12 Extend MX System with Outdoor Lighting

This chapter suggests methods for capturing in outdoor environments.

The following sections describe the various Vicon daylight capture equipment options and their use and care in an outdoor setting. Camera selection, set up, and use are covered along with logistical details to make outdoor capture sessions a success.

Understand Outdoor Capture

Performing motion capture under daylight conditions outdoors allows subjects to be in a more normal/natural environment. Many of these types of situations cannot be easily and correctly reproduced indoors.

Motion capture procedures used outdoors are very similar to indoor methods. The biggest differences are the necessity to plan for electrical power, shelter for both the users and the equipment from the weather, and the logistics required for equipment transportation setup and removal. Unlike indoor use, most outdoor setups cannot be permanent due to environmental conditions. They must be completely setup and disassembled daily.

Vicon Equipment

All T-Series NIR cameras are capable of daylight capture. All T-series NIR cameras shipped after February 1st 2011 are outdoor ready. Contact Vicon Sales for details.

PC performance requirements are the same indoors as outdoors. Although a laptop may appear to be the logical choice for outdoor capture due to its flexibility, you should ensure that it meets necessary specifications.

Details of Daylight Capture

Procedures for outdoor capture are typically the same as indoors, including camera mounting, cabling, camera aiming, calibration, data collection, and processing. The

main difference comes from environmental conditions that typically require daily setup and removal of electronic equipment. Consider trial runs indoors prior to making the trip outdoors to speed up setup. If you know the size of the capture volume and the area where cameras can be placed, set up a dry run first. This can help with camera aiming as well as other logistical issues.

If you have never taken a system on site, there may be many issues you had not considered. The following sections discuss some of the finer details of capture in outdoor environments.

Precautions

The following precautions may or may not need to be addressed in your situation and do not replace your equipment's original instruction manuals. Please refer to your original documentation for detailed information.

Temperature: Vicon T-Series equipment has an operational temperature range of 5 to 35 degrees Celsius (40 to 95 degrees Fahrenheit). It may be necessary for you to provide cooling or heating for other computer equipment as well.

Humidity: Ensure that the equipment is not subjected to a humidity range that can cause condensation. Water condensation can cause corrosion of the housings, connectors, and internal electronics. When moving equipment from a cold environment to a warm moist one or vice versa, ensure that it's done slowly so that the equipment can adjust properly. Sudden temperature changes can also cause moisture to condense on the internal surfaces of the camera lenses.

Moisture: The Vicon T-Series equipment was not designed to be water-resistant or waterproof and should be protected from all sources of water. Be aware of the ratings of your other hardware and ensure that you have the correct cleaning supplies on hand to service your equipment. Consider bringing plastic bags that can cover your cameras, Giganet, and PC in the event of unexpected precipitation. The Giganet and PCs will require some venting, so ensure there is adequate airflow.

Dust: The LEMO connectors used on all Vicon T-Series equipment are semi-dust resistant. However, dust can build up on equipment surfaces, in and around the T-Series camera's heat sink, and in the fans on the Giganet's power supply. Ensure that

these areas and similar areas on other equipment are kept free from dust build up and cleaned if needed. Use lens caps for the cameras when not in use. Have a can of dusting air and lens cloths available for cleaning purposes.

Electrical Power: If a generator is used, ensure that it has a power conditioner. A UPS system is recommended in case of a generator failure. Know the amount of Wattage required and plan accordingly; insufficient power levels can damage all types of electronics. All power cables and power strips should have the proper ratings.

Markers: To maximize reflectivity, keep all markers dry and clean. Moisture, as well as dust and oil from handling, dulls markers rapidly, especially in outdoor conditions.

Tripods: Tripods must be solid and have easily adjustable legs to account for differences in terrain. Ensure that the base is wide enough for the height that will be used. Do not allow tripods to become unbalanced. Tripods can sink into the ground over time; use base plates as necessary to prevent sinking. Check calibration often and recalibrate if needed.

Direct Sunlight: Avoid aiming cameras directly into the sun. If necessary, don't aim cameras for long periods of time. On very rare occasions, some damage to the imager may occur.

Environmental Conditions

The following conditions and objects create different results in daylight outdoor use.

Foliage: Grass, leaves, and other plant material is highly reflective of Infrared light wavelengths. To the human eye and in color images, these objects appear to be darker in color. However, since they reflect Infrared light, plant materials will appear brighter to the T-Series cameras. Fortunately, individual Infrared blades of grass and leaves are orientated in many different directions, thus scattering the Infrared light in many different directions. If these objects are in the background they usually do not present any major problems.

