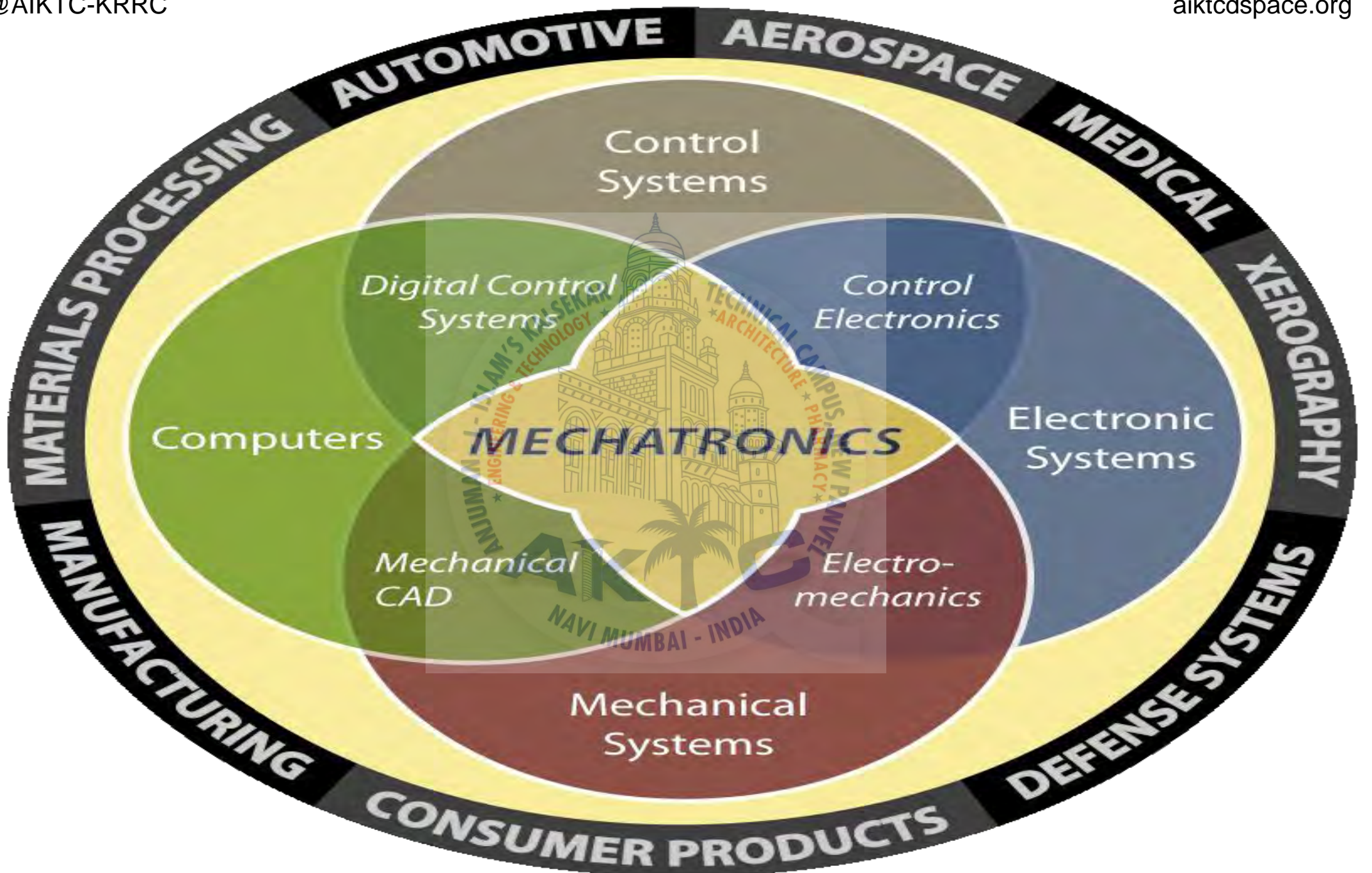


Introduction to Mechatronics

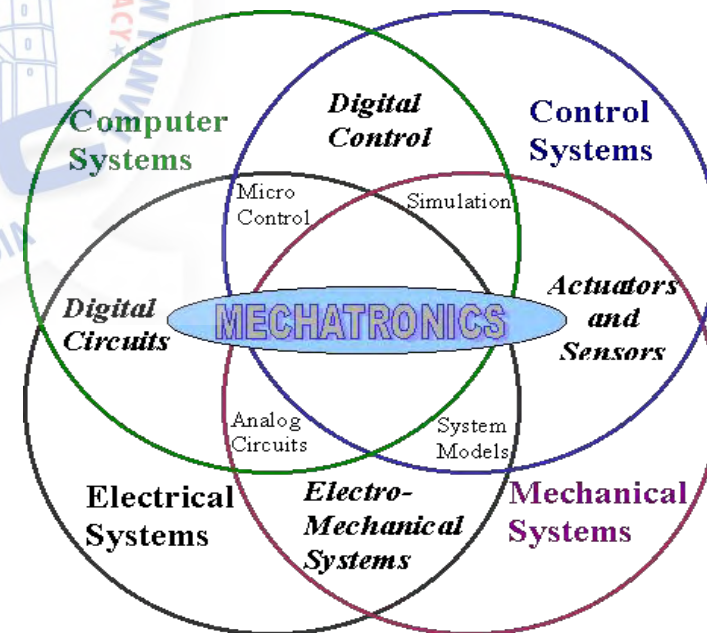
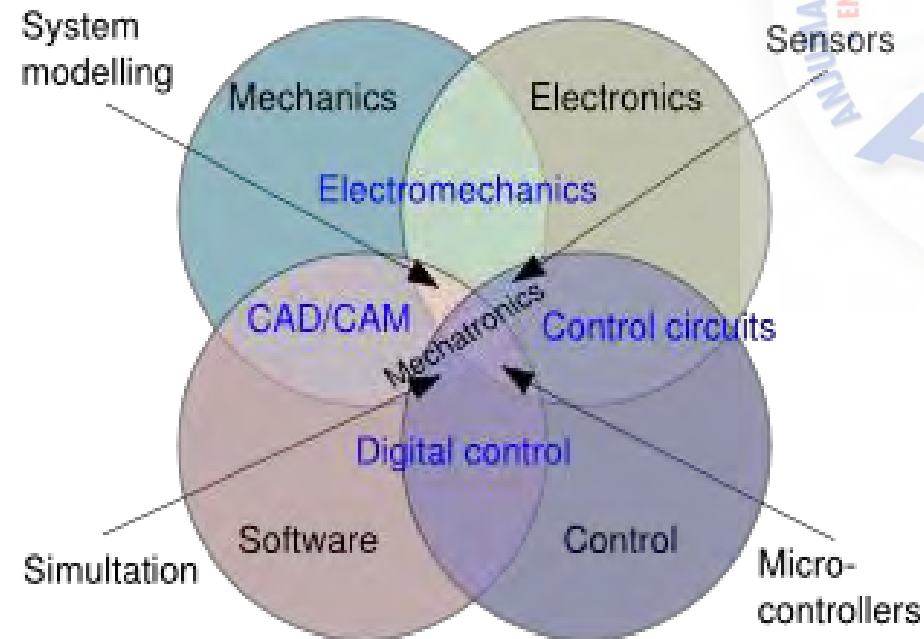




What is Mechatronics?

Mechatronics is synergistic integration of mechanical engineering, electronics and intelligent computer control in design and manufacture of products and processes.

