

# Computer-Aided Drowning Detection

## An Overview of the Poseidon System For Architects and Engineers

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## **An Overview of Poseidon for Architects and Engineers**

### **Introduction**

Poseidon, the world's first computer-aided drowning detection system, is one of the most exciting developments in aquatics in several decades.

Poseidon uses advanced computer vision technology to analyze activity in the pool. It helps lifeguards monitor what is happening below the surface of the water, and can alert them in seconds to a swimmer in trouble.

Already, many existing pools across Europe and in the United States are equipped with Poseidon. Interest is high among pool operators and owners who are planning new facilities in the future.

This overview was designed for architects and the engineers they work with. It describes Poseidon in detail, gives specific information about how the system can be integrated into design plans, and explains the support available during the entire design and installation process. With it, you can work with clients to design state-of-the-art pools, ones that incorporate the most advanced safety features *before they even open*.

### **Poseidon Technologies, Inc.**

The Poseidon System was created by Poseidon Technologies, a company focused on applied mathematics for computer vision and image processing. Poseidon has developed a set of software components for computer-aided video-surveillance, creating the world's first "Scene Interpretation Software Engine" able to work under natural lighting conditions. The engine is capable of: capturing the diverse elements that make up a scene under natural lighting conditions; reconstructing them accurately to produce a virtual, or 3D representation of the scene; and eventually interpreting what is seen, and acting accordingly.

As with many breakthroughs, developing vision technologies that could reliably save precious seconds in drowning incidents took years and long-term partnerships. In addition to its own research team, Poseidon leverages partnerships with academic research and leading applied mathematics laboratories. We have also worked with the world's leading

aquatics professionals to develop and test Poseidon, ensuring it is well suited to the demands of the pool environment.

Now, we'd like to work with you.

## **What is Poseidon?**

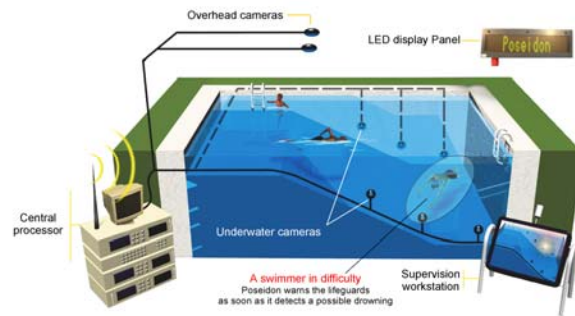
### **Poseidon Is Not Intended To Be A Substitute For Lifeguards' Vigilance.**

*It is impossible to train lifeguards to see what they cannot see.* Poseidon is an intelligent solution that uses proprietary computer vision technology to give lifeguards the tool they need to help them with the toughest part of their jobs: maintaining constant pool surveillance. Through sophisticated monitoring of swimmers' trajectories, the system is able to alert lifeguards in the event of a dangerous situation and help them initiate a rescue more quickly.

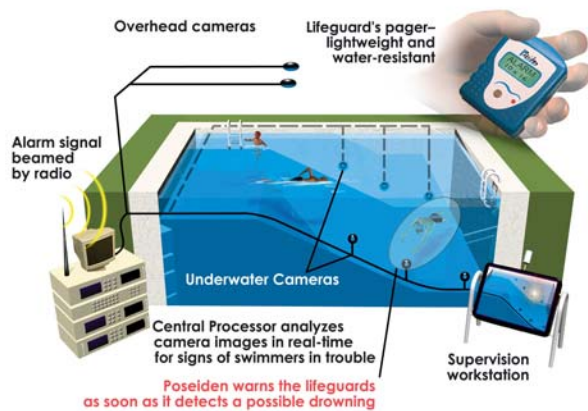
Computer vision technologies have been in development for more than two decades, enabling the first computers to "see" so that they can do things like inspect parts in manufacturing processes. However, these applications have been very limited, since they only work in highly constrained environments where camera position and lighting can be tightly controlled.

Thanks to significant advances in hardware and image processing technologies, Poseidon Technologies has been able to free computer vision from its industrial confines and apply it in natural, constantly changing environments. The system and its components represent fundamental breakthroughs in computer vision technology, including real-time image processing, light-condition-independent computer vision, and three-dimensional image analysis.

Poseidon is made up of various software and hardware components, all of which are delivered as part of the system.



Indoor Installation



Outdoor Installation

Poseidon uses a network of cameras mounted in the pool walls and above the surface of the water. The cameras are linked to a central processor unit to monitor the trajectories of swimmers in the pool and to analyze, in real time, their activity. The system can automatically identify suspicious situations, such as a person who is immobile or slowly sinking. In seconds, it alerts lifeguards via large LED panels indoors or alarm pagers outdoors and at a supervision workstation to the exact location of the swimmer in danger.

