Optimizing Swimmers' Performance

using DASYLab®

Introduction

The Counsilman Center for the Science of Swimming, part of the Indiana University Human Performance Lab, was founded in 1995. Named in honor of Big Ten coach James "Doc" Counsilman, credited with 23 Big Ten Swim Team Championships and four National Championships, the center leads the nation in academic research for the science of swimming performance. According to the Center's Web site, the facility explores the use of video and electronic technology to assess the performance of competitive swimmers, provides a source for independent perspectives on training, and acts as a testing facility for the physiological, psychological, and biomechanical status of athletes.

"DASYLab's graphical user interface allows students to easily make real-time adjustments. They spend more time conducting research and eliminate the need to learn complex programming."

Dwight H. Hector, Ph. D. President
Hector Engineering Co., Inc.

Challenge

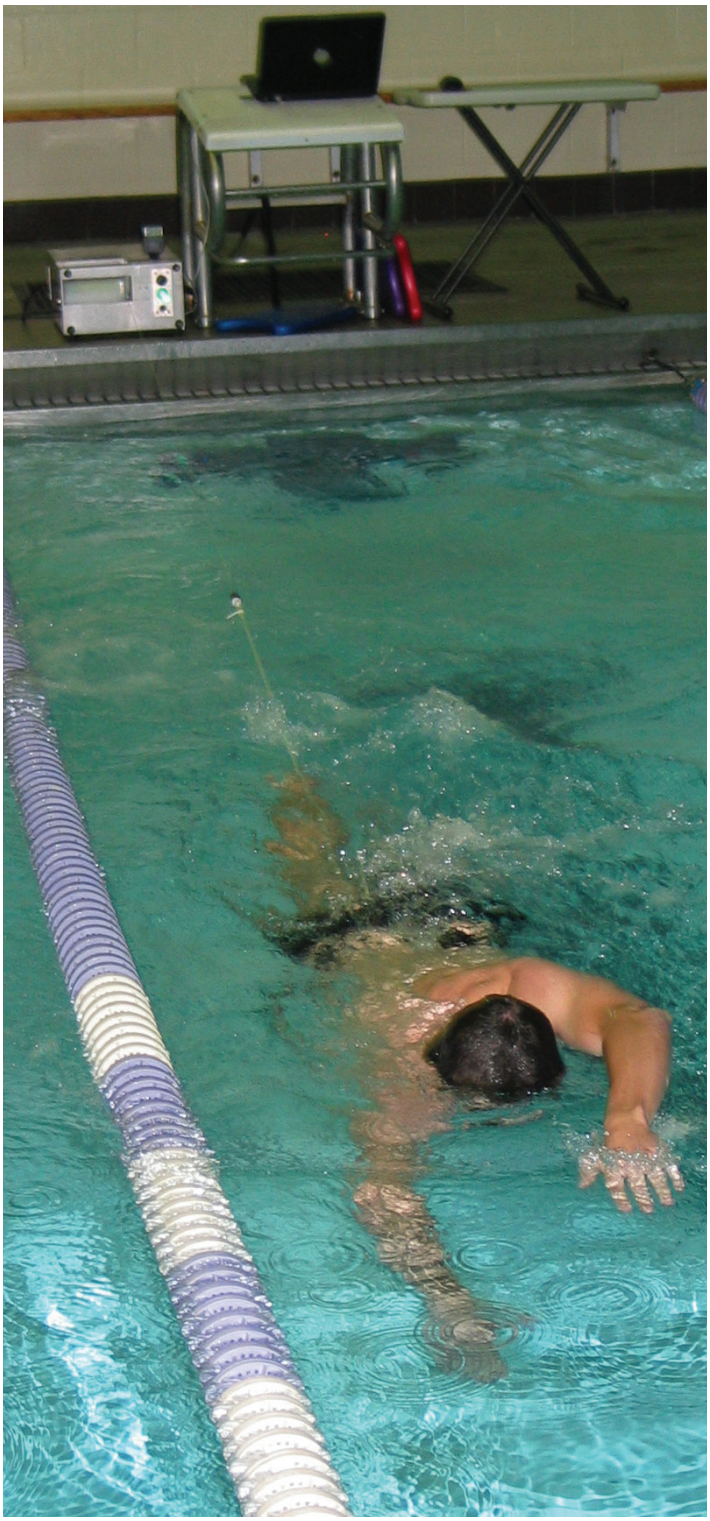
In a sport where fractions of seconds determine champions, sophisticated training programs, like those developed at the Counsilman Center, define the outcome of today's swimming competitions. Coaches and trainers seek reliable methods to train aquatic athletes on a variety of factors, many of which are obstructed under water or impossible to realize by sight. For those who research and define training programs, it is essential to assess and have objective measures of speed, power, stroke length, stroke frequency, and drag. In addition to the uniqueness of each swimmer, the dynamics of the pool itself also must be taken into account.

