



Embedded Computing *without* Compromise

The Evolving Role of GPGPUs in C4ISR Applications

Embedded Tech Trends, January 2017



The Evolving Role of GPGPUs in C4ISR Applications

- ✦ Identifying Display & Imaging Market Needs
- ✦ Why Use GPGPU?
- ✦ “Deep Learning” & “Neural Networks”
- ✦ Current Implementation

Identifying Market Needs - Displays

Number of display panels used

Increasing in industry rapidly: manned ground vehicles, cars, aircraft



Display and camera resolution

Also increasing rapidly



Flat panel display photos courtesy of Boeing/IEE

Next growth area?

Total number of pixels & display to be rendered continues to grow

Identifying Market Needs – Image Processing

Object Detection/Tracking/Classification/Threat Assessment

- ✦ Objects are often partially obscured/occluded from visual imaging
- ✦ Environmental factors and Imaging artifacts, e.g. rain, fog, adverse lighting (sun flare reflections, bloom...), night vision, Infrared, etc.
- ✦ Enemy combatants (or pedestrians) can often fail to auto-identify and classify correctly



Somewhere in the mountain foothills of Afghanistan



Partially Occluded Pedestrian Dataset, Computer Vision Center, Universitat Autònoma de Barcelona

Object Detection/Tracking/Classification

Identify the Pitfalls

CPU Core Starvation

- Constant increase to apps & features adds CPU load
- Local cache & main memory thrashing bottleneck looming

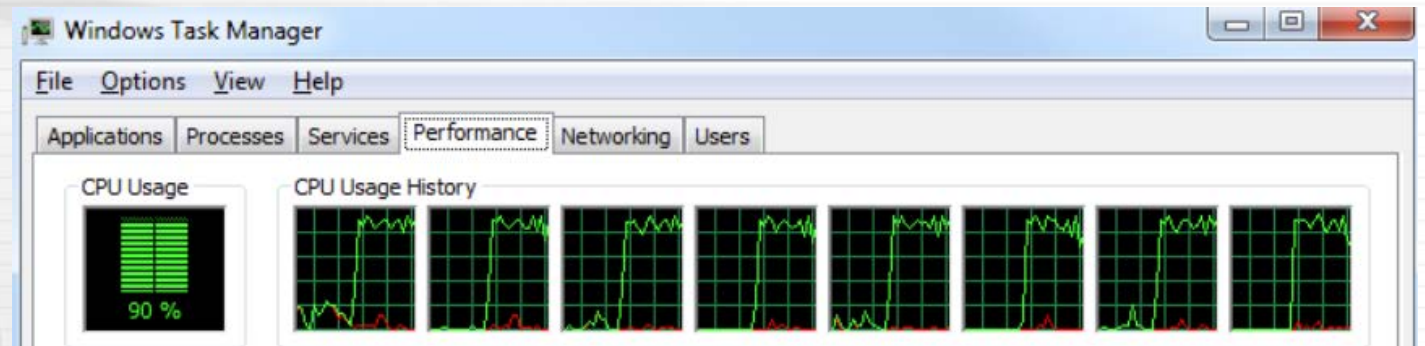
Limited Computing Power

Resort to using video from lower resolution, low frame rate cameras

Lower Resolution Images

Leads to inaccurate identification and classification of objects

All these limitations lead to slow response and are not real-time

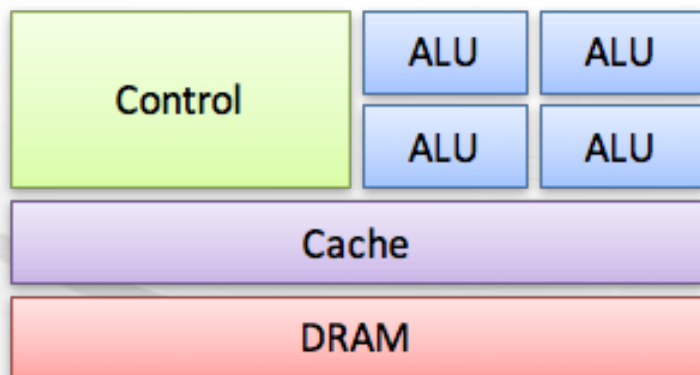


Do we need to Compromise?

