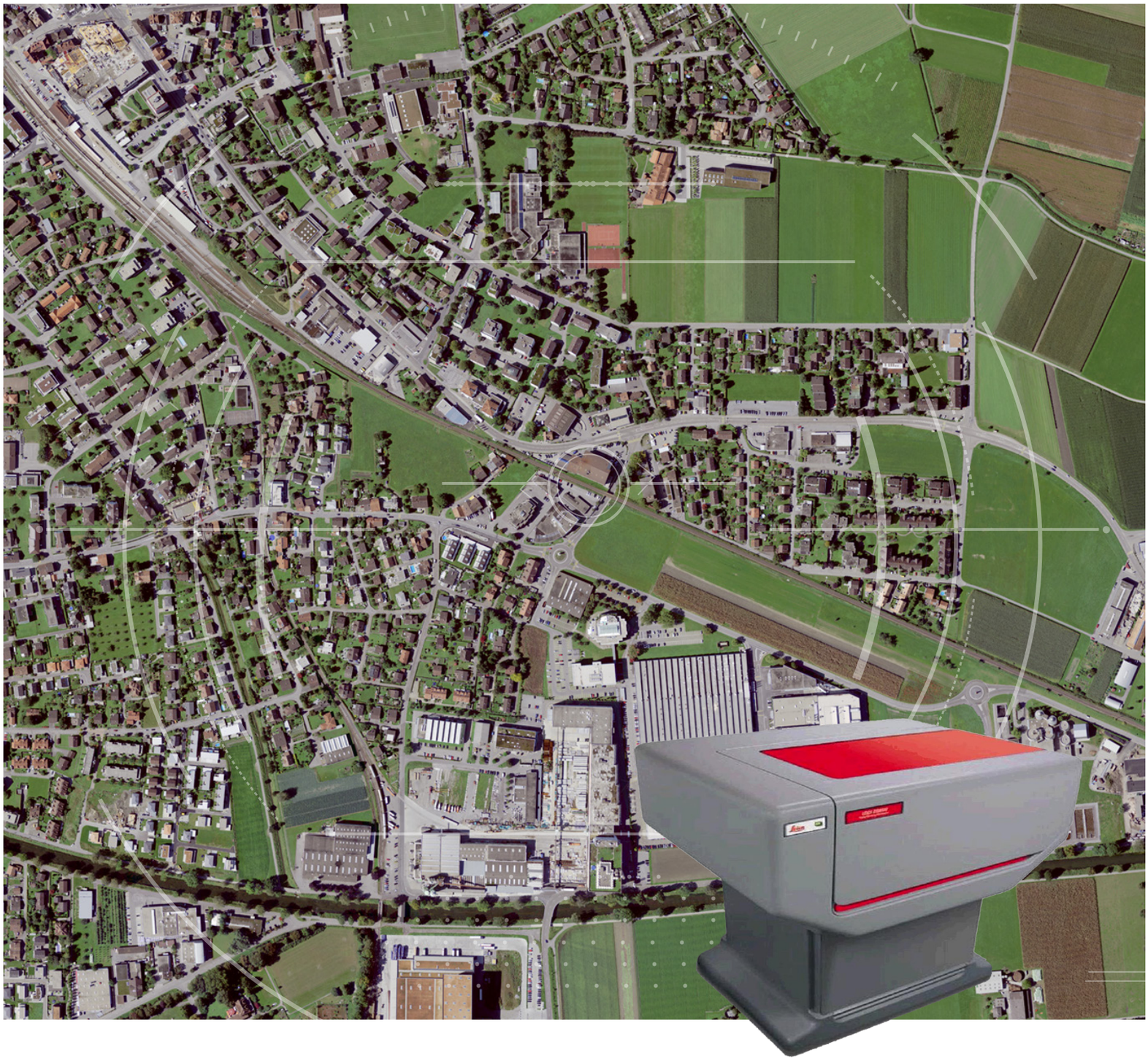
Leica DSW700V Digital Scanning Workstations

The World's Fastest Precision Aerial Film Scanner



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Overview

Softcopy photogrammetry work, stereo-compilation, and ultimately, orthophotos can only be as accurate as the source imagery. Working in a digital photogrammetry environment requires that the scanned aerial photographs are not only as accurate as possible but that the appearance of the film is reproduced faithfully and that the raw air photos are scanned quickly so that production can begin rapidly.