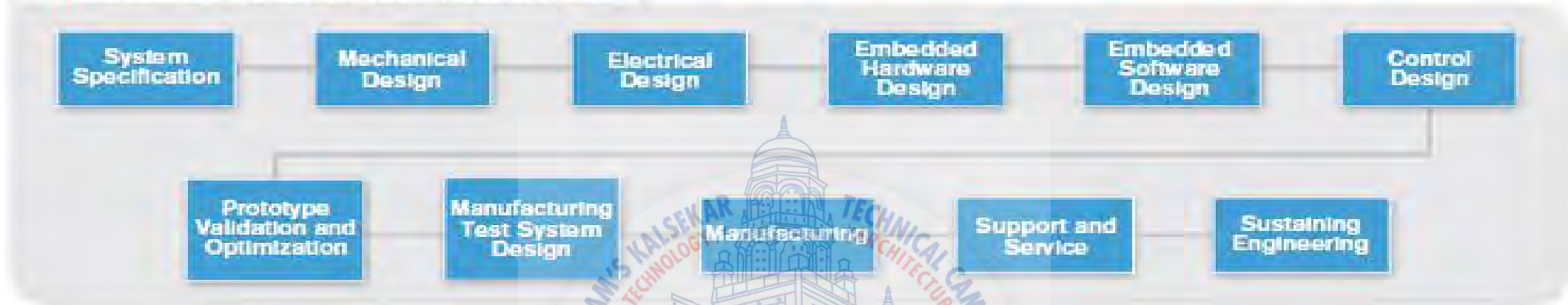
- Emphasis on integrated design for products.
- Optimal combination of appropriate technologies.



Comments to the Definition

- Mechatronics studies special conceptual approach to construction of machines.
- The definition emphasizes synergetic character of components' integration in mechatronic objects.
- Integrated mechatronic components are always chosen at the designing stage.
- Methods of parallel designing serve as methodological basis for **Mechatronic Systems (MS)** development.
- The main objects that mechatronics studies are mechatronic modules.
- **MS** are intended to perform a set movement.
- In **MS** methods of advanced intelligent control are used to secure high quality in performing precise movements.