## The Software

Utilizing complex mathematical algorithms and state-of-the-art computer advances, Poseidon's patented technologies, ActiVolume™/TextureScan™ for underwater cameras, CapScan™/Twinscan™ for overhead cameras and the VITTE™ virtual target tracking engine, allow the computer to analyze and interpret the situation within the swimming pool. These technologies help the system overcome an important challenge: to be able to accurately discriminate, in real-time, swimmers or objects from mere light artifacts, such as shadows or reflections.

*ActiVolume™* and *TwinScan™* analyze images in real-time provided simultaneously by at least two cameras using stereo-vision techniques (the analysis of several simultaneous pictures taken by cameras) to distinguish

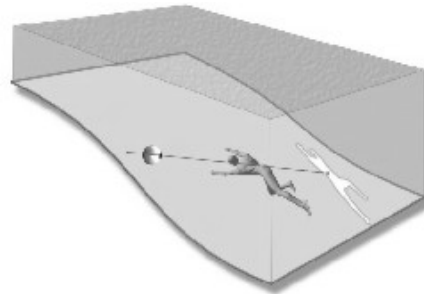
between shadows and objects. With *ActiVolume™* and *TwinScan™*, Poseidon can tell the difference between a body, which has volume, and a shadow or patch of light, which does not. (See Figures 1-3)

The application of this technology requires precise knowledge of the geometry of the bottom of the pool and the position of the cameras in relation to the pool bottom. The dimensions of the pool are taken by a professional during installation to ensure a high degree of accuracy.

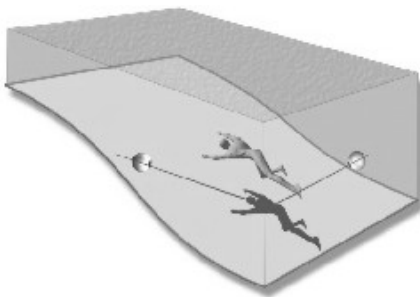
### Poseidon's Software Components

As Figure 1 shows, any body within the volume of the pool has a projection in the view of each camera (white shape) on the bottom of the swimming pool. In the case of a shadow (Figure 2), the projections observed by the various cameras overlap with the shadow itself. Therefore, there is no volume.

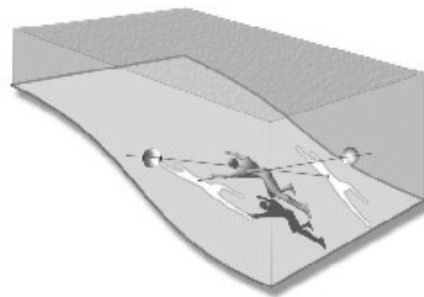
In the case of a body underwater (Figure 3), the projections are distinct: there is volume.



1. Projection of a body at the bottom of the pool



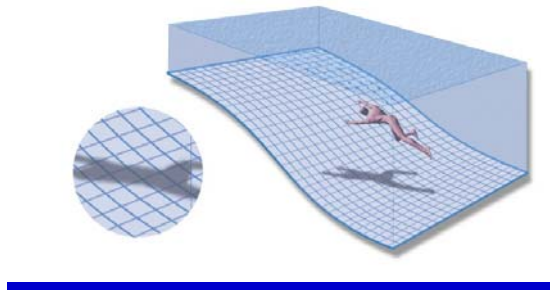
2. Shadow



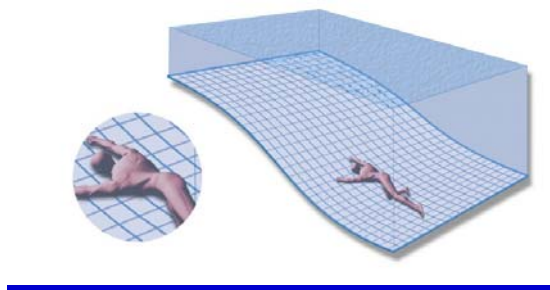
3. Body underwater

*TextureScan™* and *CapScan™* analyze the texture within the image to detect the presence of a body or an object amongst the many patterns present in the background of a scene—regardless of lighting conditions.