Solution

To support the cutting-edge research at The Councilman Center, the Center engaged Hector Engineering based on the firm's expertise in designing and fabricating custom sensor, measurement and control instrumentation for biological, physiological, kinesiology and human performance laboratories.

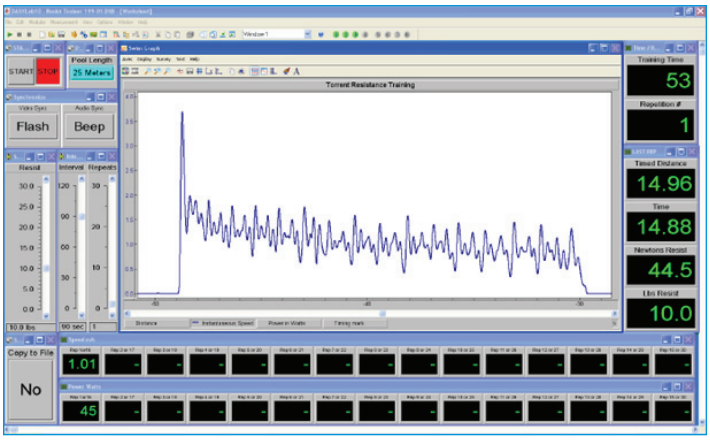
The Torrent E-Rack is capable of measuring, graphing and displaying real-time swimmer data such as distance, time, speed, power, force, and maximum thrust

Hector Engineering created the Torrent E-Rack™ built on Measurement Computing's DASYLab®, an icon-based data acquisition, graphics, control and analysis software program used to create complex applications without programming. The Torrent E-Rack is capable of measuring, graphing, and displaying real-time swimmer data such as distance, time, speed, power, force, and maximum thrust. To acquire the data, the device uses Measurement Computing's compact and rugged USB-1408FS, PC-based analog and digital I/O data acquisition module. The USB-1408FS is encased in a stainless steel water proof housing protecting it and the other electronics from the harsh chemicals of the pool environment. The USB-1408FS receives input from a tachometer measuring speed, optical counter measuring distance, and control switches. The device outputs voltage to a power interface board controlling power to a motor, electronic clutch, electronic flash for video synchronization, signal lights and horn.



Torrent E-Rack control system computes and displays number of strokes, strokes per meter, meters per stroke, and power in watts per stroke

During a swimmer's training program, the Torrent E-Rack provides automatic control of forces during speed and power tests, and records data on screen and to an Excel® file. The device can also set and maintain an appropriate resistive or assistive training force for a swimmer during repetitive training trials.



Sample Free Style Resist Training Repitition showing first repitition of resist training session

Torrent E-Rack

The Torrent E-Rack consists of a stainless steel enclosure with water proof fittings containing a reel with line connecting to the swimmer. A force generating system, motor, and electronic power interface operate the device. A speed sensor connected to data acquisition and signal conditioning hardware provides inputs to DASYLab, where data is displayed or logged to a spread sheet for further analysis and record keeping.

