BSC~Microsoft Research Centre

Computer Vision

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Dr. Tassadaq Hussain

Research Areas:

- High Performance Computing
- High-level Synthesis
- Machine Learning
- Heterogeneous Computing, based on
  - FPGAs, GPUs and Microprocessors
- Real-time Embedded Vision

Teaching Areas

- Currently:
  - Supercomputing
  - Digital System Design
  - Biomedical Digital Systems

PhD – BarcelonaTech Spain
MS – ISEP Paris France

1) **Iridology for Health-care**
2) **Design Ultra Low Cost Display Camera Interface for Mobile Baseband XGold Chip at Infineon Technologies France.**
3) Implementation of Reverse Time Migration on FGPAs at **PLDA Italia** and **REPSOL BSC Research Center.**
4) Programmable Memory Controller for Vector System on Chip **Microsoft Research Cambridge.**
5) Programmable Vector Memory Controller for **European ParaDIME research group at BSC.**
6) **Low Power Low Cost Supercomputer Architecture for Undeveloped Countries** at **RIU Pakistan and BSC Spain.**
7) **FPGA Powered Supercomputer System**

- Research Grants:
  - HEC NRPU 1
  - Barcelona Supercomputing
  - HEC TDF 3 (in progress)
- Publications:
  - Referred Top Conferences: 35
  - Book Chapter: 1
  - Journal 15
- Patent: 10

Industrial Experience:

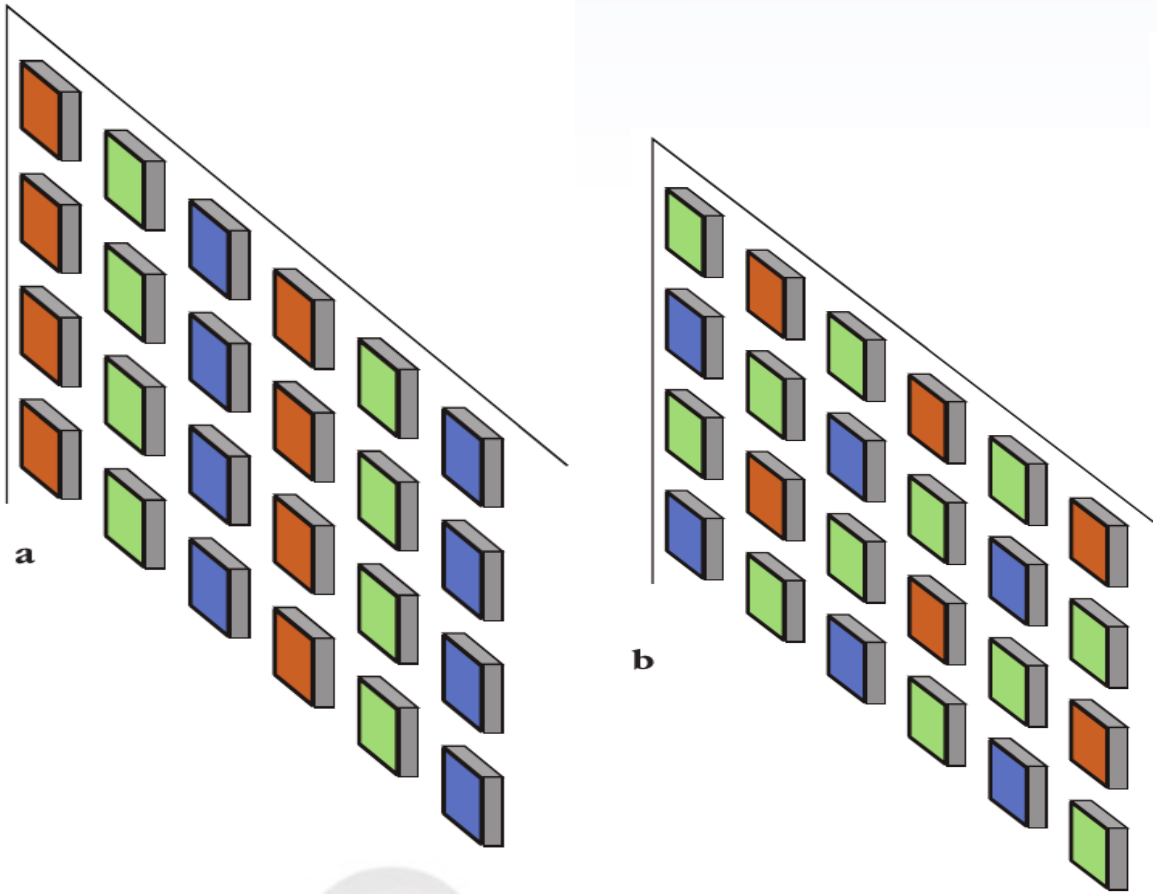
Microsoft Research
Infineon technologies
BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