In case of a shadow:  
The shadow texture is added to the pool texture.  
The pool texture remains visible



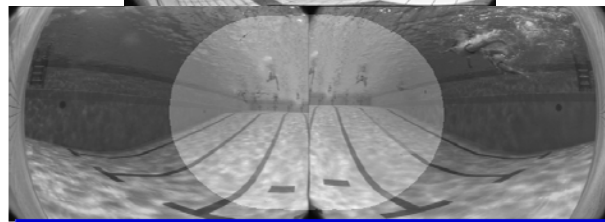
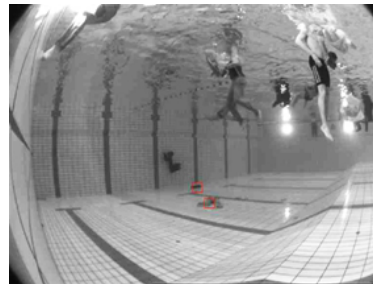
In case of a body:  
The pool texture is hidden by the body.  
It is replaced by the body's texture.



## The Hardware

Poseidon consists of the following hardware components:

- **Underwater Cameras (For Pool Depths Greater Than 7')**  
High-quality digital cameras optimized for use in swimming pools are attached to the pool walls under the water surface. Each multi-lens camera unit has a combined field of vision exceeding 180°—assuring redundant surveillance over a broad area of the pool.



Std. camera view (light gray) vs. 180° Poseidon view

- **Overhead Cameras (For Pool Depths 2' – 7')**  
Mounted above the water surface, these cameras extend Poseidon's monitoring capabilities to areas of the pool where underwater cameras may be obstructed by swimmers standing in shallow water.



- **Central Processor**

Using a fiber optic network, the cameras are linked to a central processor that analyzes the video feeds in real-time. The computer can identify suspicious situations, such as a slowly sinking or immobile victim, and trigger an alarm. The hard drive records and stores all events that trigger an alarm, and enables previously recorded events to be viewed. The central processor is linked to the main server at Poseidon's headquarters to allow for system monitoring, upgrades and remote maintenance.

This example below shows the server setup for a 3-pool facility with 3 systems:



- **LED Display (Indoor Pool Installations)**

The LED display is designed to be installed high on the wall of an indoor pool facility, such that it is visible from anywhere on the pool deck. With 7" tall letters, it can be read from as far away as 280'. When the system is armed and monitoring the swimmers in the pool, "Poseidon" is displayed in green letters, letting the lifeguards know that the system is on. The pool is assigned an X and Y axis, which the lifeguards are taught. When there is an alert, the LED displays the coordinates of the victim, alternating with the elapsed time of the alert. In addition to the visible alert, there is also a 100db siren that sounds during an alert.



- **Alarm Pagers (Outdoor Pool Installations)**

The lightweight, water-resistant Poseidon pager uses both audible and vibrating alarms. With a range that extends more than 200 feet, the unit also displays the exact location of the incident and the elapsed time since detection.



- **Supervision Workstation**

This workstation serves as the command center for the system. It is where the lifeguards log in and out to turn the system on and off. Equipped with an integrated flashing light and buzzer, the workstation has a touch-sensitive screen to select viewing and surveillance options (depicted below). Passwords limit access to the system and lifeguards can view a particular zone in the pool—even zooming in on a suspicious area.



## **The Steps to Integrate Poseidon into Pool Design Plans**

### ***It Begins With System Design...***

Poseidon Technologies knows that every pool is different. As a result, we design each system specifically for the unique characteristics of the aquatic environment in which it will be fitted. Our professionals take into consideration many factors, including volume of water, lighting conditions, shape and texture, to ensure Poseidon precisely monitors swimmers in specific settings.

While Poseidon can be installed in existing pools (the case in many of our current installations), the ideal time to install it is before a pool is built, when it can be seamlessly integrated within the pool while construction is underway. This integration should begin during the pool's schematic design, and continue through the entire design process.

We begin with a review of the pool plans, its shape and depths. Once this information is gathered, Poseidon technicians prepare a Technical Study Layout (TSL). This study shows the locations and depths of the underwater cameras and the locations and heights of the overhead cameras. It also details the areas of the pool covered by the system's detection and video modes.

Using the TSL results, Poseidon technicians may discuss any appropriate changes to the system layout to accommodate the facility, or review potential adjustments in the pool design which would increase the level of drowning detection coverage.