The Leica DSW700 Digital Scanning Workstation with 29 or 50 Megapixel sensors and upgraded controls (DSW700V or 700V) is a photogrammetric scanner, designed for maximum throughput. It is capable of scanning aerial film, cut sheets or roll, black and white, color or false color, positive or negative, at a very high speed. The geometric and radiometric performances meet all photogrammetric requirements. The 700V includes several performance innovations, while also continuing the best features of the original DSW700. One of these original features is anti-reflective coatings on the stage and cover plates to virtually eliminate Newton rings and optimize radiometric performance.

The 700V is built on the successful design of the earlier DSW200/300/500/600/700 models, based on a heavy, precise mechanical construction with moving stage plate, and stationary digital camera. The 700V adds the option of either a modern 29 Megapixel CCD or 50 Megapixel CMOS sensor. The principal performance improvements over previous scanner designs continue to capitalize on a diffuse light with LEDs of various colors, larger (29 or 50 megapixel) sensors and updated operator electronics to support faster scanning operations.

Key features

The Leica DSW700V Digital Scanning Workstation performs precision scanning of black and white, color or false color, cut or roll film negatives and diapositives at a very high speed, to provide the highest quality digital imagery for use in softcopy photogrammetric workstations.

The system consists of the following principal components:

- Heavy mechanical construction, with stage plate mechanism, to support the motorized roll-film transport, moving in the X and Y directions below the stationary illumination source and above the lens and sensor
- Diffuse light source consisting of LEDs of different colors
- 12-bit CCD or CMOS large-array sensor to capture the image patchwise
- Capable of optical pixel size changes throughout the full 3µm to 12.5µm continuous resolution range, so that scanning can take place at the pixel size required by the enduser, without resampling.
- High performance PC host computer running Windows® 10 Professional

The XY stage is built to very high mechanical standards, taking into account that both cut and roll film must be accommodated. The stage is exceptionally sturdy and provides independent positioning with respect to the X and Y sensor axes. Mounted on the base are the optics and 12-bit digital sensor used to digitize the transparencies. The optical path has been minimized for optimal performance: no beam splitters or folding mirrors are used and the light path is straight. The stage and opticalpath are mounted inside a specially designed enclosure, which prevents dust and dirt from accumulating on the film or extraneous light from entering the system during scanning. Illumination is provided directly by an LED dome light supported above the stage. This cool light source is located sufficiently above the platen, so does not subject the film, stage or optical path to unwanted heat. The light consists of LEDs of different colors to allow for color as well as black and white images to be scanned.

Hardware characteristics

Basic design - The DSW has at its center an extremely rigid base plate, manufactured as a precision casting. This is supported on a frame, furnished with casters and stabilizers (leveling screws). On the base plate are mounted precision steel rails, which derive their flatness from the base surface together with a jack screw approach, which ensures straightness before the rails are screwed tight in their final positions. Both X and Y stages are milled from aluminum.

An LED backlit panel mounted on the lower stage enables the operator to view a section of the film, for example to select a particular exposure for scanning. An automated motor and cam arrangement raises

and lowers the glass cover plate automatically, under software control, to permit roll film to be transported. For cut film, the operator raises and lowers this plate manually, at which point it behaves like a hinged lid.

Input media - The stage accepts film transparencies, as roll film or cut film, or glass plates of any thickness. The scanning format accepts images more than 260 mm square (10.2 x 10.2 inches). Input transparencies can be color or black and white and can be positive or negative.