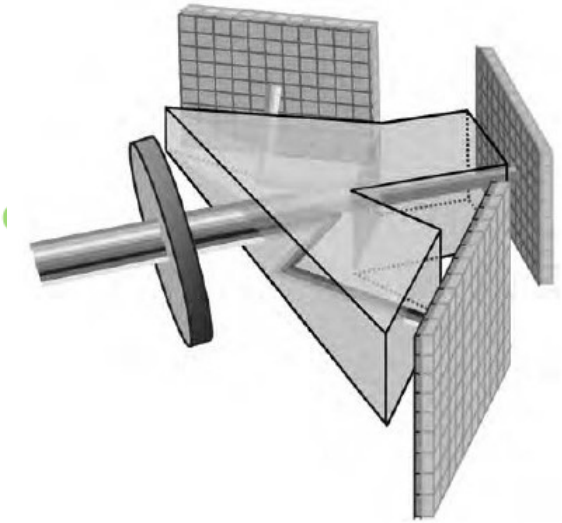
On Going Projects/Products

1) Pakistan's 1st FPGA-Powered Supercomputer System
2) A Platform for Supercomputing and Artificial Intelligence
3) Development of a Scalable Heterogeneous Supercomputer
4) An Intelligent Real-time High Performance System for BCI applications
5) HPDAS: High Performance Data Acquisition System
6) An Intelligent and High Performance Real-time System for Heart Disease Diagnosis
7) An intelligent robotic prosthesis for rehabilitation
8) An Embedded System for Brush Less Direct Current (BLDC) Fans
9) An Intelligent Digital System for Foot Weight Distribution
10) A Real-time Disease Diagnosis System Using Iris Image
11) An Intelligent Internet of Thing based Edge Server
12) Development of a Real-time Iris based Pre-Diagnostic Tool to detect dysfunctional Liver, Kidney, Stomach, Heart and Lung organs

