Information Sciences

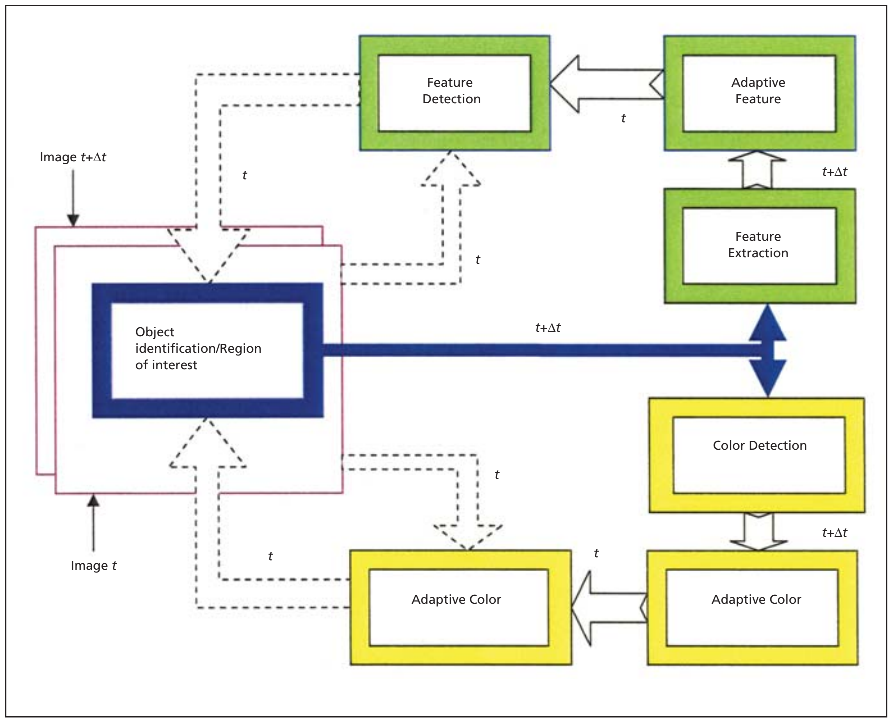
Shape and Color Features for Object Recognition Search

This technique can be used in Internet image searching, intelligent video, and security and surveillance applications.

NASA's Jet Propulsion Laboratory, Pasadena, California

A bio-inspired shape feature of an object of interest emulates the integration of the saccadic eye movement and horizontal layer in vertebrate retina for object recognition search where a single object can be used one at a time. The optimal computational model for shape-extraction-based principal component analysis (PCA) was also developed to reduce processing time and enable the real-time adaptive system capability. A color feature of the object is employed as color segmentation to empower the shape feature recognition to solve the object recognition in the heterogeneous environment where a single technique — shape or color — may expose its difficulties. To enable the effective system, an adaptive architecture and autonomous mechanism were developed to recognize and adapt the shape and color feature of the moving object.

The bio-inspired object recognition based on bio-inspired shape and color can be effective to recognize a person of interest in the heterogeneous environment where the single technique exposed its difficulties to perform effective recognition. Moreover, this work also demonstrates the mechanism and architecture of the autonomous adaptive system to enable the realistic system for the practical use in the future.



The **Color and Shape Feature Feedback Adaptive** architecture.

This work was done by Tuan A. Duong and Vu A. Duong of Caltech, and Allen R. Stubberud of UCI for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

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Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-47065, volume and number of this NASA Tech Briefs *issue, and the page number.*

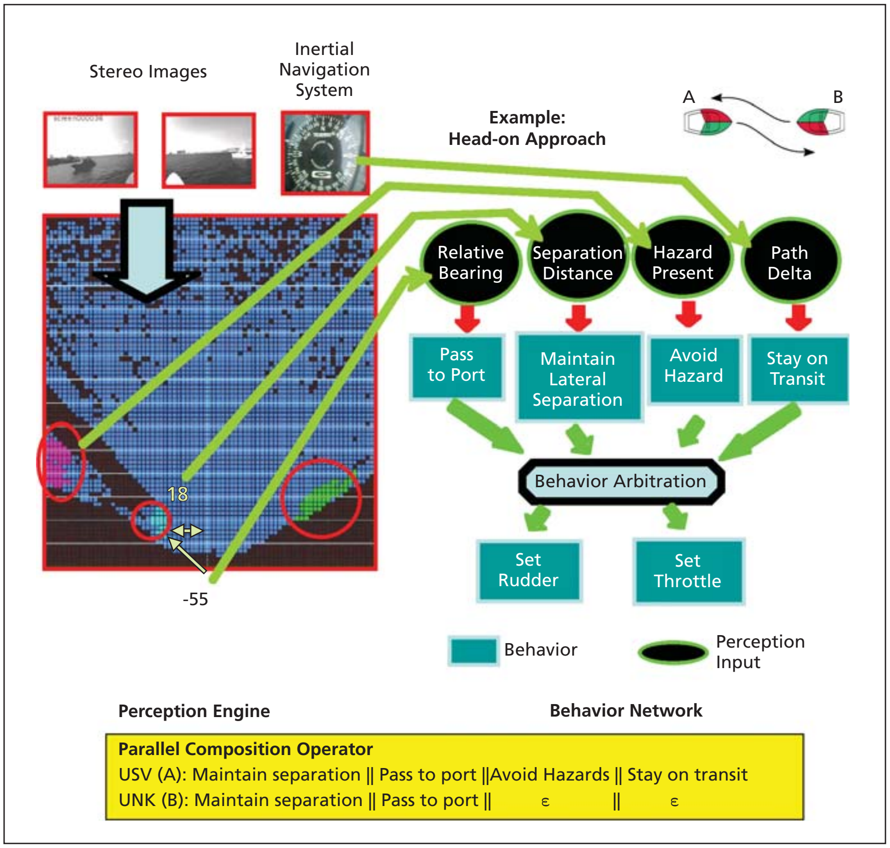
Explanation Capabilities for Behavior-Based Robot Control

