Fully Automatic Timing on a Mobile Device

Jack Jorgensen (jackj@stanford.edu)
Darin Im (darinim@stanford.edu)

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Background

The advent of fully automatic time (FAT) in the middle of the 20th century allowed for incredible precision when timing professional athletic events and competitions. Today, FAT and its derivatives are used in a wide range of competitions, including track and field meets, swimming events, horse racing, and motorsports.

While coaches will tell you that these FAT systems are invaluable to training and competition, they are expensive to purchase and their operation usually requires a team of people to ensure all things are running smoothly. In addition, the accuracy of these systems far exceeds the requirements of any coach or athlete in a training environment. Thus, we are proposing creating a fully automatic timing application on a mobile phone that will make accurate electronic timing accessible to mobile phone users at a fraction of the cost of typical systems.

Project Plan

We intend to create an application that will allow a coach to time a single runner with a mobile device. With the phone in hand, the coach will take a picture of the finish area, and then indicate a finish line by drawing a line on the image. The endpoints of this line will be located in reference to several maximally stable extremal regions, and then this information will be saved for later use.

When ready, the coach will start the timer by clicking a button or by any sound command above a to-be-determined intensity. When the athlete is about to cross the finish line, the coach will click a button on the phone, and then the phone will "look" for a runner to enter the picture. To do this, we plan on using a background subtraction method, where we take a running Gaussian average of the pixels in the image before the runner arrives. For each frame, we will subtract the pixel values from the running mean, and any absolute differences above a certain threshold will be deemed part of the foreground. When a sufficiently large foreground has developed, the application will save each frame into memory for processing in the next step.

Now, with several frames from the runner crossing the finish line saved, we will determine the locations of the MSERs in the saved images and then use these to locate the finish line in each frame. By comparing the horizontal component of the leading edge of the foreground runner to that of the finish line, we will determine the time the runner crosses the line. To improve the accuracy of this operation, we

intend to linearly interpolate exactly when the runner crossed using two adjacent frames.

Currently, we intend to allow the camera to be handheld; however, if handshaking becomes a significant issue in matching MSERs, we will switch to simple mount.

Since the intention of this device is for a practice aid, it is only designed to detect one runner per operation, and thus we will not have to attempt to distinguish between different runners.

Capturing video on mobile devices can introduce the issue of rolling shutter. To compensate for this, we intend to measure the intrusion of a foreground runner onto the finish line on the same rows along the middle of the camera display. This allows for pixel rows from two frames to be compared while knowing the exact time difference between the two frames.

The output of this application will display a time to the coach, and will ask the coach if he or she would like to time again.

References

Real-Time Extraction of Maximally Stable Extremal Regions on an FPGA
Kristensen, Fredrik and W. James MacLean. "Real-Time Extraction of Maximally Stable Extremal Regions on an FPGA."

Background Subtraction Techniques
Piccardi, Massimo. "Background subtraction techniques: a review." 2004 IEEE International Conference on Systems, Man and Cybernetics. pp. 3099-3104.

Photo Finish Record System
Balko, Jack E., Davis F. Moffatt, and Durward F. Searcy. Photo Finish Record System. Specialty Instruments Corp., assignee. Patent 3829869. 13 Aug. 1974. Web.

Automated Interval Timing Method
Conant, James R. Automated Interval Timing Method Devices and System. James R. Conant, assignee. Patent US 2009/0213700 A1. 27 Aug. 2009. Web.

FinishLynx Commercial Timing Product
www.finishlynx.com

SprintTimer Mobile Race Timing Application
www.appmaker.se