Clothing: The subject's clothing can also react differently outdoors. Materials with a high percentage of cotton will appear much brighter. Some artificial materials are highly reflective of Infrared as well. Clothing laundered with fabric softener or whitener may also reflect Infrared light more readily. Athletic equipment can also have shiny surfaces that can reflect a glint of sunlight towards the cameras.

Sky: A clear blue sky with the sun overhead has less Infrared wavelengths because of Rayleigh Scattering. As the sun sets, more Infrared is present as the horizon becomes red in color.

Clouds: With the sun overhead, a cloud layer will diffuse the light giving the background a more homogeneous brightness. Thin layers of clouds at the horizon will reflect less Infrared light than walls of fluffy storm clouds. Storm clouds on the horizon can reflect a great deal of Infrared light, especially as the sun is setting opposite them.

Wind: Plan ahead when it comes to the wind since it can be unpredictable. Not only will wind stir up dust, but it may cause the cameras on the tripods to vibrate or move. Be sure your tripod mounts are very solid and can withstand a sudden gust of wind. Sand bags can be useful to help stabilize tripods prior to calibration. Calibrate often to reduce impact of any camera movement.

Surfaces: Ground and building surfaces can diffuse or reflect Infrared light wavelengths depending on how smooth a surface they have. If at all possible, do a test prior to your actual capture to determine if surfaces are affecting results. Pay special attention to nearby water surfaces since wave patterns can vary greatly.

Heat: Changes in temperature can affect tripods and therefore camera position or orientation. Heat bands in the air can cause optical distortion affecting perceived marker position. Also, thermal expansion and contraction of the camera's lens may require recalibration.

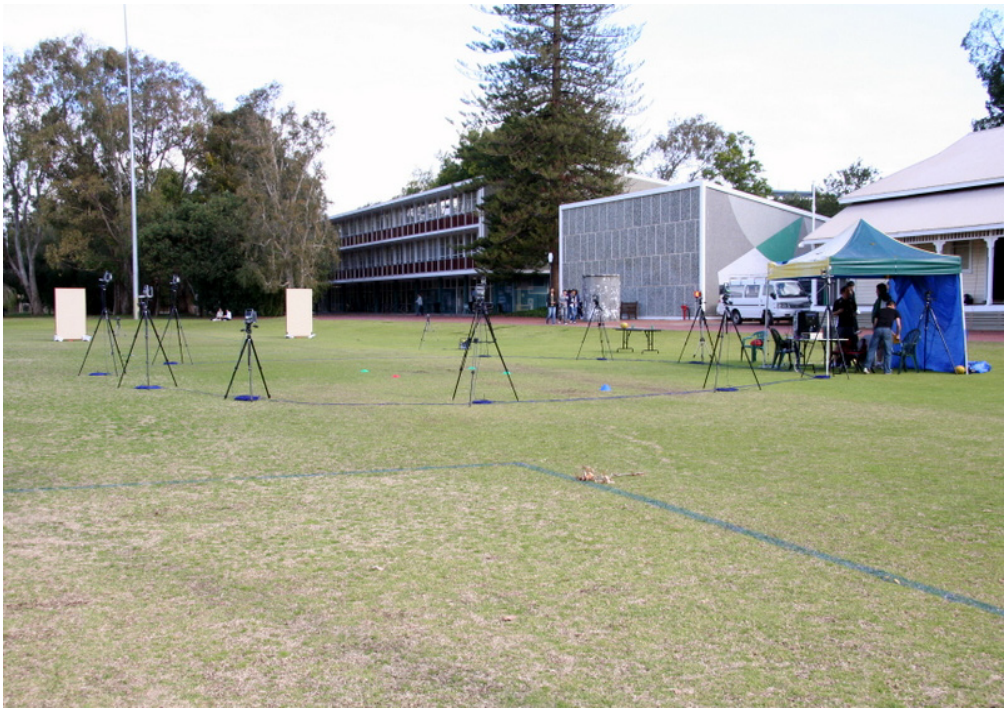
Artificial Lighting: Many sports fields have lighting that is used during the day, so be prepared and know which lights will be on or off during your capture.

