

Skilligent Robot Vision System

Skilligent Robot Vision System is a software component which implements powerful object recognition and object tracking algorithms. The system is specifically designed for robotics applications including visual object recognition and tracking, image stabilization, visual-based servoing, human-to-machine interaction and visual-augmented navigation.

Object Recognition and Tracking

Skilligent Robot Vision System keeps digital object representations in an indexed structure optimized for fast searches. The software scans a video stream coming from a camera and searches for occurrences of the objects.

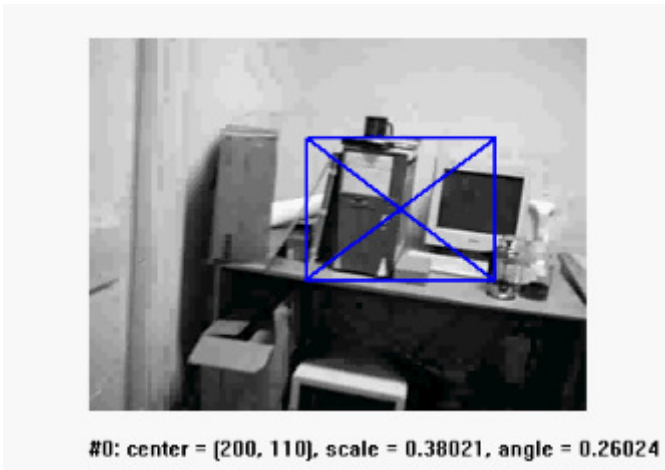


Figure 1 Visual Landmark Tracking

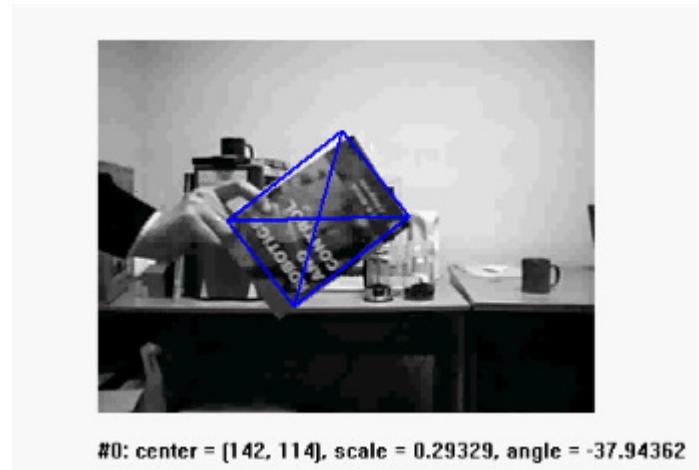


Figure 2 Object Recognition and Tracking

The robotic vision software is based on algorithms resistant to

- major changes in lightening,
- partial object occlusions (up to 30-80% depending on the object and lighting conditions),
- changes of angles of view (up to 30-45 degrees),
- and camera lens distortions.

Multi-View Object Recognition

Skilligent Robot Vision System can use multiple images of the same object, but taken from different views. This feature effectively removes the restriction (~30-45 degrees) on the maximum change of the angle of view.

Visual Localization Capabilities

The robot vision software can provide a foundation for a vision-augmented localization system¹. The software reliably detects, identifies and tracks visual landmarks objects (e.g. pieces of furniture, signs or pictures on the walls, buildings, etc) providing reference points for pose estimation.

The software is capable of determining distance to objects by combining the information coming from dead-reckoning sensors with observed changes of the optical flow.

The Multi-View Object Recognition feature enables the software to reliably recognize landmark objects from various points of view.

Image Stabilization

The capability of the system to “lock” on a target object/area can be used for building image stabilization systems. While a platform² carrying the camera is moving, the stabilized image doesn’t move creating an illusion that the point of view is not changing.

¹ Check Skilligent Visual Localization System product: <http://www.skilligent.com/products/robot-navigation.shtml>

² Such as a mobile robot, a UAV or a boat

The Algorithm

The software is based on a modified Harris Corner Detector algorithm. The software scans the video stream and extracts multiple image features. Those image features are matched against a database of known objects.