Traditional Sequential Design Approach



Mechatronics Parallel Design Approach

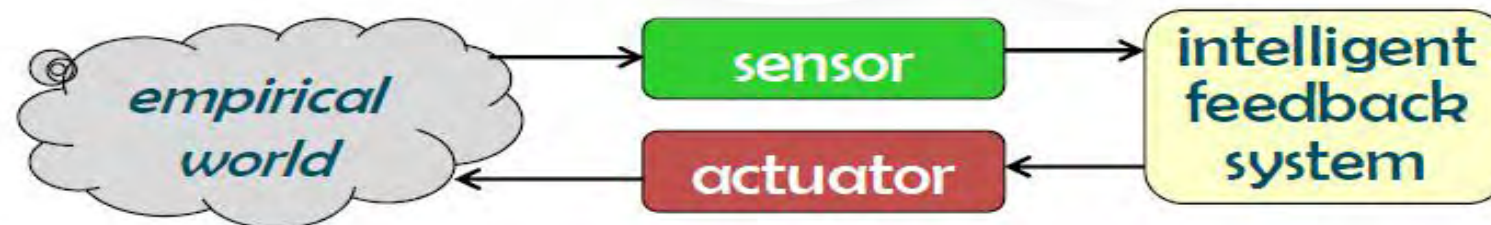


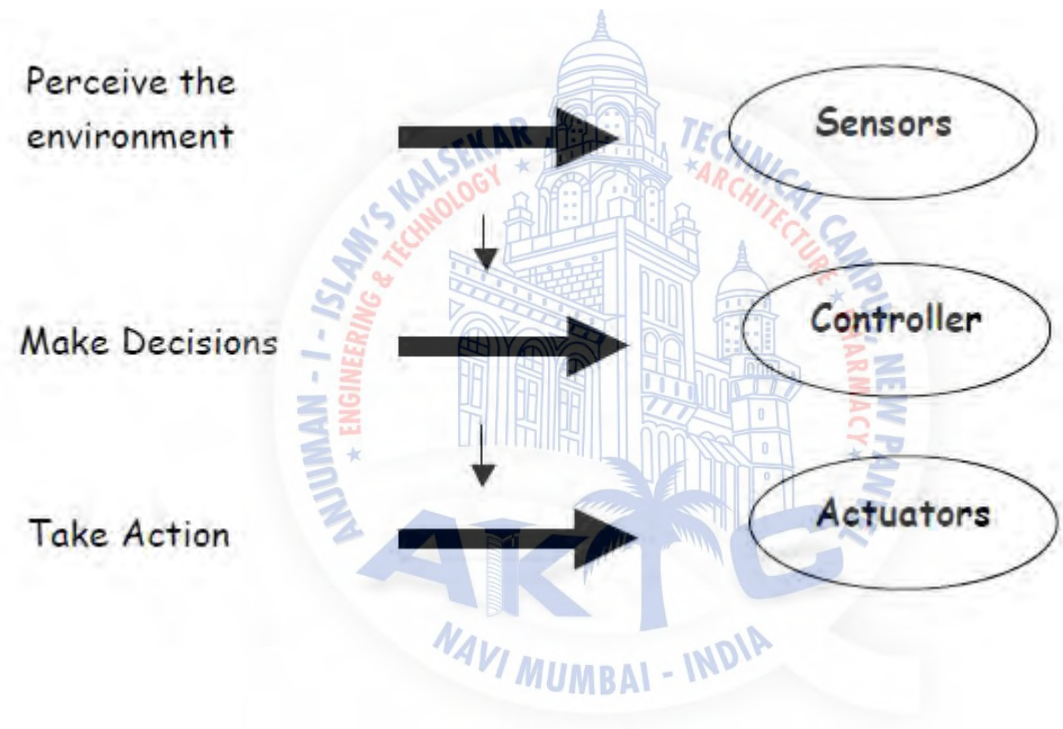
transducer: a device that converts a quantity with a primary form of energy to another

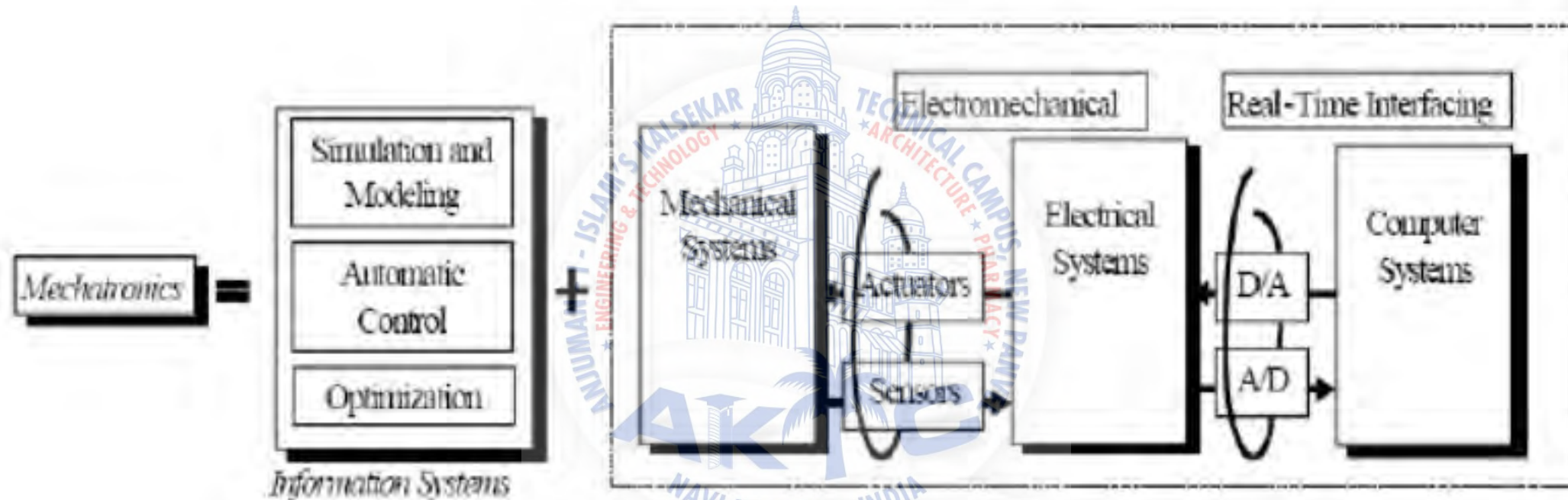
primary energy forms: mechanical, thermal, electromagnetic, optical, chemical ...

it takes form of:

