GENERIC VISUAL PERCEPTION

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GENERIC VISUAL PERCEPTION PROCESSOR

-THE ELECTRONIC EYE

- Developed after 10 years of scientific study
- Is a single chip modelled on the perception capabilities of the human brain
- Can detect objects in a motion video signal
- Can detect and track them in real time
- Can handle 20 bips
- Can handle most tasks that ranges from sensing the variable parameters
- Can handle most tasks performed by human eye

Generic Visual Perception Processor (GVPP)

- Models the human perceptual process at the hardware level
  - by mimicking the separate temporal and spatial functions of the eye-to-brain system
- Sees its environment as a stream of histograms regarding the location and velocity of objects
- Solve pattern recognition problems
- Can function in day light or darkness

BACKGROUND OF THE INVENTION

- Methods and Devices for
  - Automatic visual perception
  - Processing image signals
- Using two or more histogram calculation units to localize one or more objects in an image signal
- Using one or more characteristics an object such as the shape, size and orientation of the object
- Devices can be termed an electronic spatio-temporal neuron
- General outline of a moving object is then determined with respect to a relatively stable background

Potential sighted

- Invented by BEV founder Patric Pirim
- A CMOS chip to implement in hardware the separate contributions of temporal and spatial processing in the brain
- The brain-eye system uses layers of parallel-processing neurons
- Resulting in real-time tracking of multiple moving objects within a visual scene

Work by PIRIM

- Created a chip architecture that mimicked the work of neurons with the help of multiplexing and memory
- Result is an inexpensive device
- The GVPP tracks an object based on
  - Hue
  - Luminance
  - Saturation
  - Speed
  - Spatial orientation
  - Direction of motion
- Upto 8 objects can be tracked

How?

- The GVPP tracks an object
  - anticipating where its leading and trailing edges makes “differences” with the background
  - When an object gets closer to the viewer or moves farther away
  - That it can track an object through varying light sources or changes in size

Major performance strength

- Adaptation to varying light sources

  -means GVPP adapt to real time changes in lighting without recalibration,day or light

- Limitation of traditional processors were removed

  -traditional processors slice each and every complex program into simple tasks

  -requires an algorithm

- GVPP does not require an algorithm
- Solve a problem using neural learning function
- Fault tolerent

HOW IT WORKS?

- The chip is made of neural network modeled resembling the structure of human brain.
- The basic element here is a neuron
- Each neuron is capable of implementing a simple function
- Many input lines and an output line
- It takes the weighted sum of its inputs and produces an output that is fed into the next layer
- The weights assigned to each input are a variable quantity

Synaptic connections

- A large number of interconnected neurons form a neural network
- Synaptic connections
  - Every input to a neuron passes through entire network
  - Every time the weight changes
  - Stable values for weights
  - Information is stored