Introduction Images

Three-chip color Camera

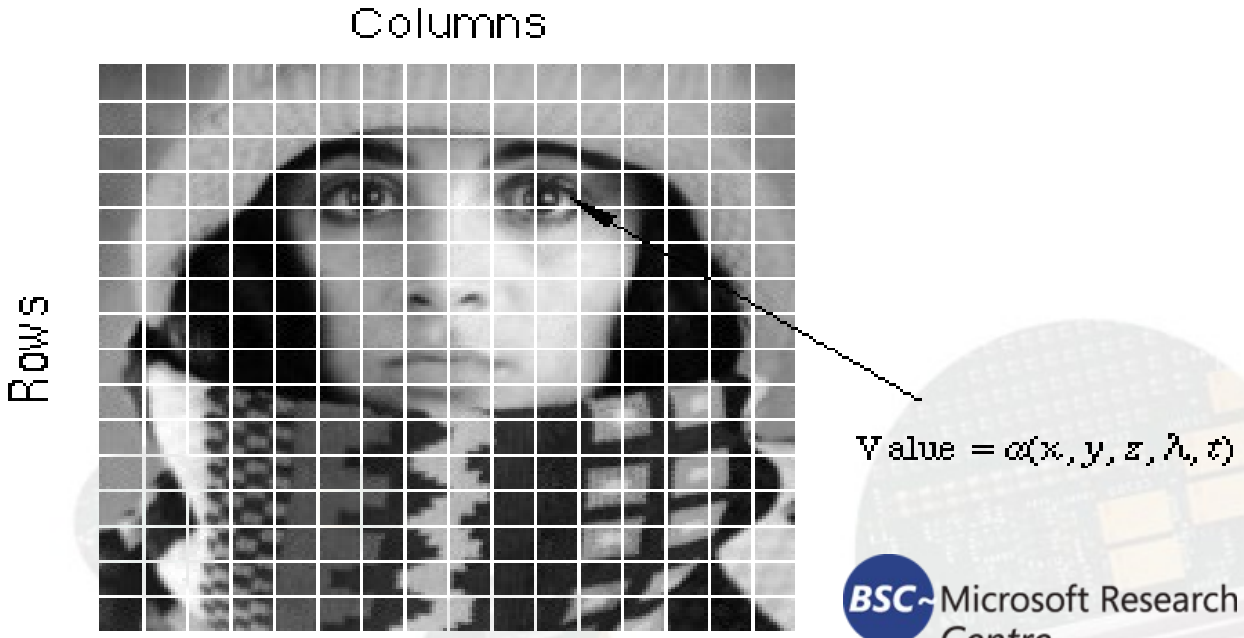




(a) Bayer (b) Filter patterns used in single chip cameras.

Color Pixel = **Red** (8bit) + **Green** (8bit) + **Blue** (8bit)