Servo drives - The drive mechanism is a friction drive that provides excellent performance and requires little maintenance. This design has been successful on all DSW models for the past fifteen years. Modern precision positioning encoders with non-contact reading heads have been selected for improved performance.

Stage accuracy - The resolution of stage positioning at any point is 0.5 µm. The accuracy is typically 1.5 µm root mean square error (rmse) or better on each axis, based on computer calibration and compensation. Stage calibration is provided via automated grid plate measurement and is required infrequently.

Light source and optics - The illumination system provides uniform overhead illumination over the field of view of the sensor. The 700V uses an LED diffuse light, supported in a stationary position above the stage plate. The light consists of precisely positioned arrays of red, green, and blue LEDs. The LED source is more economical, with a life expectancy of more than 10 years under constant use. Most importantly, the use of LEDs in the 700V allows for the most efficient implementation of sequential color capture.

Flat bed scanners sometimes produce a phenomenon called Newton rings when the film is not held perfectly flat between the pressure plates. Typically, they become visible in a color scanned image as a rainbow series of light and dark rings around nondescript points in homogeneous areas. Unless a special optical fluid is used to eliminate the air gaps and therefore the index change between two media, Newton rings will usually form. The solution is to reduce significantly the formation of ring patterns by controlling one of the contributing physical factors - the reflection coefficient of the surfaces. By suitably reducing the amount of reflection between the glass pressure plates, it is possible to reduce the ring amplitude until it is virtually invisible.

Digital sensor and lens - A precisely aligned, 12-bit CCD or CMOS array sensor is fitted into the 700V. These provide better performance than any previous DSW sensor model in terms of the area of the film that can be captured. More sensitive and faster readout sensors that are also lower in noise translate directly into speed and quality improvements. Modern sensors and matched lenses create a cleaner, more consistent scan and allows future efforts to be redirected away from perfecting raw capture towards higher level image processing, such as dodging or automatic light balancing in roll-film scanning.

A 120 mm color-corrected, macro lens has been selected to image the film on to the sensor. This lens provides optimal light throughput and low distortion. Optional lenses for even higher resolution applications can also be discussed.

By varying the vertical positions of the sensor and lens, which are mounted on a rail mechanism with clamps and slow motion screws, the physical pixel size at the film plane is adjustable in the range 3-12.5 µm. Raw imagery is captured and may be output at any pixel size selected by the user, up to 256x the raw pixel size at the film plane. The precise sensor alignment geometry and low distortion optics provide an almost distortion-free image.

New stage control and operator interface - A new user control panel is mounted inside the upper casing of the 700V. It uses a bright, wide-angle view, 7 inch LCD touch panel to input user commands, run diagnostics, etc. It is directly connected via USB and HDMI cables to a new, Linux microcomputer underneath the stage to control the stage movement, roll film movement and interface via USB with the host workstation. The panel is also used for manual movement of the stage and roll-film transport.

Power supplies and electronics - There are five DC power supplies: two gives 5V and 12V for the electronics and cover plate motors, one gives 40V for the servo and roll film motors, one gives 12V for the camera sensor, and the fifth gives 24V for the LED light.

The 700V runs at 3.2 amps on 110V (1.6 amps at 220V) and the peak load with a 500 foot (152 m) film roll is calculated to be 6 amps.

Outer housing - The stylish skins of the DSW consist of two main parts. The pedestal around the base structure is made from pressure formed plastic and the top housing of fiberglass. The pedestal is dark gray, the top housing silver gray and the colored inserts Leica red. The product name is in black and the Leica logo in red on white. There is a single LED to indicate power. The top housing has a large lid for loading and unloading cut or roll film or for viewing the position of a film roll.

Tools and accessories - Standard system delivery provides all special tools and accessories required for routine maintenance, lubrication and calibration, including a precision glass grid plate for checking stage accuracy, and special filters for calibration of sensor radiometric response.