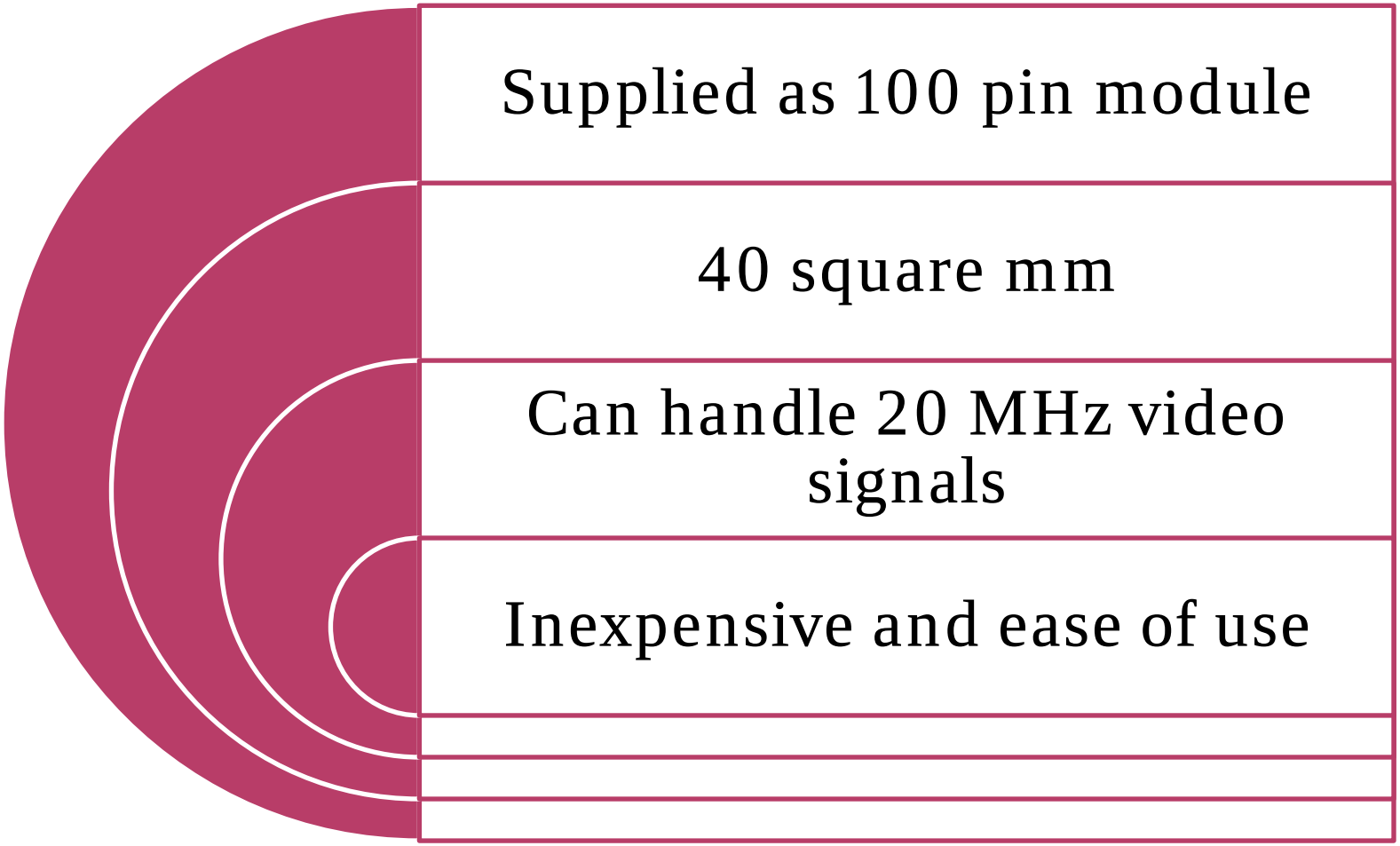
NEURAL NETWORK

- Geometrizes computation
- State diagram of a neural network
- The network activity burrows a trajectory in this state space
- The trajectory begins with a computation problem
- The problem specifies initial conditions which define the beginning of trajectory in the state space
  - Eg. Pattern learning-patterns to be learned
  - Eg. Pattern recognition-patterns to be recognized
- Trajectory ends when system reaches equilibrium
- Final state

HARDWARE FEATURES

- Hard-wired silicon circuitary around each pixel in sensor array
- Sensor array
  - Is a set of several sensors that an information gathering device uses to gather information
  - Each silicon neurons cosists of
    - ✓ RAM
    - ✓ A FEW REGISTERS
    - ✓ AN ADDER
    - ✓ A COMPARATOR
- Each parameter has a neuron
- Each pixel has two auxiliary neurons that define the zone in which the object is located

THE CHIP IS


Supplied as 100 pin module
40 square mm
Can handle 20 MHz video signals
Inexpensive and ease of use

Divide and conquer

- Processing in each module on the GVPP runs in parallel out of its own memory space
- So multiple GVPP chips can be cascaded to expand the number of objects that can be recognized and tracked
- When set in master-slave mode, any number of GVPP chips can divide and conquer,
  - for instance, complex stereoscopic vision applications.