Programs for six test and training modes are included. In the Speed and Power program, the instrument allows the user to measure and record time, distance, peak speed, peak power, and stall force (maximum dynamic thrust up to 43 lb). These values are used to evaluate a swimmer's speed and power, determine appropriate resistive training forces, and assess the swimmer's improvements periodically throughout a training program. In the Resist Training program, a desired resist training force, the number of repetitions, and the repetition interval are set. The swimmer swims to the far end of the pool and the E-Rack senses when the swimmer stops and retrieves the swimmer to the starting position. After the preset interval, the swimmer is signaled to start the next trial. After the preset number of repetitions has been completed, the instrument stops. All data collected can be stored for later analysis. The Assist Training program allows the user to set a desired assist force, training interval, and number of repetitions for a training protocol for an individual swimmer. The swimmer swims out at a preferred unresisted speed, and at the turn, the set assist force is automatically applied and assists the swimmer to swim at a higher speed returning to the original position. Audible signals are given to direct the swimmer's training sequence.

Another program combines the Resist Training and the Assist Training in each repetition. A Towing program allows the swimmer to be towed at a higher speed for studying streamline posture at the push-off.

A Timed 10 Meter Sprint program measures the swimmer's average speeds over repetitive ten meter sprints with selected resist forces. The program displays in real time distance, time, speed, power, force, peak speed, and peak power. Using the DASYLab interface and modules, the number of strokes, strokes per meter,

meters per stroke, and power in watts per stroke can easily be determined from the real-time on-screen record. When power is plotted against strokes, and peak power is plotted against peak speed, it is possible to compare the performance of a swimmer to the performance of the fastest swimmers, and determine the most appropriate training protocol for improving strength or speed. All of the modes record instantaneous and average speed over the length of the training distances so that stroke-by-stroke analysis can be performed if desired.

Using DASYLab, Dr. Hector was able to easily define custom displays for each of the six programs. A chart recorder displays distance, speed, and power. A vertical meter set records and displays training session time, repetition number, resist and assist forces in Newtons and pounds for each repetition. These meter values are held until the next repetition begins. Another meter set captures and holds values for average speed and average power. The last 15 repetitions are held with a maximum total of 30 repetitions for each session. Using DASYLab's drag-and-drop icons to build the interface, Dr. Hector incorporated pull-down scroll bars, allowing on-screen measurement for any values displayed on the chart recorder. For any mode of operation, values at any point, including: maximum and minimum values for each stroke, acceleration at any point, average over any interval, stroke rate, and stroke length are available. And for each of these, DASYLab provides zooming for better analysis of chart record data.

Result

With the Torrent E-Rack solution and DASYLab, research students can now devote more time to conducting their research trials. With the ability to make real-time adjustments with the graphical interface, the need to program complex software updates is no longer required by the researchers. Hector Engineering saved hours of development time creating the E-Rack interface with DASYLab's intuitive graphical programming and library of modules. They were able to concentrate their efforts on providing their domain expertise without investing in learning complex programming languages. In addition, Hector Engineering realized savings by using DASYLab modules to perform calculations in software rather than acquire the measurements with more expensive hardware devices.

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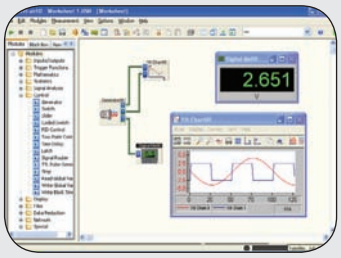
Products used in this application:



ICON-BASED DAQ SOFTWARE
DASYLab®

- Create powerful applications without writing code
- Control, analysis, display, reporting, and more
- Included support with most MCC hardware

LOW-COST MULTIFUNCTION MODULE
USB-1408FS

- 8 analog inputs
- 14-bit resolution
- 48 kS/s sampling
- Digital I/O, counters/timers
- 2 analog outputs
- Included software and drivers