Host computer and software

Host computer - The DSW700V requires a modern host computer running the Windows® 10 Professional operating system. The current standard configuration is:

- HP Workstation Z6 G4
- 2nd Generation Xeon Scalable processor
- 48 GB ECC RAM
- fast SSD storage drive
- NVIDIA Quadro P2200 or P4000 graphics card
- DVD read/write drive
- I Gigibit and 10 Gigibit CAT 6 network interfaces

Operating system, user interface and application environment - The PC operating system is any current Microsoft supported Windows 10 Professional release. The application software consists of the Leica SCAN and Image Utilities, which includes the FastDODGE product. The Scan software is GUI-based and promotes a consistent "point and select" operation in all functionality.

Stage calibration - A calibrated grid plate, supplied with the system, is utilized to determine a table of corrections to be applied in real-time to the stage coordinates to achieve the final stage positioning accuracy of the system. It proceeds automatically once the operator has manually pointed to the first grid intersection. The grid intersections, spaced at 15 mm intervals, are driven to and measured automatically, using the correlator mode of operation to point precisely to each grid intersection. When all grid intersections have been measured, a table of corrections is computed.

Finally, the precision estimates for the unit are calculated by scanning the glass grid, measuring the intersections in the scanned image and comparing them to the corrections built.

S**ensor calibration -** This function performs both a geometric and a radiometric calibration of the sensor. For the geometric calibration, a calibration grid is used to determine the actual optical pixel size (the X and Y pixel dimensions are measured independently). A transformation is developed between the sensor and the stage coordinate system of at least 25 distinct points to model the path of light as it passes through the film, glass, and lens and ultimately strikes the sensor.The radiometric calibration uses four-color image patches and time variable dark frame captures to determine a set of bias and gain adjustments. These adjustments are

measured for every pixel in each color band to correct for variations in radiometric response over the entire sensor area, as well as discrepancies in time of exposure. The bias and gain adjustments are then saved in calibration files for later application to the image patches captured during digitization.

Photo/stage orientation (interior orientation) - This function is used to establish a precise photo-to-stage coordinate transformation (interior orientation) for the input film placed on the digitizer stage. The transformation is based on the measurement of up to eight fiducial marks. It provides for transformations from a simple scale and rotation to a standard affine fit. The program assists the operator in the location of the fiducial marks, automatically slewing to their approximate positions. Real-time light control and zooming of the image is available to assist the operator in pointing (measuring a sub-pixel location). The user can easily store the coordinates of the fiducial marks with the other camera calibration data. When the fiducial marks on the first image from a particular camera are measured, their image patches are stored as templates to enable automated interior orientation of subsequent images acquired by the same sensor, essential for autonomous operation with roll film. In addition, fiducial marks can be specifically enhanced in the scan without disturbing the geometric placement. This allows scans to be made with highly readable fiducials.

Image scanning - Image scanning, sometimes called image digitizing, utilizes the sensor to convert the image transparency into digital data for use on digital photogrammetric workstations. A large capacity SSD storage drive is provided as standard equipment for archiving of scanned imagery. Other output devices can be provided. In standard configurations where the DSW700V is an element of a larger system, imagery can be transferred electronically over a local network, in which case a 10 gigabit connection with Category 6 cabling is strongly recommended. Several image formats are supported, including plain raster (BIL), VITec, TIFF, tiled TIFF, tiled TIFF JPEG, NITF JPEG. An embedded set of minification levels may be optionally stored in the tiled TIFF formats

Supporting software - In addition to the applications described above, the software package includes a number of utilities which can be used to accomplish a variety of common tasks. This set of command line utilities are most commonly applied to: reformat scanned imagery into any of the common raster formats mentioned above; have the final resolution of a digitized image resampled to any coarser final resolution; and convert color images to black and white, or have the final radiometric characteristics of the image modified after data collection. Additionally, since all of the utilities are executed from a command line, they may be embedded in a script or batch file to modify a large number of images at once. A powerful viewing program is also included to check the appearance of the completely scanned image.