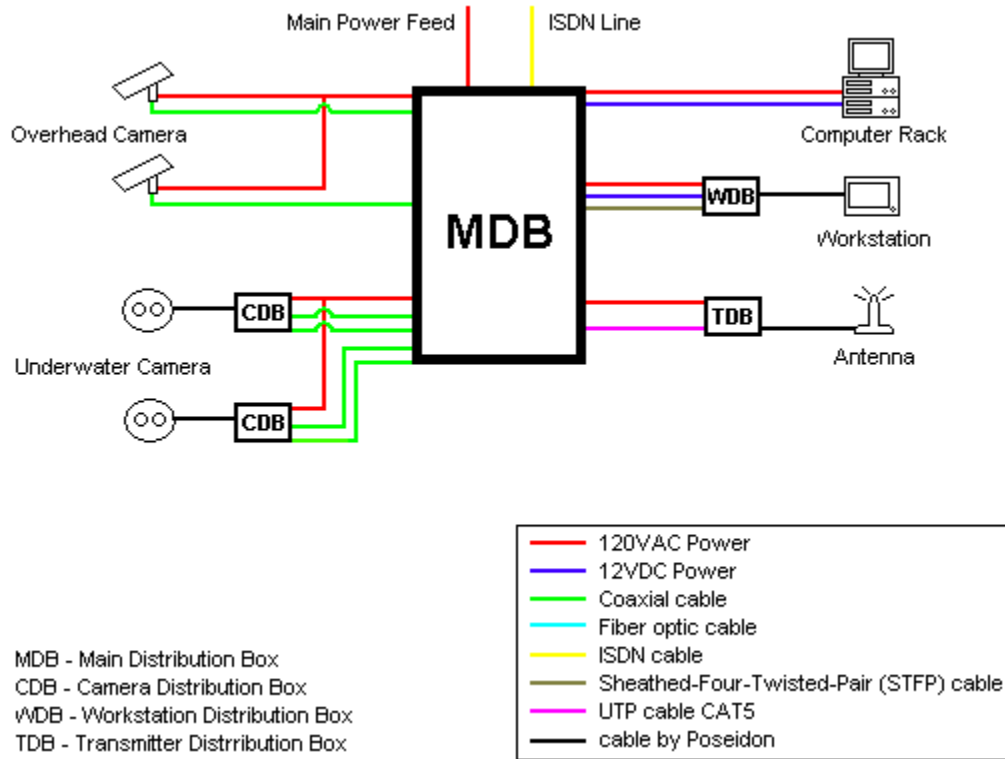
### ***Then Moves To Installation of All The Components...***

Once the TSL is completed and approved, Poseidon Technologies provides an installation guide to assist the electrical engineer in adding the system to the construction drawings and technical specifications. We also provide a cost estimate for the system; actual installation costs are developed by the pool's electrical engineer or the electrical contractor, working with Poseidon Technologies professionals as required.

Before system installation begins, Poseidon Technologies delivers all of the systems' components to the approved contractors. These components

are connected together and operate seamlessly from the main distribution box.

### Poseidon System Components



### Main Distribution Box

The components of Poseidon are connected to the main distribution box (MDB) for both data transmission and power supply. The MDB, which is backed up by an uninterruptible power supply, is provided by Poseidon Technologies and installed by the purchaser. A 120 volt, 30 amp power supply is required to run the system, as is an ISDN line that allows Poseidon Technologies to continuously monitor the system's performance. Both the power supply and ISDN line are supplied by the purchaser.

## **Underwater Cameras (For Pool Depths Greater Than 7')**

The Poseidon system uses underwater digital cameras. Each camera is connected to its camera distribution box by a coaxial/low voltage power cable and connector, all supplied by Poseidon Technologies.

In the pool, the cameras are attached to a mounting plate, which is fitted to the wall by the contractor. A 2.5 inch diameter waterproof conduit running from the mounting plate through the pool wall to the pool deck is required for the connection; it is provided and installed by the purchaser.

For outdoor installations, the camera distribution box (see description below) should be housed in a waterproof box, provided by the purchaser. Because of the voltage drop in the low voltage system, the maximum length of cable from the underwater camera to the distribution box is approximately 40 feet. The box should be located at the edge of the pool deck, above ground level. The installation is similar to the transformer required for a low voltage pool lighting system.

For indoor installations, the camera distribution box is usually mounted on the natatorium wall. In this case, a waterproof box is also required to protect the components from the harsh pool environment.

The underwater cameras must be properly grounded and installed in accordance with local codes.

## **Overhead Cameras (For Pool Depths 2'-7')**

Poseidon Technologies provides the overhead cameras and the camera housings. The purchaser (or contractor) provides the mechanical fixture kits and installs the cameras.

Poseidon Technologies can assist with the final positioning of the cameras. The ideal location for overhead cameras is above the edge or corner of the pool. For indoor installations, the mechanical fixture kit is usually attached to the roof's structural system. For outdoor installations, the cameras are mounted on Poseidon-specified pre-stressed concrete poles (included in installation cost) with arms to allow the cameras to extend over the edge of the pool. Poseidon Technologies professionals will provide information on the height of the pole and the allowable camera movement in the horizontal and vertical directions at a specified wind load.

