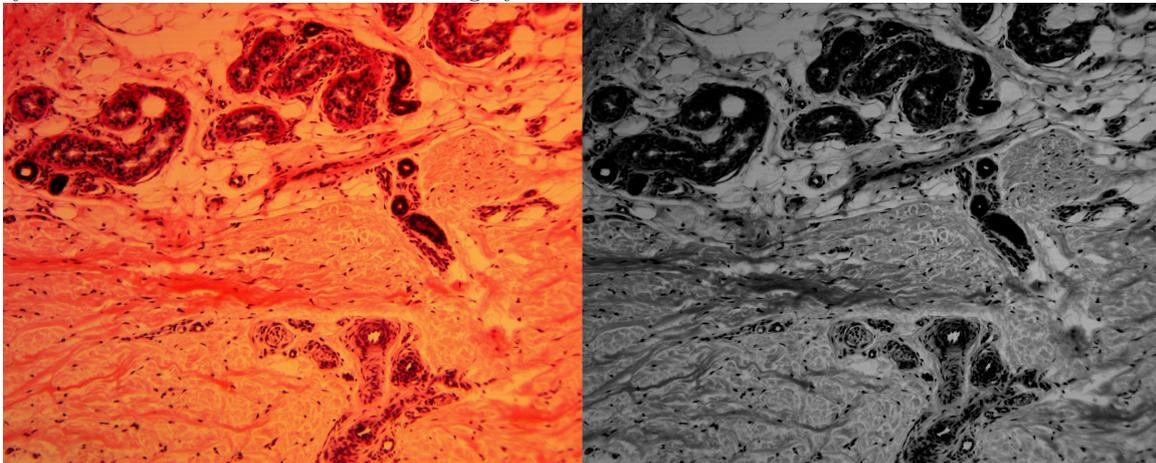
This camera also provides a video mode. When I tried this with the Linux software, I had problems with it, the resolution was too low, and the image was "blocky". I did not try the Windows version.

What was really useful was the software's "instant save" mode. One must first give a prefix for the file name, and state the file type, and then a simple click on an icon will capture the numbered image at any point in time, and each subsequent click will give another file with the number counter incremented.

There are ways to use sequences of this sort with the panorama program "hugin" to generate images with vastly increased depth of field. One needs to move the focus through the image,and take several images along the way. The Unix script that follows will generate an amazing enhanced depth of field image!!!

```
#!/bin/bash
align_image_stack -a ais_ *.tif
enfuse -o result.tif --exposure-weight=0 --saturation-weight=0 --contrast-weight=1
    --hard-mask ais*.tif
```

For a demonstration of this, twelve images were obtained at different focus depths from a sectioned and stained dog muscle prepared slide. Using Touplite sequential image mode, the set of images were saved in bmp mode. The image magic program mogrify converts many image formats, and it works wonderfully here to convert all the bmp images to TIF. (Direct Tif saves do not seem to work with this software. Because the touplite program does not seem to be coded for multithreaded computer systems, jpg and png consume too much processor time for quick sequential image saves.) The camera was mounted on a Leitz Orthoplan, using a Leitz 40x 0.95 apochromatic objective.
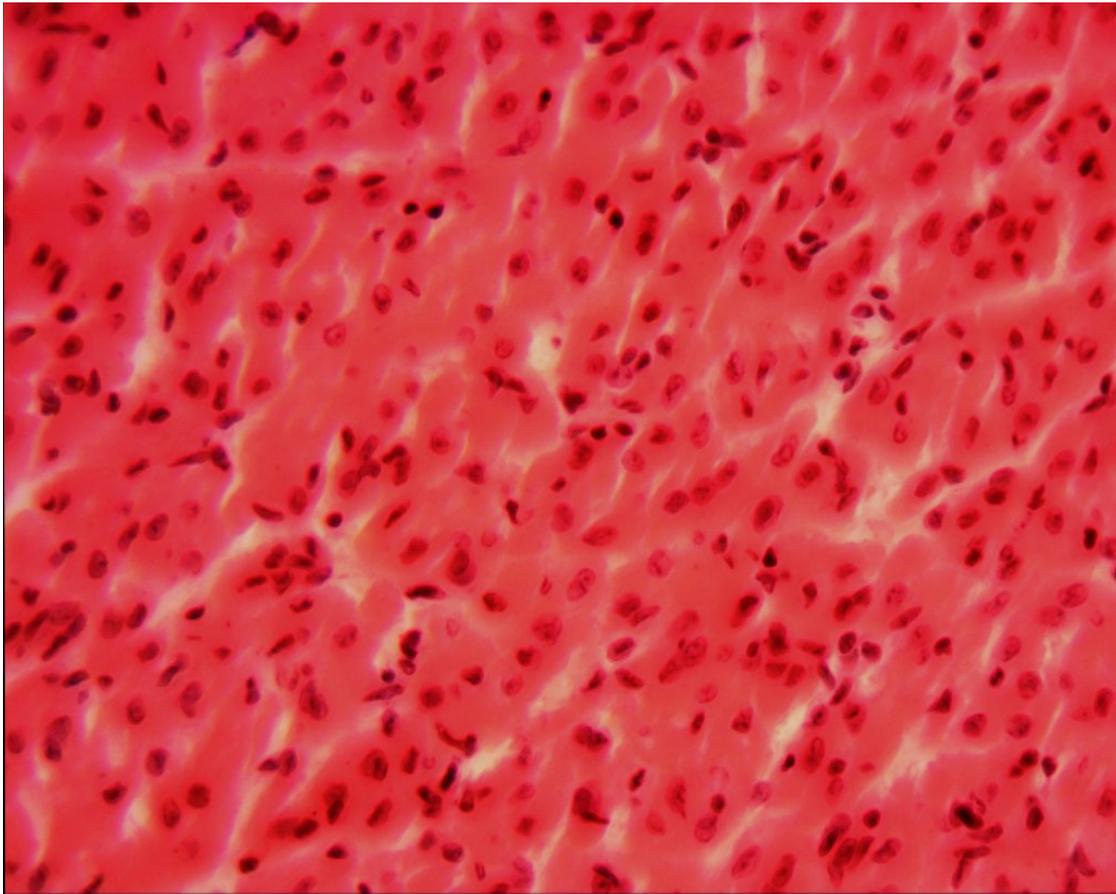

