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A New Vision Interface:
"Defining What instead of How"

Making image analysis functions transparent to the user by coupling them to handling tasks in an intuitive interface for materials handling applications

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Engineering

December 1997

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ABSTRACT

This thesis addresses the need for adaptability in vision systems that measure system state information in a sensory feedback role for the control and coordination of flexible discrete-item materials handling operations, such as those performed by a robotic palletising system. In addition, this thesis addresses the need for vision systems that are more easily configured by users, such as factory technicians and operators, who have lower skill levels than those generally required to (re-)configure a machine vision system.

In response, a unique coupling mechanism and intuitive human-computer interface have been developed, hiding the complexity of image analysis from the end-user and simplifying the way that a machine vision system is configured. The mechanism couples machine vision-related "visual checks" to materials handling tasks in a generic framework of materials handling activities. Visual checks which define what control information is required are implicitly linked to image analysis functions which define how that information is extracted from digitised images of a materials handling system. Consequently, this research has developed a set of task - visual check "building blocks" that can be used in various combinations to define the sequence of actions and image analysis required to perform a variety of materials handling operations. In addition, a number of pre-defined task - visual check combinations and mechanisms for manipulating them have been developed, providing solution templates that can be used immediately or modified to suit application-specific requirements.

These developments have been realised together with several aesthetic, ergonomic and functional features in a machine vision configuration interface, known as SlyVision. SlyVision's modularity, extensibility and upgradeability expressed to both the end-user and the system developer through its underlying object oriented architecture and intuitive user interface design make important contributions to its overall adaptability. Demonstrations involving a typical palletising and a de-palletising operation have shown how SlyVision is used to specify visual checks and configure the associated machine vision components without requiring the end-user to select or apply image analysis techniques or functions. In addition, the relative simplicity of the configuration process is demonstrated.

Consequently, these developments assist people with limited understanding of machine vision technology to set up and maintain a vision system, thereby improving their ability to keep pace with frequent changes in their materials handling operations, while limiting the cost in time, money and effort required to (re-)configure a vision system.
Created by God
Unknown to man
*Revealed by God*
Recorded by man
*To the glory of God*
ACKNOWLEDGMENTS

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LIST OF ABBREVIATIONS

ABB     Asea Brown Boveri
AGV     Automated Guided Vehicle
AMCell  Automated Manufacturing Cell
APP     Associative Pattern Processor
ASAP    Automatix Standard Application Package
ASICs  Application Specific Integrated Circuits
CAD     Computer Aided Design
CASE    Computer-Aided Software Engineering
CCD     Charge Coupled Device
CNC     Computer Numerical Control
dsp     Digital Signal Processor
EVA     European Vision Association
FIC     Flexible Inspection Cell
GLIDE   Global Lab Image Development Environment
GTR     Gantry Type Robot
GUI     Graphical User Interface
HCI     Human-Computer Interface
HIPS    High resolution Image Processing System
IAMS    Institute for Advanced Manufacturing Sciences
ISO     International Standards Organisation
MIL     Matrox Imaging Library
MIT     Massachusetts Institute of Technology
MMS     Manufacturing Message Specification
MPW C   The Macintosh Programmer’s Workshop C
MSG     Manufacturing Systems Group
MVA     Machine Vision Association
OCR     Optical Character Recognition
OEM     Original Equipment Manufacturer
OOA     Object Oriented Analysis
OOD     Object Oriented Design
OOP     Object Oriented Programming
OPA     Object-Process Analysis
PC      Personal Computer
PCI     Peripheral Component Interconnect
PIP     Programming in Prolog
PLC     Programmable Logic Controller
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<td>Pattern Processing Technology</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
</tr>
<tr>
<td>RIA</td>
<td>The Robotics Industries Association</td>
</tr>
<tr>
<td>RISC</td>
<td>Reduced Instruction Set Computer</td>
</tr>
<tr>
<td>ROI</td>
<td>Region of Interest</td>
</tr>
<tr>
<td>SCARA</td>
<td>Selective Compliant Automatic Robotic Arm</td>
</tr>
<tr>
<td>SME</td>
<td>Society of Manufacturing Engineers</td>
</tr>
<tr>
<td>SRI</td>
<td>Stanford Research Institute</td>
</tr>
<tr>
<td>UKIVA</td>
<td>United Kingdom Industrial Vision Association</td>
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<tr>
<td>VIM</td>
<td>Vision Input Module</td>
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