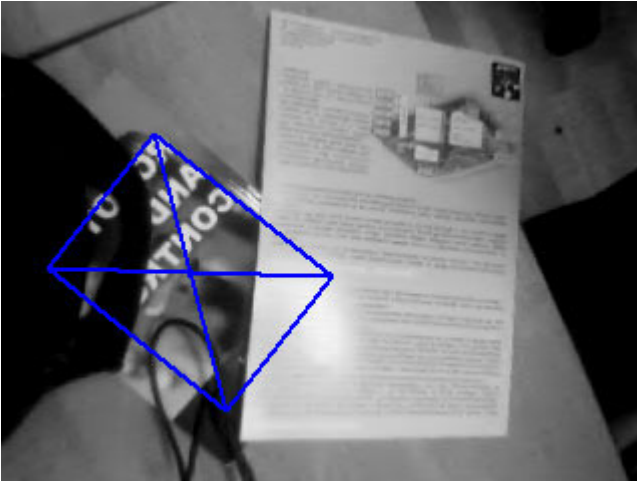


Figure 3 Partially occluded object

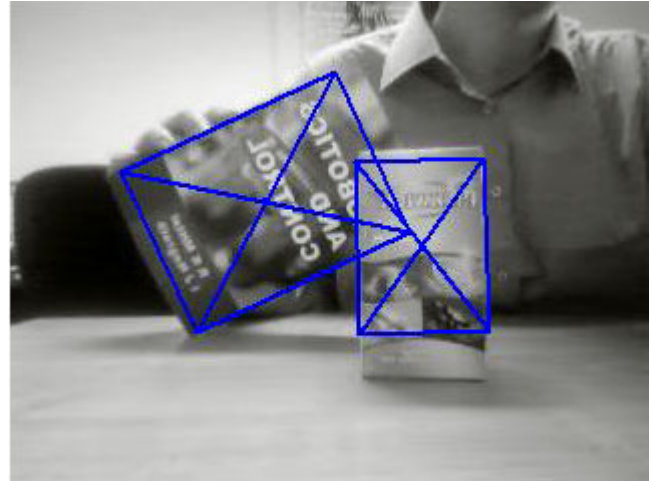


Figure 4 Two recognized objects

Hardware Requirements

The software is designed to run x86 SBC/computers including

- high-speed computers with multi-core CPUs (for maximum real-time performance)
- Mini-ITX and PC/104 systems for power efficiency and smaller size



Figure 5 Sample small-factor Mini-ITX board (170mm x 170mm, 6.7" x 6.7")

Please consult with Skilligent when selecting a video camera.

Specifications

Parameter	Value
Image detection algorithm ³	Modified Harris Corner Detector
Max change in the angle of view, flat object	30-45 degrees ⁴
Partial object occlusions	Up 30-80% depending on the object
Max recognition scale	~400% at resolution 320x240
Min recognition scale ⁵	~20% at resolution 320x240
Max changes in illumination	Sun light <-> Dark in door
Performance, fps	0.5-25 fps depending on the performance of the host computer and chosen camera resolution ⁶
Operating Systems	Windows XP, Vista, XP Embedded, Server 2003 Linux (Ubuntu 8.x)
Interfaces (APIs)	<u>Object Recognition and Tracking Interface:</u> 1. Low-latency UDP binary protocol 2. RS232 binary protocol <u>Image Database Interface:</u> 1. TCP/IP text protocol 2. RS232 text protocol
Programming Languages	C/C++, C#, Java, Python, Visual Basic – any language with TCP/IP or UDP networking capabilities

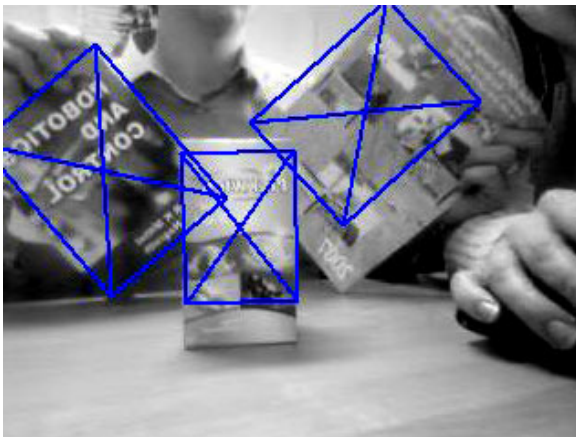


Figure 6 Tracking three objects

³ Additional algorithm options are also available; the options provide better speed (in terms of frames per second), but with some degradation of the stability of object recognition.

⁴ This limit is eliminated if the Multi-View Object Recognition feature is used. Also, depends on the camera choice.

⁵ With Logitech Orbit Web Cam

⁶ Please contact Skilligent for details

About Skilligent

Skilligent's flagship product is a trainable control system for autonomous robots such as mobile service robots, UGV, UAV or AUV. The software enables the robots to learn new behaviors, tasks and skills by observing how human operators accomplish the same tasks. A robot vision system, a part of the package, reliably recognizes objects, landmarks and gestures under real life conditions. The vision system enables the robots to visually navigate, control a manipulator and socially interact with the users.

<http://www.skilligent.com>