Software aspects

- a host operating system on an external PC communicates with the GVPP's evaluation board via an OS kernel within the on-chip microprocessor
- "programming by seeing and doing"
- “Once debugged, these tiny application programs are loaded directly into the GVPP's internal ROM"
- Makes calls to a library of assembly language algorithms for visual perception and tracking of objects

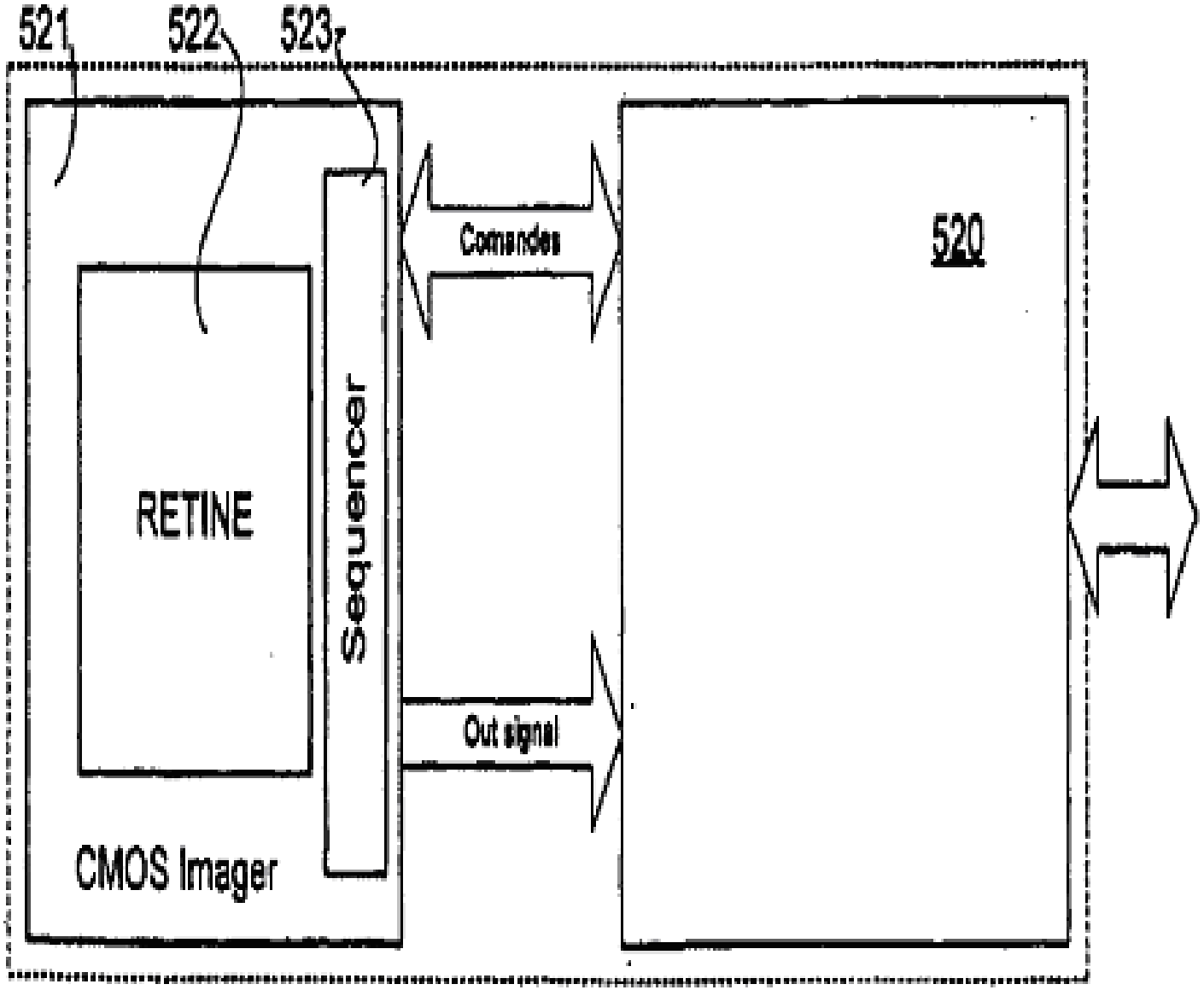
How it recognizes?