The camera signal is transmitted through 75 ohm coaxial cable to the MDB. Each camera must have a direct connection to the MDB. The camera requires a 120 volt power supply and can be provided in series. The power supply originates in the MDB. The coaxial cable, power supply cable and separate conduits are provided and installed by the purchaser.

### **Computer Rack and Servers**

The computer rack, which houses the servers, is connected to the main distribution box. Poseidon Technologies provides the computer rack, the computers and the uninterruptible power supply to the computers. The customer provides and installs the power and conduit required to connect the computers to the MDB.

### **Workstation Distribution Box**

The workstation distribution box is connected to the MDB and transmits data between the computers and the supervisor workstation screen. This box is provided by Poseidon Technologies and installed by the customer, who is also responsible for providing and installing the power, signal cables and conduit needed to connect the workstation distribution box to the MDB. The cable connecting the interactive screen is provided by Poseidon Technologies and installed by the customer. The length of connector cable is limited to twelve feet. There is no limit on the distance between the MDB and the workstation distribution box.

The location of the interactive screen is determined by the purchaser. Some owners elect to install the screens poolside; others prefer to install it away from the deck, for example in the pool manager's office.

### **Transmitter Distribution Box**

The transmitter distribution box, which transmits the signal alerts to the beepers, is also connected to the MDB. This box is provided by Poseidon Technologies and installed by the purchaser, who also provides and installs the power and signal cables required to connect the transmitter distribution box to the MDB. The distance between the box and the pool area is limited by the strength of the transmitter (approximately 200 feet).

The limit on the distance between the transmitter distribution box and the MDB is 300 feet.

### **Camera Distribution Box**

The camera distribution box transforms the voltage and contains the necessary connections that link the cameras to the computers and to each other.

In summary, Poseidon Technologies and our customers share the responsibility for the successful installation of Poseidon in every pool. Here is what each delivers:

### **Hardware/Software Acquisition Cost Includes:**

- Computer vision software package
- Main Distribution Box
- Cameras, both overhead and underwater as appropriate
- Camera Distribution Boxes for underwater cameras as appropriate
- Computers and rack for storing them
- Uninterruptable Power Supply
- Workstation Distribution Box
- Interactive Touch Screen
- Transmitter Distribution Box
- LED Display (Indoor Installations)
- Lifeguard Pagers (Outdoor Installations)

### **Installation Cost Includes:**

- Main distribution box power supply and ISDN line
- Purchase and installation of power, signal cables and conduit to connect computers to the MDB
- Installation of the workstation distribution box; purchase and installation of power and signal cables, conduit to connect workstation distribution box to the MDB
- Installation of the cable between the interactive screen and the workstation distribution box
- Installation of transmitter distribution box and purchase, installation of power and signal cables, conduit required to connect transmitter distribution box to the MDB
- Purchase and installation of the mechanical fixture kits for overhead cameras

- Purchase and installation of the protective box housing the camera distribution box for outdoor installation of the underwater cameras
- Installation of underwater cameras and mounting plates attached to the pool wall
- Ensuring underwater cameras are properly grounded and installed in accordance with local codes.
- A three dimensional model of the pool. This takes into account the pool shape, any patterns on the floor, lights, and underwater camera locations. A technical specification and explanation are provided to a surveyor of the purchaser's choice. "As built drawings will be sufficient in areas of the pool that are covered by overhead cameras.

### ***The System is Tested, Then Tested Again...***

Once the initial steps are complete and the pool is filled, Poseidon technicians then connect all of the components and activate the system. Over a period of three to four weeks, they perform the set-up of the system, which consists of creating the set of software parameters specific to the pool, and then perform rigorous validation tests. They also ensure that the system has been properly installed.

### ***Now, Poseidon Is Ready To Operate...***

Since it is considered a complementary tool for lifeguards, the system training program for lifeguards is vital. Once the lifeguard system training is complete, the system is turned on and fully operational.

### **The Poseidon Support Network**

Poseidon Technologies provides all of the supporting technical staff to ensure that system installation runs smoothly. Our trained engineers work closely with the architects and engineers designing and building the pool to ensure Poseidon is accurately installed and operational. They are available 24 hours a day, seven days a week through the duration of the project.

However technical support doesn't end when the system is turned on. Architects' clients can choose from a wide range of maintenance and support options, from simple software upgrades to full-time, uninterrupted technical support.

## Now That You Know More

This overview provides a simple background on Poseidon and its role in helping to raise the safety levels of the pools that you design.

We're here to answer additional questions, or to talk about your specific plans and how Poseidon can fit into them. Just give us a call!



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