Sunlight: Computer screens and other displays can be difficult to see outdoors in the daylight. You will likely need shading so that equipment displays can be seen. A portable canopy over the main equipment station is helpful.

Suggested System Setup

While it is difficult to describe all possibilities for the system setup for daylight capture, this section provides some general guidelines system setup and configuration.

Position the cameras around the capture volume just as you would for indoor use. If possible, set up the cameras at a higher location aimed down toward the ground to minimize the possibility of the sun shining directly into a camera lens. This will also minimize background reflections. If time permits, set up one camera on its tripod first and connect it to the system. Using your desired collection frequency, do some experiments to determine the best lens aperture setting. This can then be set on the remaining cameras before they are installed on their tripods.



Cabling can be run from one central location around the perimeter of the area to each camera. If the cable is lying on the ground, protect it from moisture, dust, and foot/vehicle traffic.

Use spare markers on the ground to assist in aiming the cameras. It can also be useful to have markers on stands that can guide aiming for the height of the capture volume.

If possible, plan out the setup and test it indoors before proceeding on site. Cables and cameras can be pre-adjusted and labeled for faster setup. Lenses can also be focused for the correct working distances.

Calibration Methods

Because of wind, heat issues, and the possibility that cameras can get bumped more easily, perform calibrations more often. Otherwise, the calibration procedure is the same as used indoors.

System Configuration

The configurations used for capturing in daylight settings will vary greatly depending

on the geographical location, time of year, time of day, and the weather conditions. Therefore, it is not feasible to describe every possibility in exact detail. Below is a discussion of general guidelines for the system configuration along with some typical settings for the camera system. Your applications will be similar in some way and possibly very different in others. It is important to carry out preliminary tests to fine tune all system settings.

Lens: In daylight, it is necessary to close the lens aperture to reduce the amount of ambient light reaching the camera's imager. Typically, a Vicon 18 mm lens will need an f-stop of 5.6 or greater. Because the amount of ambient light varies, always perform a test during setup to adjust the f-stop for the current conditions. Markers placed over the camera's field of view can be used to get the aperture set.

Camera Masks: Be cautious not to mask too many areas of each camera's field of view. Remember, markers will not be tracked when they enter a masked area so try to keep masking to a minimum. Also, if the cloud cover is changing rapidly, carefully monitor the areas you have masked. Changes may need to be made over time.

Strobe Intensity: Keep the strobe intensity setting as close to "1" as possible. This will maintain the maximum amount of light coming from the strobe to provide marker reflection.

Threshold: Because of additional light in the scene, camera thresholds will be on the higher end of the range. They may be about 0.9. Perform a test and balance this setting with the lens aperture. Ensure that the lens aperture is closed enough so that you are still able to maintain a threshold that does not exceed the maximum. If the daylight conditions change dramatically at some point, you'll need to adjust to the change using the camera threshold setting without having to change the lens aperture setting.

Circularity: As with indoor capture, set the marker circularity as high as possible. This can also help by rejecting any background reflections that might be mistaken for markers. The circularity setting is similar to controlled lighting situations. Make most adjustments using the camera threshold setting.

Grayscale Mode: If possible, set the camera's grayscale mode to "none." In this

mode only marker centroids will be transmitted. This will also help with not allowing random background reflections to be mistaken for markers

Sample Settings

The table below shows several T-Series cameras optimized for a *particular* outdoor setting. These sample settings may not suit your environment, but may provide ideas on where to start.

Table 1 Sample outdoor settings for T-Series camera

Camera Type	T40		T40S		T160	
Strobe Degree	NIR Std	NIR Std	NIR Std	NIR-Std	NIR Std	NIR Std
Lens (mm)	18	18	18	18	18	18
Aperture	5.6	5.6	5.6	5.6	5.6	5.6
Threshold	0.22	0.1	0.4	0.32	0.18	0.1
Frame Rate	120	240	120	240	120	240
Marker Diameter (mm)	14	14	14	14	14	14
Distance (ft)	36.7	32.9	39.9	35.9	36.5	29.3

Other Considerations

- Aperture can be stopped down to higher levels than normal (i.e., f-stop of 5.6 or 8.0 or more are typical).
- Threshold is a very important parameter. It may have to be run at 0.8 - 0.9.
- For particularly challenging environments with significant direct sun exposure on a lens, you may want to experiment with sun visors, flags, or "barn doors."
- Outdoor lighting changes throughout the day. You may need to adjust settings and masks accordingly.