- A set of second-level pattern recognition commands permits the GVPP to search for different objects in different parts of the scene

  -> for instance, to look for a closed eyelid only within the rectangle bordered by the corners of the eye

  -> since some applications may also require multiple levels of recognition, the GVPP has software hooks to pass along the recognition task from level to level

Architecture of GVPP



GVPP ARCHITECTURE

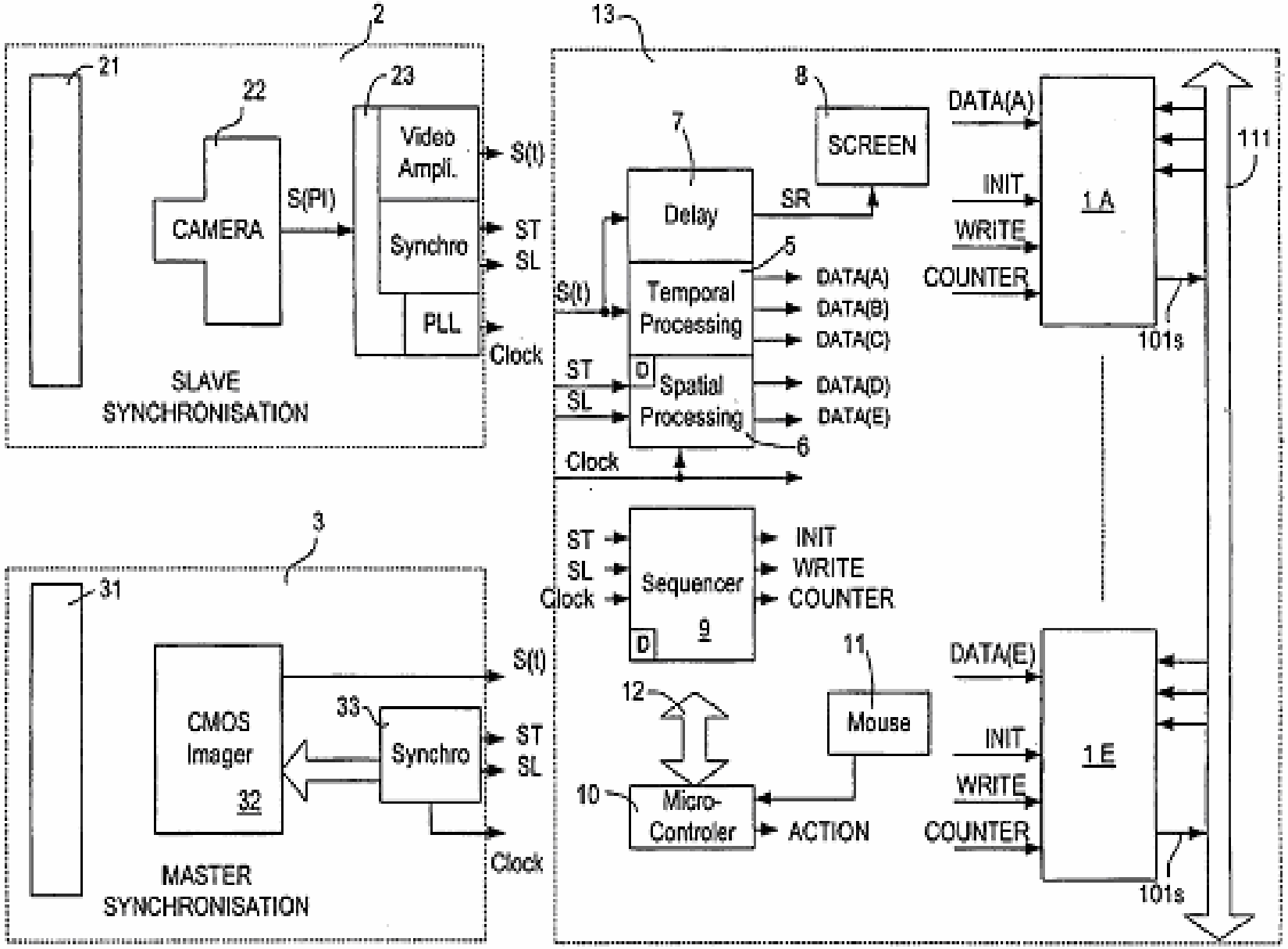
- Chip consists of 23 neural blocks, temporal and spatial
- Each with 20 input and output synaptic connections
- Multiplexes this with off-chip sratchpad memory
- Thus total 6.2 billion synaptic connections per sec
  - Temporal neurons
    - Identify the pixels that have changed
    - Generate a 3-bit value
  - Spatial neurons
    - Analyzes the resulting histogram to calculate speed and direction of motion