Use GPGPU to Avoid the Pitfalls



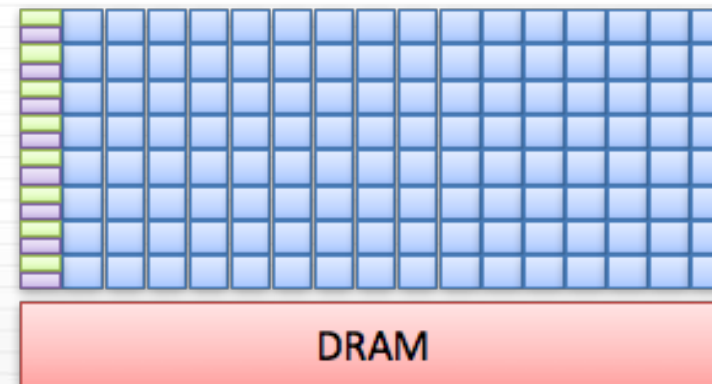
CPU



- ❑ Task oriented
- ❑ Serial processing
- ❑ Sophisticated complex cores



GPGPU



- ❑ Processing multiple image data elements - simultaneously
- ❑ Parallel processing
- ❑ Simple cores, but many of them

Parallel processing is the way to go...

Open Source CUDA* Libraries & Toolkits

GPU-Accelerated Libraries

- Fast Fourier Transforms (cuFFT)
- Basic Linear Algebra Subroutines (cuBLAS)
- Sparse Matrix Routines (cuSPARSE)
- Dense and Sparse Direct Solvers (cuSOLVER)
- Random Number Generation (cuRAND)
- Image & Video Processing Primitives (NPP)
- NVIDIA Graph Analytics Library (nvGRAPH)
- Templated Parallel Algorithms & Data Structures (Thrust)
- CUDA Math Library

Development Tools

- NVIDIA CUDA C/C++ Compiler (NVCC)
- Nsight Integrated Development Environments
- Visual Profiler
- CUDA-GDB Command Line Debugger
- CUDA-MEMCHECK Memory Analyzer

Reference Materials

- CUDA C/C++ code samples
- CUDA Documentation



*CUDA = Compute Unified Device Architecture: Platform & API model

GPGPU in Automotive

- ⊕ Today's midrange models include built-in display panels for navigation
- ⊕ Increasing complexity in design and implementation of car computers requires GPUs and robust software stacks to handle advanced features
- ⊕ And there are more displays coming!



GPGPU in Military Vehicles

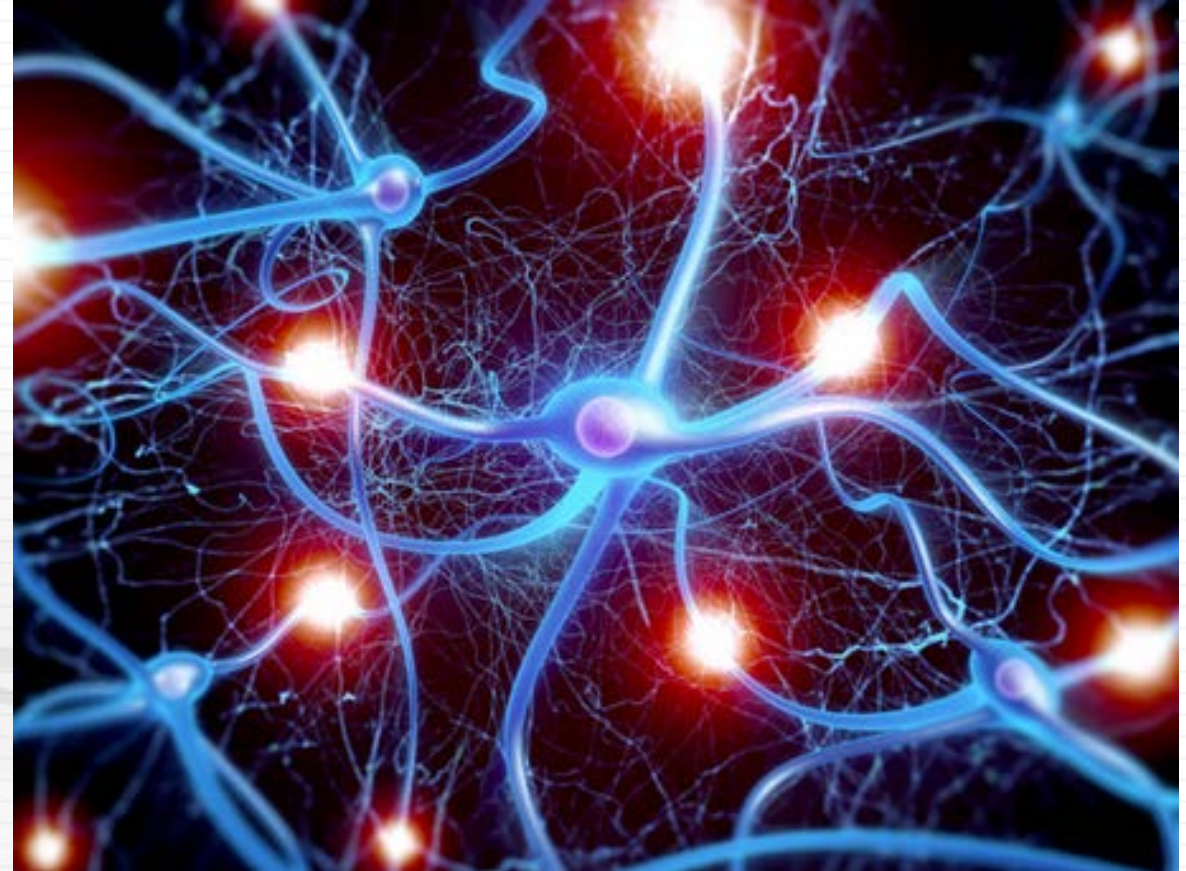
- ⦿ Today's military services are demanding the highest performance rugged systems
- ⦿ Battlefield situational awareness displays are critical to troops' success
- ⦿ And even more C4ISR displays and image processing needs are coming...



