Joseph L. Mundy
President, Vision Systems Inc.

EDUCATION:

Rensselaer Polytechnic Institute
Ph.D. Electrical Engineering, 1969; M. Engr., 1966; B.E.E., 1963.

GE Career Highlights:

Dr. Mundy joined General Electric's Research and Development Center (CRD) in 1963. His early projects at CRD include: High power microwave tube design, a superconductive computer memory system, the design of high density integrated circuit associative memory arrays, the application of transform coding to image data compression. He is the co-inventor of varactor bootstrapping, a key technique widely used today in the design of MOS integrated circuits. His design of an integrated associative memory cell is still the most compact and requires only 5 MOS transistors.

From 1972 until 2002, Dr. Mundy led a group involved in the research and development of image understanding and computer vision systems. In the early 1970's his group developed one of the first major applications of computer vision to industrial inspection. A system was developed to inspect incandescent lamp filaments at the rate of 15 parts/sec and achieved classification performance of less than one error per thousand. The system operated in production for many years.

During the late 1970's his group developed an extensive system for the inspection of jet engine turbine components involving both 3-d range sensing and ultra-violet imaging of fluorescent crack features. This project involved the use of 3D bicubic CAD models to control the motion of a fifteen-axis inspection machine and the development of high throughput hardware for the processing of flaw image data. A final version of this machine was installed at Kelly AFB and was demonstrated to be superior to human inspectors with significant cost savings in used part recovery. This system pioneered many techniques in CAD model-supported inspection of industrial components.

In the 1980's Dr. Mundy's group began to apply image understanding algorithms to aerial reconnaissance. He developed a system for aircraft recognition based on a sparse feature, called the vertex-pair, which achieved 98% recognition accuracy in a test on realistic airfield scenes.

Dr. Mundy also participated in the development of a novel CAD-based wafer inspection system in the mid-1980s that led to a start up company. The company produced a working prototype in collaboration with Hewlett-Packard. The company, Contrex, was eventually sold to Fairchild Semiconductor.

During the 1990's the group developed the use of X-ray stereo photogrammetry to enable the measurement of internal casting features from multiple X-ray views. The system employs robust statistical bundle adjustment over dozens of views. The 3-d reconstruction achieves an accuracy of better than 0.005'', allowing practical manufacturing metrology. This new approach is currently being used in production by GE's Aircraft Engine division to plan drilling operations for airfoil castings.

While at GE, Dr. Mundy accumulated over 20 granted patents.

Brown University Career Highlights:

Dr. Mundy joined the division of engineering at Brown in 2002 as Professor of Engineering (Research). Prof. Mundy carried out research in including nano-computing architectures with emphasis on CMOS devices with nano-scale gate lengths so that logic operation is dominated by thermal noise. He originated novel logic circuits that produce correct logic results even when random noise dominates the logic signals. He also developed a new approach to analyzing such circuits using queuing theory. These architectures are aimed at the next generation of silicon devices where the gate lengths are only a few nanometers. His research at Brown also included the development of new algorithms for the 3D reconstruction of blood vessel networks from computer tomographic imaging scanners (CT). These vessel networks provide unique information about the effect of cancer drugs on tumors, whose growth is enabled by the evolution of new vessel pathways. This work led to the founding of Bio Tree Systems, a company he co-founded to develop diagnostic tests for the effectiveness of cancer drugs. He also conducted research in aerial reconnaissance for the Department of Defense, including the National Geospatial Intelligence Agency. This work involved the development of new probabilistic representations of 3D space to account for the inherent ambiguity of extracting geometric descriptions from multiple image views. This new representation supports accurate determination of scene dynamics (change detection) in spite of the spatial ambiguity. While at Brown, he advised and graduated eight Ph.D. students who carried out research in image analysis and 3D modeling from imagery.

Vision Systems Career Highlights:

Dr. Mundy left Brown in June 2016 to focus on his company, Vision Systems Inc. (VSI) as President. Vision Systems carries out research on aerial reconnaissance for the Department of Defense and other intelligence agencies. Some current projects at VSI include the fully automated construction of large scale digital elevation models (DEMs) from satellite imagery to support military planning and with commercial application to virtual reality tours for sports such as skiing and mountain biking. This work

VSI also is developing an anatomical model of the human face to improve recognition accuracy in a 4 year research program on facial recognition. This research is also funded by IARPA and has commercial application in the field of plastic surgery. The development of a new model for the human eye anatomy is described in a paper at the Joint Meeting of the American Society of Plastic Surgeons in May 2016. VSI has also recently started a project on behalf of the Air Force Research Laboratory (AFRL) to integrate multiple satellite constellations in support of image intelligence analysts by improving the timeliness of the discovery of events of interest.

Academic Qualifications:

Dr. Mundy was an adjunct full professor of computer science at Rensselaer Polytechnic Institute. He taught the core graduate course on Artificial Intelligence from 1975 until 1997. This course was selected to be presented in video format to a wide audience of graduate students at IBM, Xerox and GE.