HISTOGRAM

- Is a bar chart of the count of pixels of every tone of gray that occurs in the image
- Helps to analyze, and more importantly , correct the contrast of the image
- Maps luminance,which is defined from the way the human eye perceives the brightness if different colors

MULTIPLE PERCEPTIONS

- Chip has three functions
    1) Temporal processing
    2) Spatial processing
    3) Histogram processing
- Temporal processing:-processing of successive frames of an image to prevent interference
- Spatial processing:-processing of pixels within a localized area to determine the
    - Speed
    - Direction of movement of each pixel



Representation of histogram calculation unit

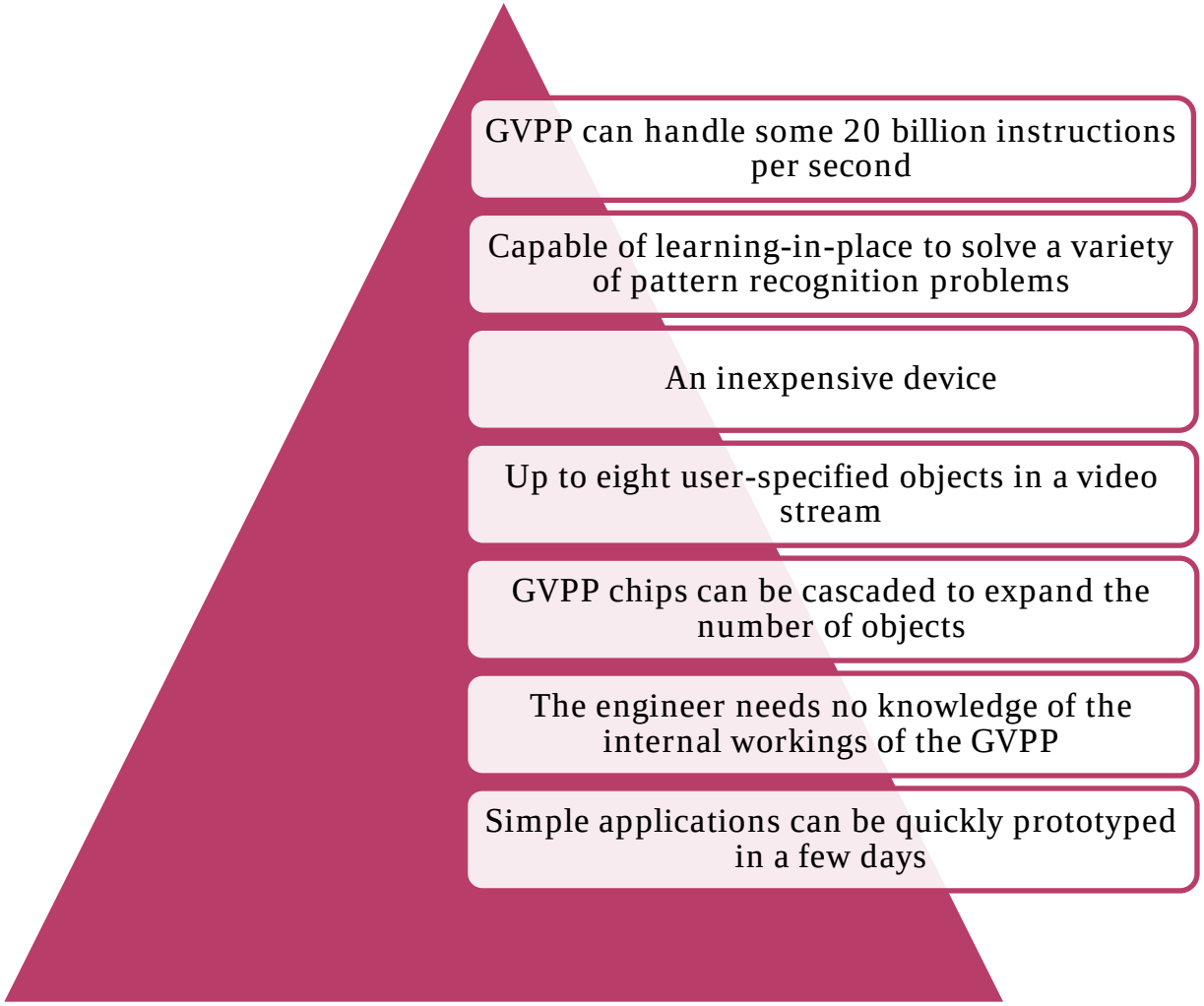
EXAMPLES

In case of driver falling asleep while driving a car

- First, the driver is identified
- Then the microprocessor directs the vision processor to search within the corner points of a rectangular area in which the nose of the driver would be expected to be located
- Then the eyes are identified
- High speed movement of blinking of eyes
- Histograms to check whether blinking duration is fast
- Then it determines whether the driver is falling asleep

Triggers an alarm

ADVANTAGES


GVPP can handle some 20 billion instructions per second
Capable of learning-in-place to solve a variety of pattern recognition problems
An inexpensive device
Up to eight user-specified objects in a video stream
GVPP chips can be cascaded to expand the number of objects
The engineer needs no knowledge of the internal workings of the GVPP
Simple applications can be quickly prototyped in a few days