Upgrades from earlier models - As a result of the incremental development of the DSW line over the years, it has been possible to create upgrade products to enable users of many earlier models to benefit from all the new features of the 700V. Original DSW600 and DSW700 models may be fully upgraded to 700V status. Customers under Leica support may also upgrade their Windows 7 workstations and obsolete DOS stage electronics to faster, fully supportable Windows 10 workstations and Linux stage controllers. Customers wishing for a more modest quality upgrade can order replacement cover and/or stage glass plates with the anti-reflective coatings to combat Newton rings. All upgrades are available for customers under Leica support.

General physical requirements

Temperature - The system should be installed in a normal, air-conditioned office environment. The operating temperature range is 21±2˚C, but no equipment failures occur over the range 17-25˚C.

Humidity - The operational relative humidity range is 40-70%. The maximum relative humidity is 90%.

Vibration - Externally induced floor vibrations must be less than 0.01g at all frequencies.

Floor space and carrying capacity - The equipment can be installed in a 1 x 2 meter area with a floor carrying capacity of 800 kg.

Electrical power - The required electrical supply is 60±2 Hz, 110V or 50±2 Hz, 230V nominal. The normal configuration requires a single independent 20 amp circuit.

Documentation

Instruction manuals are supplied giving detailed operating procedures as well as hardware description and maintenance instructions. In addition, the normal system hardware and software documentation provided with the computer and operating systems software is included. Training is available.

Product Specifications

SPECIFICATIONS	
Basic Technology	Moving stage, stop and stare, stationary sensor array

XY STAGE	
Geometric resolution	0.5 µm
Geometric precision	< 1.5 rmse on each axis
Scanning format	In excess of 260 x 260 mm
Speed of stage travel	Maximum 80 mm/second

ROLL FILM TRANSPORT - MOUNTED IN XY STAGE	
Maximum spool diameter	194 mm (7.625 inches)
Film length	Post processed (specification)
Film width	Maximum 152 m (500 feet)
Automatic frame advance	Available for 125-240 mm widths
Rewind sped	10 minutes for 152 m (500 foot) roll

SCANNING OPTICS AND ELECTRONICS	
Light source	LED dome light
Stage and cover plates	Optically flat glass, with anti-reflective coating
CCD/CMOS array sensor	6500x4300/7900x6000 pixels
Sensor pixel size	5.5/4.6 µm
Lens	Schneider 120 mm, f/5.9, color-corrected
Optical resolution	3-12.5 µm

ELECTRICAL POWER	
Input power	110/220V AC, 50/60 Hz
Maximum load	6 amperes

DIMENSIONS	
Size	1238 x 1003 x 1175 mm width x depth x height
Weight	288 kg (633 lb)

HOST COMPUTER	
Workstation	HP Z6 G4 with 2nd Generation Intel Xeon Scalable processor
RAM	48 GB
Storgae drive	4TB SSD
Monitor	(optional) recommended minimum HD 1920x1200
Graphics	Nvidia P2200 or P4000
Peripherals	DVD read/write, 1 and 10 Gigabit CAT6, Ethernet
Operating system	Windows 10 Professional

SCANNING SOFTWARE	
Calibration	XY stage geometric, sensor geometric and radiometric
Interior orientation	Interactive, semi-automated, fully automatic
Scanning formats	Plain raster (BIL), VITec, TIFF, tiled TIFF, tiled TIFF JPEG, NITF JPEG.

AERIAL FRAME SCANNING 230X230 MM/50MP	
12.5 µm / 2000 DPI in b/w	40 seconds
12.5 µm / 2000 DPI in color	55 seconds
7 µm / 3600 DPI b/w	55 seconds
7 µm / 3600 DPI color	65 seconds

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