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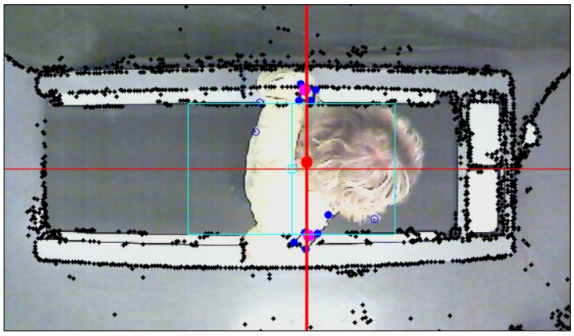
Subject Area	Digitale Signalverarbeitung
Project Partner	Sportma SA, Oslo, Norway

Speed Control of a Treadmill

by the use of a video camera



Corner detection algorithm applied to a video frame of the running system.

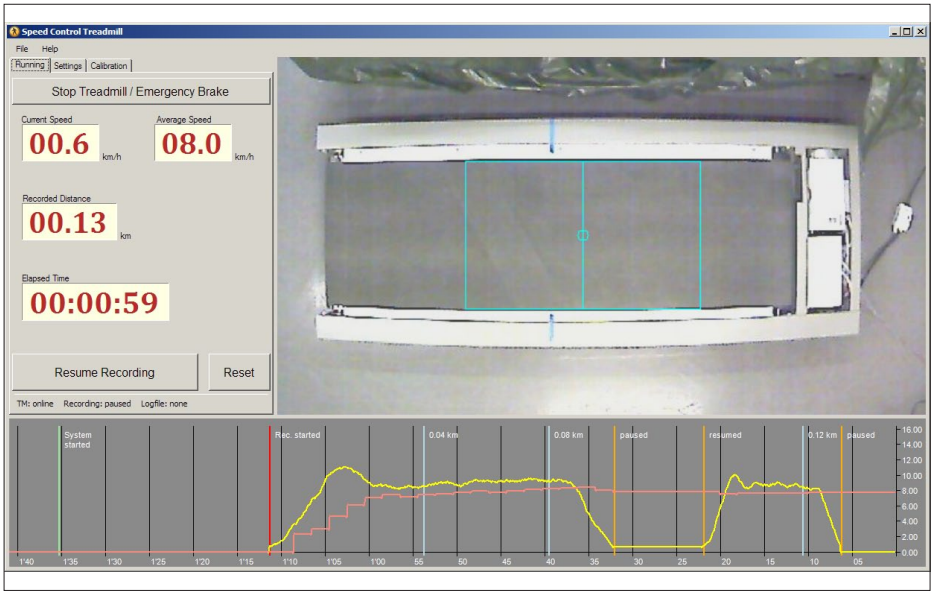
	Harris Corner Detection with Reflectors	Harris Corner Detection without Reflectors	Differential Detection	Combination Corner and Differential Detection
Needs Reflector	YES	NO	NO	NO
Sharpness Interference	medium	medium	low	medium
Ambient Light Interference	low	low	medium	low
Influence of Clothes/Hairdress of Runner	strong	strong	small	small
Initialisation Time	< 3s	< 3s	immediately	< 3s
Refreshrate (Release Version)	20-22 fps	20-22 fps	25 fps (limited by video framerate)	18fps
Time Delay	~0.3s	~0.3s	~0.5s	~0.4s
Reliability / Malfunction behaviour	medium	good	good	very good
Stability and Accuracy	good	good	medium	very good
Qualified for	dark and plain clothes	bright or patterned clothes	everything	everything

Overview of the implemented image processing algorithms

Problem: Common treadmills in sport centres run with a certain speed, predefined by a manual input of the runner. However, professional sports equipment should adapt to the user's behaviour instead of only following a fixed preset. That is why the company Sportma SA in Oslo wants to build a treadmill where users can run according to their own speed demands.

Approach/Technologies: The realisation of the application is based on the managed Visual C++ .NET Framework and uses the OpenCV library for image processing. The camera is positioned above the treadmill to catch both the X and Y axes to control the treadmill speed and to realise an emergency handling. The detection of the runner is solved by a Harris Corner Detection and a differential method comparing two successive frames. During the operation, the controller keeps the runner always in the middle of the treadmill. The application provides a development and a user GUI. In the development mode, it is possible to monitor the detection algorithm and controlling process whereas the user mode displays the speed data and allows to record the running data.

Solution: The developed detection algorithms work fine by their own and are optimised to its robustness. Nevertheless, exceptional circumstances can still lead to a fault of the detection. The combination of the algorithms can be handled in almost the same processing time but allows a safeguarding if one detection fails. A challenge was to find matching controller parameters, because of the non-linearity of the whole treadmill system. The parameters depend on the application areas and have to be optimised for the desired behaviour. An implementation of the detection and controller algorithm on a real-time system and using a non-LAN camera would reduce the delay between runner position and controlled speed.



The final application provides a graphical user interface for the runner and joins the image processing, controller circuit and I/O interface together.