Gray scale intensity = 0.299 R + 0.587 G + 0.114 B



Pixel >> Image >> Video

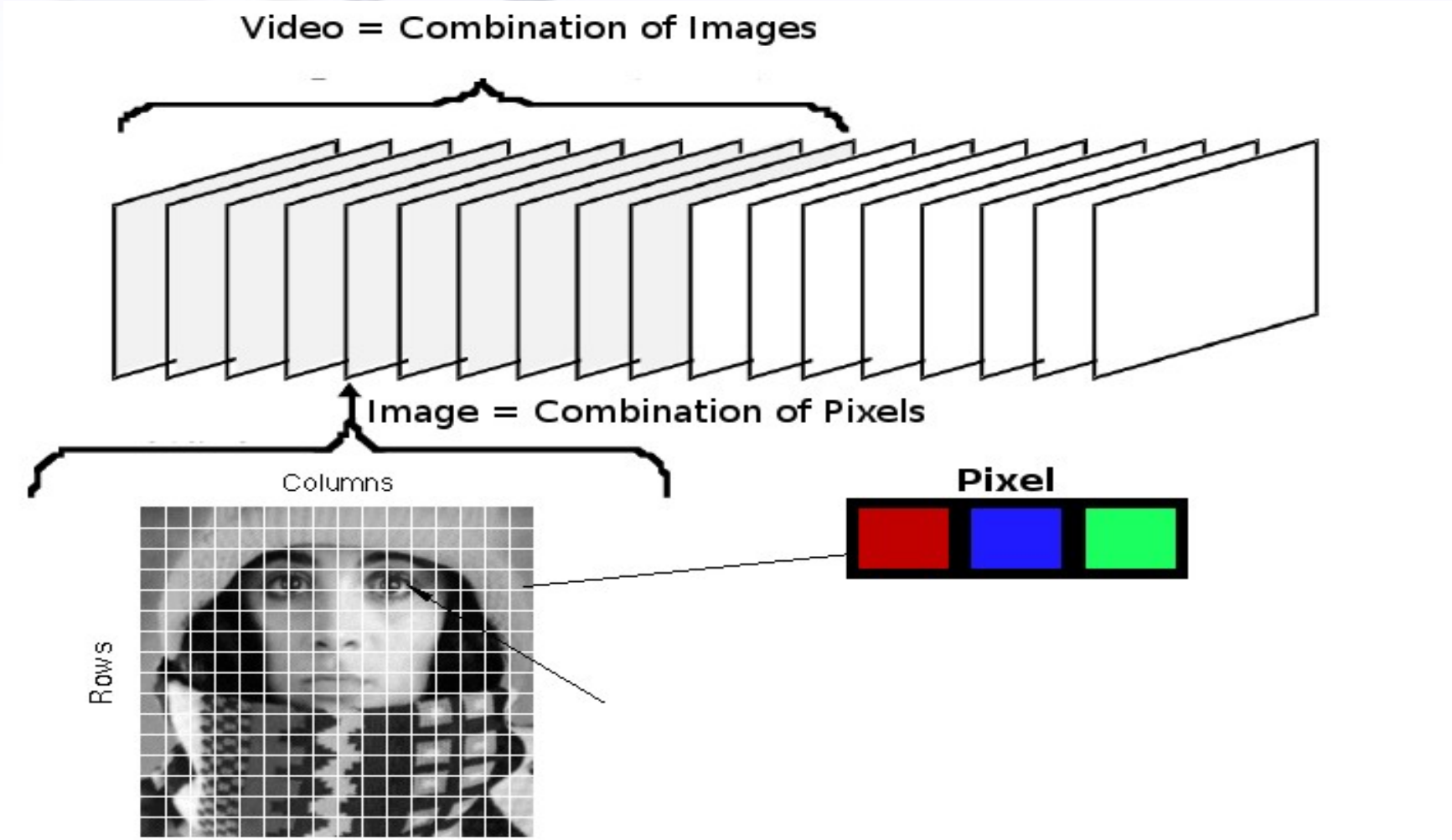


Image Resolution

(a) 256 × 256; (b) 128 × 128; (c) 64 × 64, (d)32 × 32.

Pixel Depth

Image 256x256 array pixels: (a) 32 bit (b) 16 (c) 8 (d) 4

Performance Measures

- 3 Mega Pixel Image = 3145720 pixels
- A 32 bit Processor = 3.14 million operation / sec

  Pixels = 2048 x 1536 x 24 bits/pixel
- Local Memory = 9.4 Mega Byte for single Image
- Video Processing = $3.14 \times 10^6 \times 30$ (fps)

  $= 94.2 \times 10^6$

Processor / System	Dhrystone MIPS / MIPS
Nios II	190 MIPS at 165 MHz
ARM Cortex A7	2,850 MIPS at 1.5 GHz
ARM Cortex-A9 (Dual core)	7,500 MIPS at 1.5 GHz
Raspberry Pi 2	**1186 MIPS per core at 1.0 GHz**
Nvidia Tegra 3 (Quad core Cortex-A9)	13,800 MIPS at 1.5 GHz

Uses

3D Vision

Health-care

Security

Communication

Information

Automobile

Simple Thresholding

```
Read Image Pixel // I/O Operation
if(pix_value>value) // Branch Operation
pix_value=value // Assignment Operation
```

A 3 Mega Pix Image requires

2048 x 1536 Input/Output Operations

2048 x 1536 Branch Operations

2048 x 1536 Assignment Operations

Total = 2048 x 1536 x 3 = 9 Million Operations

Topics of the Course

Image/Video Handling

Real-time Basic Image Processing

Bit-wise Operations

Filtration

Features Detection and Extraction

Matching (Templates, Features etc)