The next image was obtained by combining 12 images that were obtained using phase contrast Leitz Fluotar Phaco 40x 1.3 na oil immersion objective. Unfortunately the bacteria and other small objects are bounced around by Brownian movement and often are either lost or appear more than once! Still the epithelial cell was large enough to remain in place. If one were to put living cells in a gelatin solution, and then cool it down until the gelatin set, there would be less movement problems. Still the image is remarkably sharp.
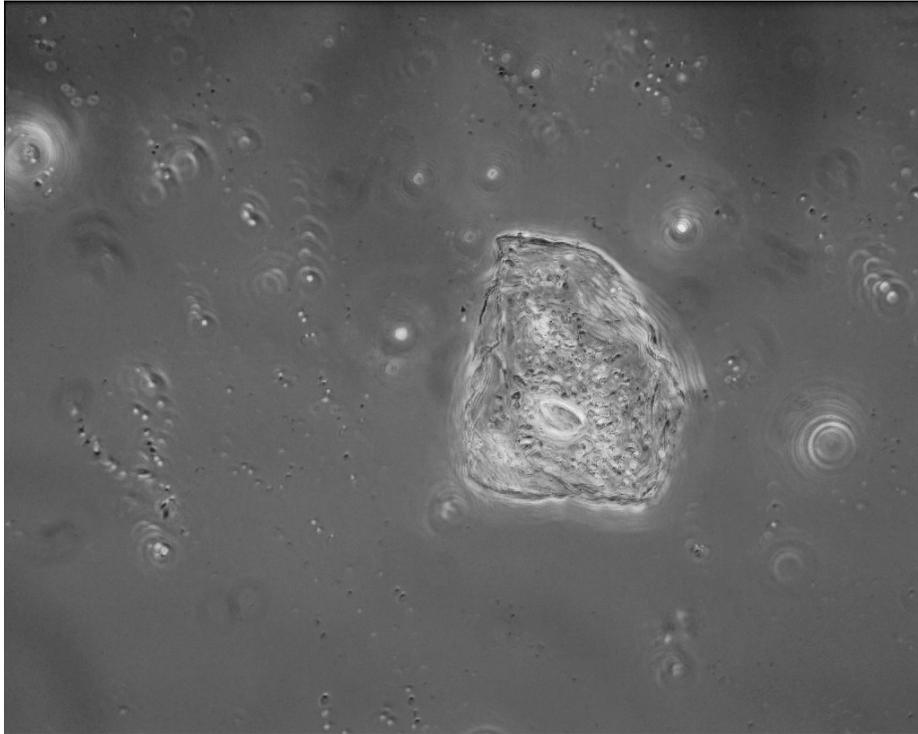
The Toupcam camera seems to work very well with the Wild photo attachment that was manufactured for Wild microscopes like the M20, M21, and M40.

The next image was obtained by using a Wild M21 polarising microscope. No special adaptor needed to be machined for this!