The M1/ABV: Best Military Combined Air/Ground Combat Vehicle – Ever!

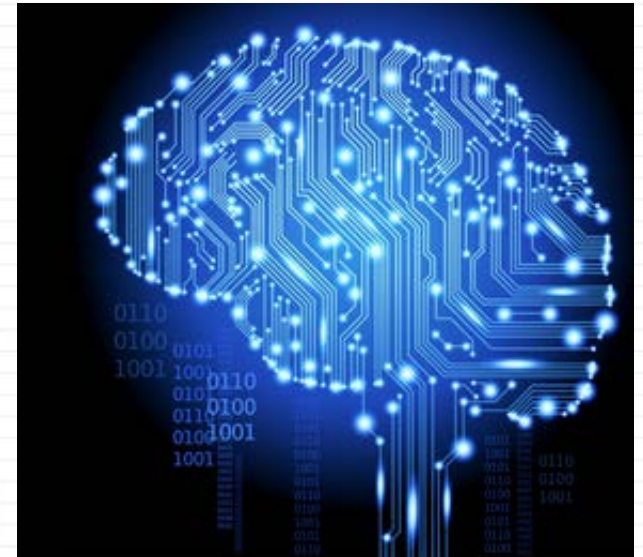
WTH is Deep Learning & Neural Networks?

- ➊ Deep learning systems: modeled on how the human brain works
- ➋ Based on learned actions over time, neurons prioritize the various inputs fed into the brain
- ➌ Neurons then deliver an output for other neurons to act on



WTH is Deep Learning & Neural Networks?

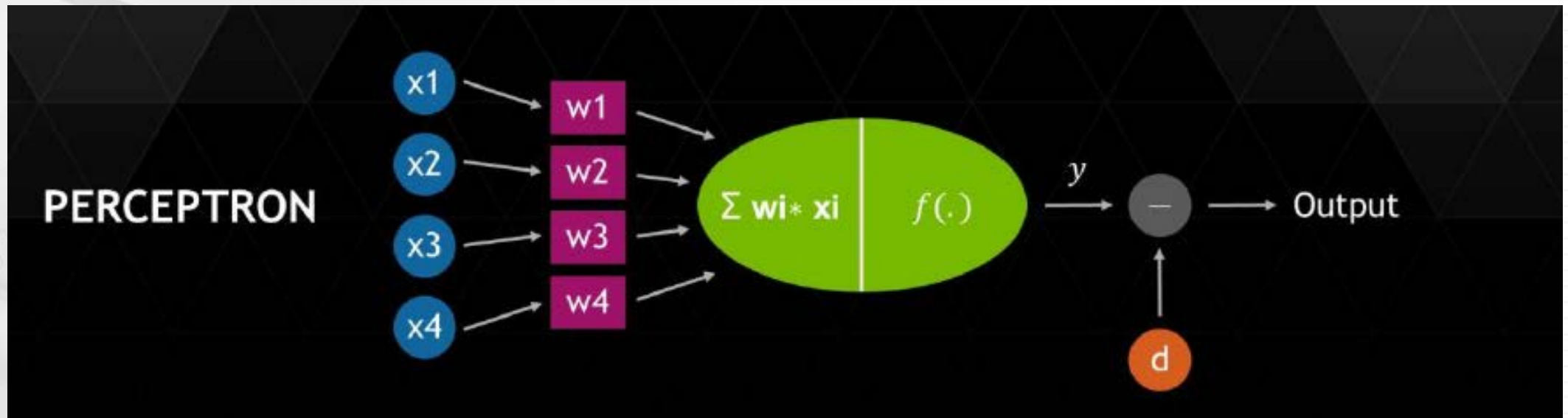
- ❁ Computing based on deep learning models the brain's neural learning process
 - ❁ Continuous learning
 - ❁ Increased intelligence over time
 - ❁ Delivering more accurate, faster results
- ❁ NVIDIA CUDA model uses deep learning capabilities to address complex computing problems
 - ❁ Parallel computing platform
 - ❁ Application programming interface (API)
 - ❁ Train in object recognition and classification
- ❁ Increased intelligence and efficiency in identifying basic and occluded objects, while also assigning context