Dr. Mundy has advised numerous masters and four PhD students in his capacity as adjunct professor. He also has had periodic adjunct appointments in the Department of Electrical and Computer Systems Engineering, where he has taught courses in digital image processing. He is co-taught a course on the application of mathematics to computer vision with Prof. Charles Stewart.

In collaboration with Prof. Deepak Kapur, Dr. Mundy developed new approaches to formal geometric reasoning based on algebraic techniques. These ideas resulted in the development of an automatic geometric theorem proving system called Geometer. Geometer was capable of proving many theorems from plane geometry and perspective construction. This work led to an international workshop on geometric reasoning in 1986 and produced an edited proceeding of the workshop papers.

In 1988, Dr. Mundy received the Coolidge Fellowship, which is GE's highest award of technical achievement recognizing academic impact as well as contribution to GE businesses. The fellowship provides a year sabbatical to carry out basic research.

While on this sabbatical at Oxford University during the years 1988-89, Dr. Mundy initiated a reading course in projective geometry that established a new approach to object modeling and recognition, called geometric invariance. In collaboration with Andrew Zisserman, David Forsyth (now at Berkeley) and a PhD student Charles Rothwell, these ideas were implemented in a generic object recognition system, called LEWIS.

Geometric invariance research has made significant contributions to our basic understanding of computer vision. Two international workshops have been held, co-chaired by Dr. Mundy and Prof. Andrew Zisserman of Oxford. Both

first book, Dr. Mundy prepared an extensive appendix on the application of projective geometry in computer vision that has been influential to many research groups.

Dr. Mundy's most recent topics of research at GE were the integration of perceptual grouping and photometric theory with the goal of understanding 3-d textures. He also developed a Bayesian model-based approach to the segmentation of lung tissue in CT images.

He continued to foster basic research within his group at GE, including the work of Dr. Richard Hartley who made major contributions to the fundamental understanding of 3-d model reconstruction from multiple views.

His laboratory pioneered a new approach to constructing 3D models from satellite imagery based on a probabilistic volumetric algorithm this work lead to a best paper award from the American Society of Photogrammetry and Remote Sensing in 2011. He was also principal investigator on a number of military surveillance projects funded by DARPA, NGA and Lockheed Martin. He and his students contributed to an extensive C++ library for computer vision processing called VXL, which is still under active use and extension by the computer vision research community.

Government-Sponsored Research Projects:

Dr. Mundy received his first Defense Advanced Research Projects Agency (DARPA) grant in 1985, under DARPA's basic research program in image understanding (IU). The DARPA IU research community represents many of the leading university computer vision groups. Thus it was a significant recognition of his research achievements to be selected. His research has continued to be funded by DARPA through a number of competitive grant procurements.

From 1992-1996, he was a principal contributor to DARPA's RADIUS project, providing algorithms to the RADIUS Test bed System (RTS) that makes use of the context provided by a 3D site model. These algorithms include change detection based on various levels of image segmentation and specific object structure matching. He has continued the development of context-based change detection and image registration through the FOCUS program, which has continued to develop automated exploitation tools in a site model framework. The FOCUS system has been successfully demonstrated on operational imagery in support of NIMA applications.

He was chairman of DARPA's Image Understanding Environment (IUE) Committee, which has specified and supervised the development of the IUE. The IUE is an extensive C++ hierarchy of computational structures in

support of image understanding research programming. This object-oriented design was the first comprehensive study of the representations inherent in computer vision algorithms. This work led to special recognition by DARPA.

Dr. Mundy played a lead technical role in DARPA's Dynamic Database (DDB) program, an ambitious effort to automatically extract situation hypotheses from a continuous stream of imagery from a variety of sensors. He was responsible for the DDB object model to support the integration of algorithms supplied by many contractors. This model extended the IUE to incorporate reasoning about dynamic scenes.

He was principal investigator on a project to integrate natural language and computer vision in the analysis of video news sequences. This contract is supported by a newly formed government body called the Advanced Research and Development Agency (ARDA) that is focused on supporting research specifically aimed at the intelligence community.

Professional Activities:

Dr. Mundy's professional activities involve active participation in the areas of computer vision and image understanding over three decades. He has served on many program committees and review bodies including: International Conference on Computer Vision, Computer Vision and Pattern Recognition, International Joint Conference on Pattern Recognition and various SPIE conferences.

Some highlights:

- Co-chairman of the workshop on industrial applications of machine vision that resulted in a special issue of the IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), 1980.
- Chairman, International Workshop on Geometric Reasoning, Oxford, 1986.
- Co-Chairman, International Workshop on the Integration of Symbolic and Numeric Computing, Saratoga 1990.
- Co-Chairman, 1st International Workshop on Geometric Invariants, Reykjavik, Iceland, 1991.
- Co-Chairman, 2nd International Workshop on Geometric Invariants, Ponta Delgada, Azores, 1993.
- Co-chairman of the IEEE workshop on Context-Based Vision held in conjunction with ICCV, Cambridge MA, 1995.

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