This mathematical framework can be applied to search and rescue or remote exploration robotic systems.

NASA's Jet Propulsion Laboratory, Pasadena, California

A recent study that evaluated issues associated with remote interaction with an autonomous vehicle within the framework of grounding found that missing contextual information led to uncertainty in the interpretation of collected data, and so introduced errors into the command logic of the vehicle. As the vehicles became more autonomous through the activation of additional capabilities, more errors were made. This is an inefficient use of the platform, since the behavior of remotely located autonomous vehicles didn't coincide with the "mental models" of human operators.

One of the conclusions of the study was that there should be a way for the autonomous vehicles to describe what



An example of the **Inference Mechanism** in a Rules-of-the-Road behavior shows two boats approaching each other head-on. The left side shows the sensory inputs that are needed by the behaviors that are competing with each other to control the actuators. The right side shows the behavior network with four behaviors fed into the Arbitration module to produce the settings for the rudder (heading) and throttle (speed) of the vehicle. Mapping of the behavior network to an equivalent cost-calculus expression is shown at the bottom.

action they choose and why. Robotic agents with enough self-awareness to dynamically adjust the information conveyed back to the Operations Center based on a detail level component analysis of requests could provide this description capability. One way to accomplish this is to map the behavior base of the robot into a formal mathematical framework called a cost-calculus. A cost-calculus uses composition operators to build up sequences of behaviors that can then be compared to what is observed using well-known inference mechanisms.

The explanation system is broken up into three subsystems that address the principal developments needed:

1. An inference mechanism for the mapping of observed behaviors into the cost-calculus: The observation equivalence of behaviors on a single autonomous agent and between two or more agents is done through bi-simulation relations. An example of the inference mechanism at work in a Rules-of-the-Road behavior is shown in the figure.
2. A learning mechanism for the cost-expression generation for observed behaviors outside of the cost-calculus tactical behavior base: Reinforcement learning of observed behavior patterns is used for the common grounding of behaviors sequences that were not previously observed, or that are in the command dictionary of the autonomous agent.
3. Explanation capabilities for the system: A dynamic decision tree decomposition of the observed behaviors is used to generate a set of rules for explanation. An adaptive level of detail is automatically built into this process in that all of the sensory information that led to a behavior is available, and can be conveyed to the operator if the human/machine interface (HMI) has a detail level of request capability.

This work was done by Terrance L. Huntsberger of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-46864.

A DNA-Inspired Encryption Methodology for Secure, Mobile *Ad Hoc* Networks

An encryption mechanism uses the principles of DNA replication and steganography.

Goddard Space Flight Center, Greenbelt, Maryland

Users are pushing for greater physical mobility with their network and Internet access. Mobile *ad hoc* networks (MANET) can provide an efficient mobile network architecture, but security is a key concern. The figure summarizes differences in the state of network security for MANET and fixed networks. MANETs require the ability to distinguish trusted peers, and tolerate the ingress/egress of nodes on an unscheduled basis. Because the networks by their very nature are mobile and self-organizing, use of a Public Key Infrastructure (PKI), X.509 certificates, RSA, and nonce exchanges becomes problematic if the ideal of MANET is to be achieved. Molecular biology models such as DNA evolution can provide a basis for a proprietary security architecture that achieves high degrees of diffusion and confusion, and resistance to cryptanalysis. A proprietary encryption mechanism was developed that uses the principles of DNA replication and steganography (hidden word cryptography) for confidentiality and authentication. The foundation of the approach includes organization of coded words and messages using base pairs organized into genes,