Machine Learning

Tasks

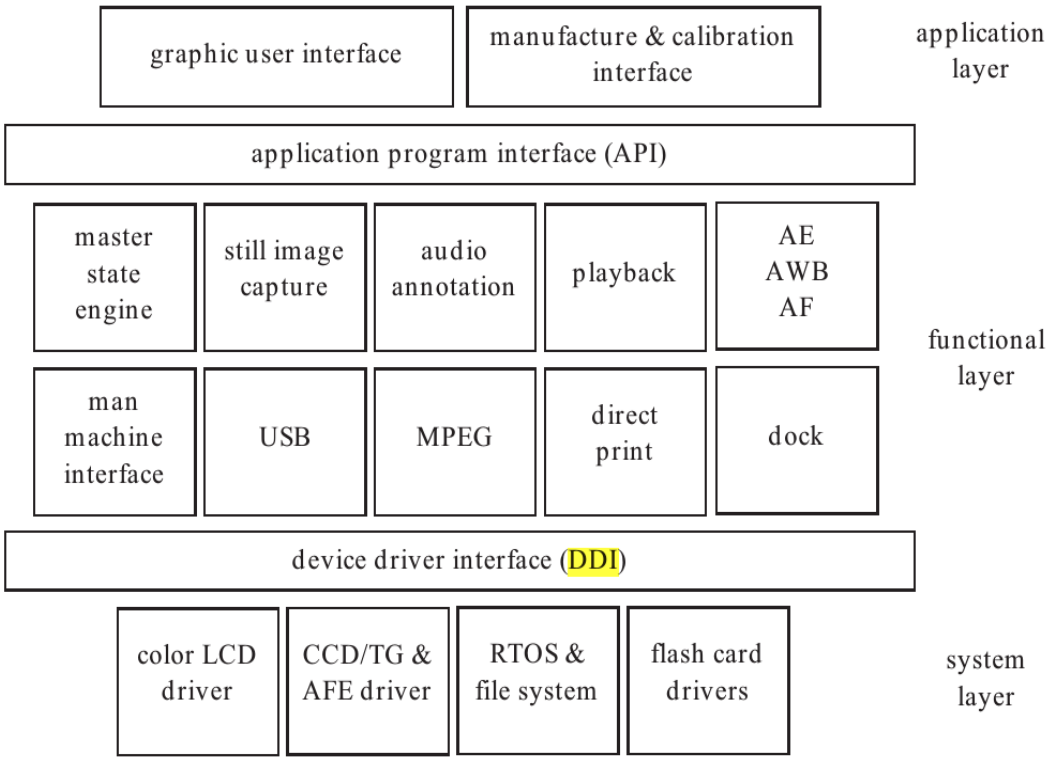
Install Ubuntu 18 version

- Python 3.4
- OpenCV 3.4
- Machine Learning Tools

Semester Project

- Health-care
- Security
- Etc.