Multi-core GPGPUs fit this model

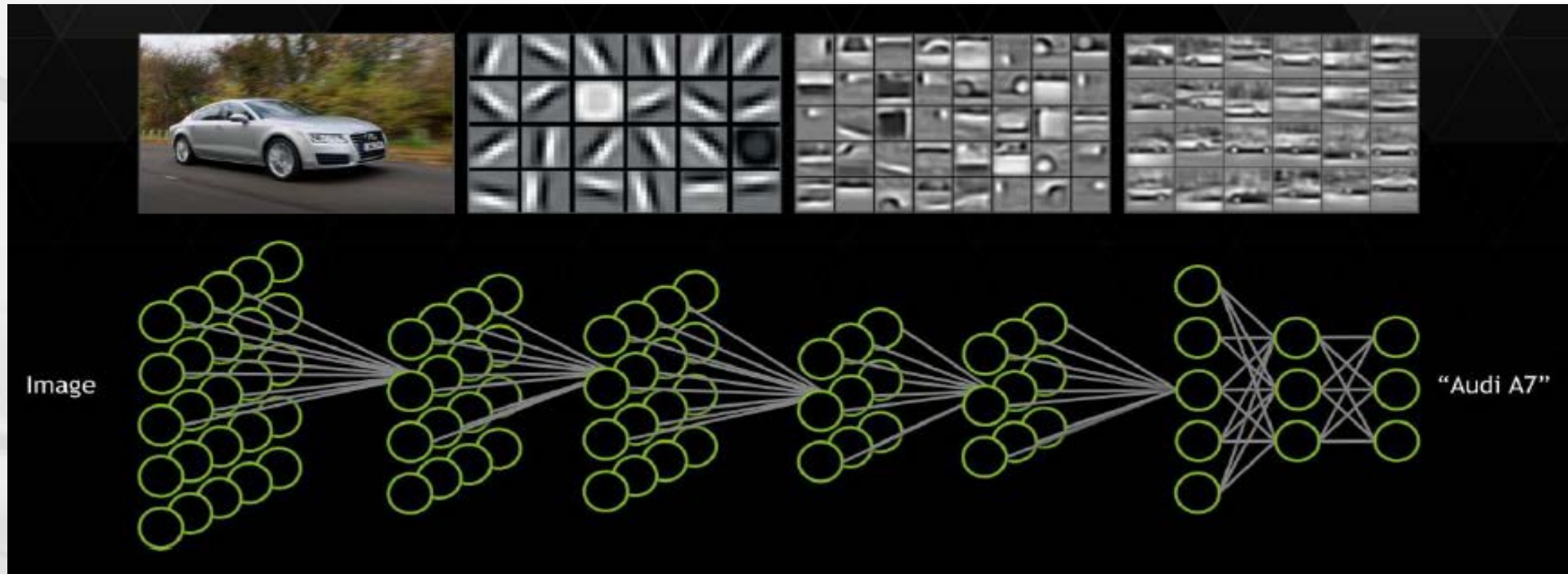
WTH is Deep Learning & Neural Networks?

- The Perceptron is the most basic neural network model
- Has several inputs that represent various object features that its being trained to recognize and classify
- Each feature is assigned a certain weight, based on importance in defining the shape of that object



WTH is Deep Learning & Neural Networks?

- ❖ Multi-layered neural network model may consist of several interconnected, complex Perceptron-like nodes
- ❖ Each node looks at many input features and feeds its output to several other nodes, for example:



Current GPGPU Use in Rugged Embedded Systems

Aitech A176 Cyclone

Smallest, most powerful rugged GPGPU, ideally suited for rugged, military or automotive distributed systems

NVIDIA® Jetson™- based GPGPU provides:

- ✦ 256 CUDA Cores & ARM Cortex A57 Quad Core CPU
- ✦ Over 1 TFLOP @ 15 W (max), >66 GFLOPS/W
- ✦ SD/HD Imaging Cameras and Displays with H.264/H.265 CODECs
- ✦ I/O includes: GbE, Serial, USB Ports & Discretets
- ✦ Internal SATA SSD Drive with Secure/Quick Erase

Video and signal processing for the next generation of autonomous vehicles, surveillance and targeting systems, EW & C4ISR systems



EV176 Eval Kit

Ultra Small Form Factor: 5.1" [129 mm] square, <2.2 lbs [1 kg]



Thank you!

