# Lecture 2 Fundamental Steps In Digital Image Processing

Binary image technical and artistic applications, for example in digital image processing and pixel art. Binary images can be interpreted as subsets of the two-dimensional A binary image is a digital image that consists of pixels that can have one of exactly two colors, usually black and white. either a 0 or 1. e. Each pixel is stored as a single bit — i 5e03a75fe8

Parallel multidimensional digital signal processing The use of mD-DSP is fundamental to many application areas such as digital image and Parallel multidimensional digital signal processing (mD-DSP) is defined as the application of parallel programming and multiprocessing to digital signal processing techniques to process digital signals that have more than a single dimension. However, as the number of dimensions of a signal increases the computational complexity to operate on the signal increases rapidly. The use of mD-DSP is fundamental to many application areas such as digital image and video processing, medical imaging, geophysical signal analysis, sonar, radar, lidar, array processing, computer vision, computational photography, and augmented and virtual reality. to process digital signals that have more than a single dimension. This relationship between the number of dimensions and the amount of complexity, related to both time and space, as studied in the field of algorithm analysis 5e03a75fe8

Hardware acceleration Therefore, hardware acceleration Hardware acceleration is the use of computer hardware designed to perform specific functions more efficiently when compared to software running on a general-purpose central processing unit (CPU). Any transformation of data that can be calculated in software running on a generic CPU can also be calculated in custom-made hardware, or in some mix of both. functional units can be composed in parallel, as in digital signal processing, without being embedded in a processor IP core 5e03a75fe8

To perform computing tasks more efficiently, generally one can invest time and money in improving the software, improving the hardware, or both. There are various approaches with advantages and disadvantages in terms of decreased latency, increased throughput, and reduced energy consumption. Typical advantages of focusing on software may

include greater versatility, more rapid development, lower non-recurring engineering costs, heightened portability... 5e03a75fe8 A broad range of industrial and consumer products use computers as control systems, including simple special-purpose devices like microwave ovens and remote controls, and factory devices like industrial robots. Computers... 5e03a75fe8

Central processing unit This role contrasts with that of external components, such as main memory and I/O circuitry, and specialized coprocessors such as graphics processing units (GPUs). A central processing unit (CPU), also called a central processor, main processor, or just processor, is the primary processor in a given computer. Its electronic circuitry executes instructions of a computer program, such as arithmetic, logic, controlling, and input/output (I/O) operations. Its A central processing unit (CPU), also called a central processor, main processor, or just processor, is the primary processor in a given computer 5e03a75fe8

Like traditional physical watermarks, digital watermarks are often only perceptible under certain conditions, e.g. after using some algorithm. If a digital watermark distorts the carrier signal in... 5e03a75fe8

Natural language processing The study of NLP, a subfield of computer science, is generally associated with artificial intelligence. Natural language processing (NLP) is the processing of natural language information by a computer. NLP is related to information retrieval, knowledge representation, computational linguistics, and more broadly with linguistics. The study of NLP, a subfield of computer science, is Natural language processing (NLP) is the processing of natural language information by a computer 5e03a75fe8

Image registration It is used in computer vision, medical imaging, military automatic target recognition, and compiling and analyzing images and data from satellites. Data may be multiple photographs, data from different sensors, times, depths, or viewpoints. Image registration is the process of transforming different sets of data into one coordinate system. Data may be multiple photographs, data from different Image registration is the process of transforming different sets of data into one coordinate system. Registration is necessary in order to be able to compare or integrate the data obtained from these different measurements 5e03a75fe8

The form, design, and implementation of CPUs have changed over time, but their fundamental operation remains almost unchanged. Principal

components of a CPU include the arithmetic–logic unit (ALU) that performs arithmetic and logic operations, processor registers that supply operands to the ALU and store the results of ALU operations, and a control... 5e03a75fe8

Pixel In most digital display devices, pixels are the smallest element that can be manipulated through software. In digital imaging, a pixel (abbreviated px), pel, or picture element is the smallest addressable element in a raster image, or the smallest addressable In digital imaging, a pixel (abbreviated px), pel, or picture element is the smallest addressable element in a raster image, or the smallest addressable element in a dot matrix display device 5e03a75fe8

Computer Conventionally, a modern computer consists of at least one processing element A computer is a machine that can be programmed to automatically carry out sequences of arithmetic or logical operations (computation). to the Digital Revolution during the late 20th and early 21st centuries. The term computer system may refer to a nominally complete computer that includes the hardware, operating system, software, and peripheral equipment needed and used for full operation; or to a group of computers that are linked and function together, such as a computer network or computer cluster. Modern digital electronic computers can perform generic sets of operations known as programs, which enable computers to perform a wide range of tasks 5e03a75fe8

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels... 5e03a75fe8

Image segmentation ) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. In digital image processing and computer vision, image segmentation is the process of partitioning a digital image into multiple image segments, also known In digital image processing and computer vision, image segmentation is the process of partitioning a digital image into multiple image segments, also known as image regions or image objects (sets of pixels). Image segmentation is typically used to locate objects and boundaries (lines, curves, etc 5e03a75fe8

A binary image can be stored in memory as a bitmap: a packed array of bits. A binary image of 640×480 pixels has a file size of only 37.5 KiB,

and most also compress well with simple run-length compression. A binary image format is often used in contexts where it is important to have a small file size for transmission or storage, or due to color limitations on displays or printers. 5e03a75fe8 Each pixel is a sample of an original image; more samples typically provide more accurate representations of the original. The intensity of each pixel is variable. In color imaging systems, a color is typically represented by three or four component intensities such as red, green, and blue, or cyan, magenta, yellow, and black. 5e03a75fe8 Major processing tasks in an NLP system include: speech recognition, text classification, natural language understanding, and natural language generation. 5e03a75fe8 In some contexts (such as descriptions of camera sensors), pixel refers to a single scalar element of a multi-component representation (called a photosite in the camera sensor... 5e03a75fe8 It also has technical and artistic applications, for example in digital image processing and pixel art. Binary images can be interpreted as subsets of the two-dimensional integer lattice Z2; the field of morphological image processing... 5e03a75fe8

Digital watermarking Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. A digital watermark is a kind of marker covertly embedded in a noise-tolerant signal such as audio, video or image data. It is prominently used for tracing copyright infringements and for banknote authentication. It is typically used to identify A digital watermark is a kind of marker covertly embedded in a noise-tolerant signal such as audio, video or image data. Digital watermarking is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to, contain a relation to the carrier signal. It is typically used to identify ownership of the copyright of such a signal 5e03a75fe8

ematics__of-scientific-computing_the__sally-series-pure-and-applied_undergraduate_texts-vol__2.pdf