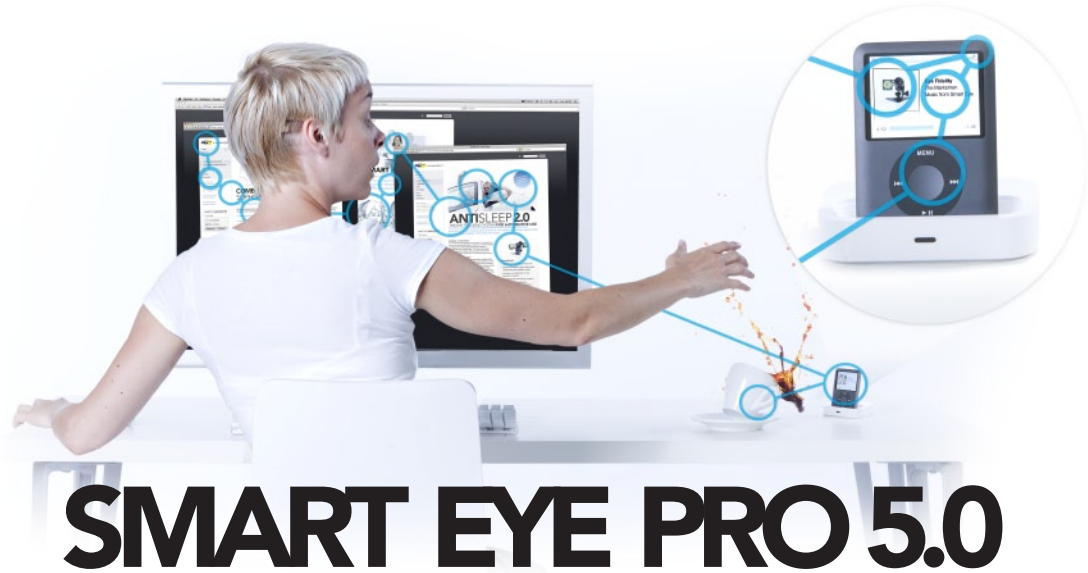

SMART EYE PRO 5.0

– THE ACCURACY OF CORNEAL REFLECTION AND THE HEAD BOX OF IMAGE PROCESSING

When measuring human machine interaction, non-intrusiveness is a key factor. It has also been essential to be able to measure unrestricted head motion in a large head box for optimal testing results. New technology has now enabled higher accuracy, while at the same time making it possible to measure a larger visual field.

INTRODUCTION

Recent advances in machine vision research and computer technology have now made it possible to measure head pose and eye state with great accuracy in real time, using video cameras. The latest technique combines a high degree of accuracy with the possibility of running a system with an extremely wide field of view. Several areas in which this application can be used include automotive safety research, operator performance evaluation, simulator studies, psychophysical studies, etc.

REQUIREMENTS

Realistic measurement scenarios offer a challenge to technical developers. In order to meet this challenge, the following demands were identified as decisive in the development of a new system:

- Immunity to difficult light conditions, including darkness and rapidly varying sunlight.
- Non-intrusiveness, allowing natural behavior. No strings attached, automatic profile generation etc.
- Field of view large enough for free and unobstructed head movement.
- Small cameras and flexible camera placement, enabling installation in constrained spaces such as instrument panels and cockpits.
- No moving parts, such as pan/tilt cameras or motorized iris/focus/zoom lenses.
- Independent of any particular camera technology. Should be able to run on a cheap VGA CMOS board camera, as well as high-resolution CCD industrial cameras.
- Run on standard off-the-shelf hardware (computer, cameras, etc.)
- Modular software with a platform-independent and portable kernel. Use of standard interfaces wherever possible.

TECHNOLOGY

IR illumination

In order to cost-effectively maximize performance under extreme light conditions, Smart Eye Pro 5.0 uses an innovative IR lighting approach, which suppresses the effect of sunlight and shadows, and enables the system to work in both daylight and in complete darkness without recalibration.

Multiple view geometry

The Smart Eye method is based on calibrated multiple view geometry. This means that 3D positions can be triangulated directly by using both knowledge of camera properties (focal distance, lens distortion) and relative camera positions. The cameras can thus be placed in more or less arbitrary positions, which is an absolute requirement for many applications. A 3D head model is easily generated by using a simple step-by-step guide. The user marks some landmark features in the face image. Once the system runs in tracking mode, the 3D feature locations are determined from their previous locations and motion prediction.

Continuous tracking

For each set of video frames, the 6D (translation and rotation) head pose is estimated with a simple and robust method, based on a 3D head model and tracking of facial features. A major advantage of this new method is that tracking can continue even with partial or full occlusions in one or more of the cameras.

Several trackers

While the face is being tracked, gaze direction, eyelid positions and iris opening are determined by combining image-edge information with 3D models of the eyes and eyelids. The accuracy is further refined by the use of corneal reflection information, when available. If tracking should be lost, a fast face detection procedure reacquires the head position, and normal tracking will resume within a few frames.

SMART EYE PRO

Smart Eye Pro has been developed for users who require non-intrusive, high-accuracy 3D measurements of head pose and eye gaze in real time, and under realistic test conditions.

Features of Smart Eye Pro 5.0

- Real-time measurement (60 Hz sample rate, system lag typically <50 ms).
- Natural head motion (translation and/or rotation) using up to six cameras.
- Immunity to external light situation using active IR illumination.
- Flexible camera positioning provides adaptability to various measurement scenarios.
- Fast camera calibration through a simple chessboard procedure.
- Semiautomatic profile generation
- Occlusions handled gracefully utilizing redundancy in multiple-view cameras.
- Instantaneous tracking recovery.
- 6 DOF head tracking. Accuracy: Rotation 0.5 degrees, translation <1 mm.
- 2 DOF gaze tracking. Accuracy of gaze-vector: down to 0.5 degree under ideal conditions.
- Compatible with contact lenses and glasses/sunglasses.
- Eyelid opening in 60 discrete steps, reported in mm.
- Pupil radius in mm.
- Consensus, left eye, right eye and quality values for all results.
- Gaze direction can be calculated by iris or pupil position.
- Corneal reflection or head model based gaze direction available.
- User customizable coordinate system.
- Tools for definition of gaze zones in a 2D or a 3D world.
- Live visual feedback including gaze and head motion in a 3D world model.
- Results in real time via network (UDP/TCP) or serial ports, also in customizable text logs.
- CAN-bus interface for output data.
- Customizable network client, including source code.
- Scene camera for overlay of gaze data on user view.
- Toolkit for synchronizing measurement data with external time sources.
- Remote control functionality for automation of experiments.
- Integration with 3rd party products, such as E-prime™, Gaze Tracker™ & Net Station™.
- Statistical tools for post-processing of measurement data, on demand.
- Development toolkit for customers who want to tailor their own applications.
- Offline analysis of video recordings from Smart Eye cameras.
- Scripts for importing logs into MatLab or SciLab.

Smart Eye Pro 5.0 is developed by Smart Eye AB. The company was founded in 1999 and their business concept is to provide the general public, industry and advanced research institutions with computer vision software that enables computers and machines to sense and make use of human face and eye movements. Today, Smart Eye AB provides an easy-to-use system that is used in a number of different applications.

Smart Eye AB I Första Långgatan 28 B I 413 27 Göteborg I Sweden I Phone: + 46 (0) 31 60 61 60
Fax: + 46 (0) 31 701 05 15 I e-mail: info@smarteye.se I for sales inquires: sales@smarteye.se