Software Platform of Digital Camera



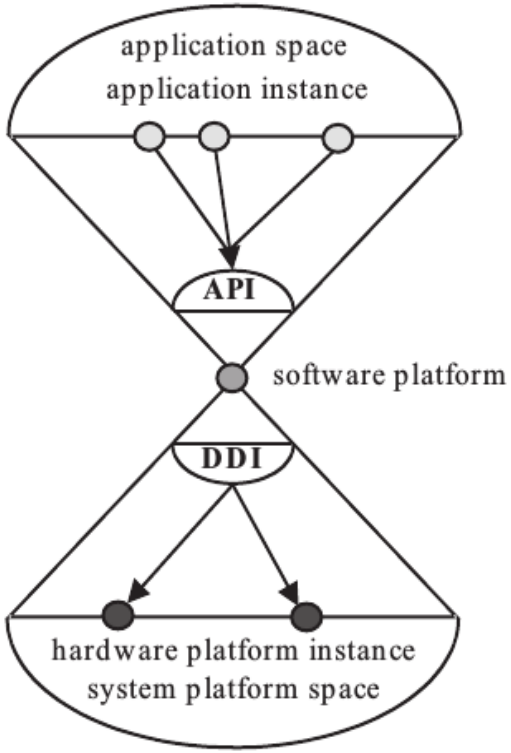
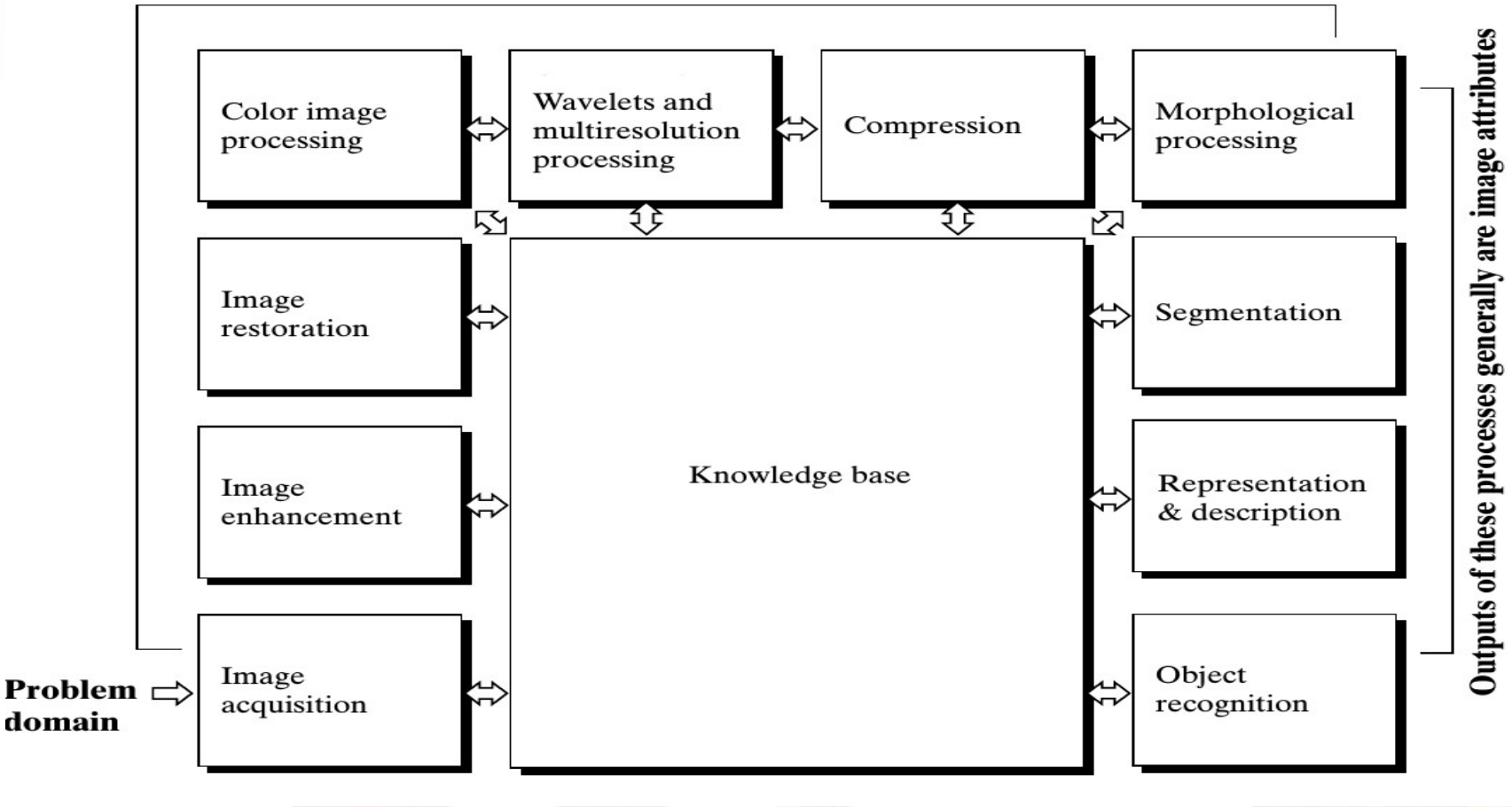


Image Processing Problems



Graphics System