This image shows hexaphenylbenzene crystals. This compound is highly symmetrical and has an extremely high melting point. (455C!)
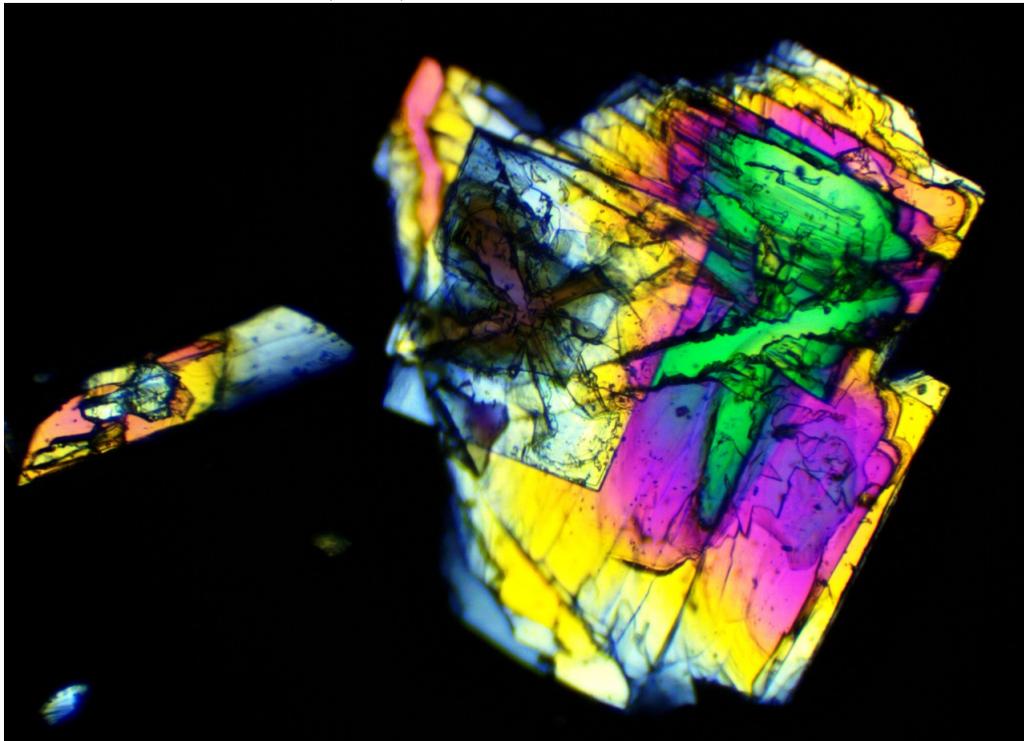
The camera on an Olympus BHM trinocular head requires no special adjustment. The next image shows a Peruvian coin using this system with a 40X metallurgical objective.
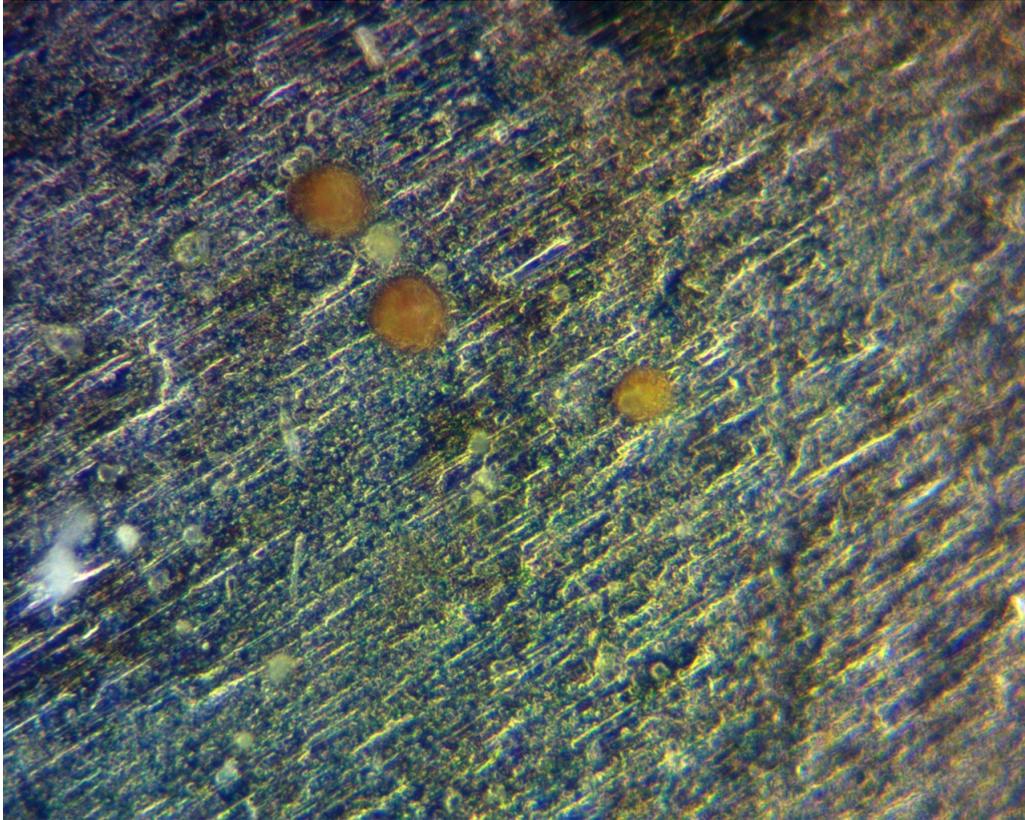
The Windows software provided with this camera has routines for stacking and joining images as well as some other image processing routines. Those who are not already familiar with and using other software systems for these purposes may prefer to utilise Windows Toupview as provided with the device.

Overall, this camera and its vendor provided software functioned very well. Devices like this are better and much less expensive than they were a very few years ago.

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(email in anti-spam format. Copy string and insert characters instead of capitals.)