DISADVANTAGE

The chip is not really a medical marvel, poised to cure the blind

APPLICATIONS

Automotive industry

- Trigger alarm
- Collision avoidance
- Smart air bags
- License plate recognition
- Measurement of traffic flow
- Electronic toll collection
- Cargo tracking

Robotics

- Feeding hot parts to forging presses
- Cleaning up hazardous waste
- Spraying toxic coatings on aircraft parts

APPLICATIONS(CONT…)

Agriculture and fisheries	• Disease and parasite identification • Harvest control • Ripeness detection • Yield identification
Military applications	• Military target acquisition and fire control • Automatic target detection • Trajectory correction
Medical applications	• Medical scanners • Blood analyzers • Cardiac monitoring

Future scope

Scientists are working on a “visual mouse” for hand-gesture interface to computers that take advantage of that high compression ratio

Future studies also involve using this processor as an eye of the robots, which provides tremendous applications

CONCLUSION

- The generic visual perception processor can handle about 20 billion instructions per second, and can manage most tasks performed by the eye
- Modeled on the visual perception capabilities of the human brain, the GVPP is a single chip that can detect objects in a motion video signal and then to locate and track them in real time
- This is a generic chip, and we've already identified more than 100 applications in ten or more industries
- The chip could be useful across a wide range of industries where visual tracking is important


Thank You!