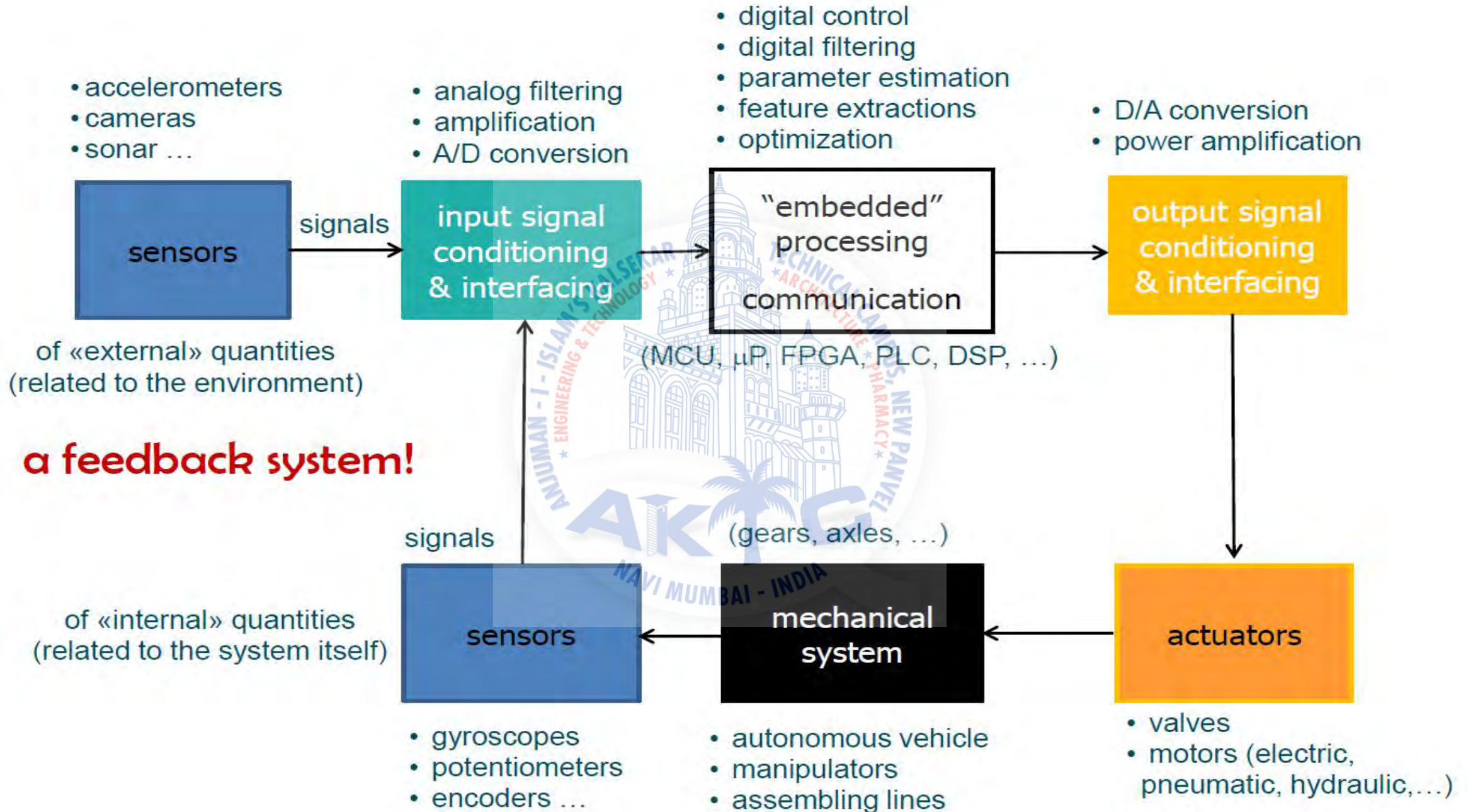
- **sensor** (e.g., thermometer): a transducer that acquires information from the “empirical world” providing an electrical signal at its output
- **actuator** (e.g., heater): a transducer that acts on the “empirical world” converting information into an action



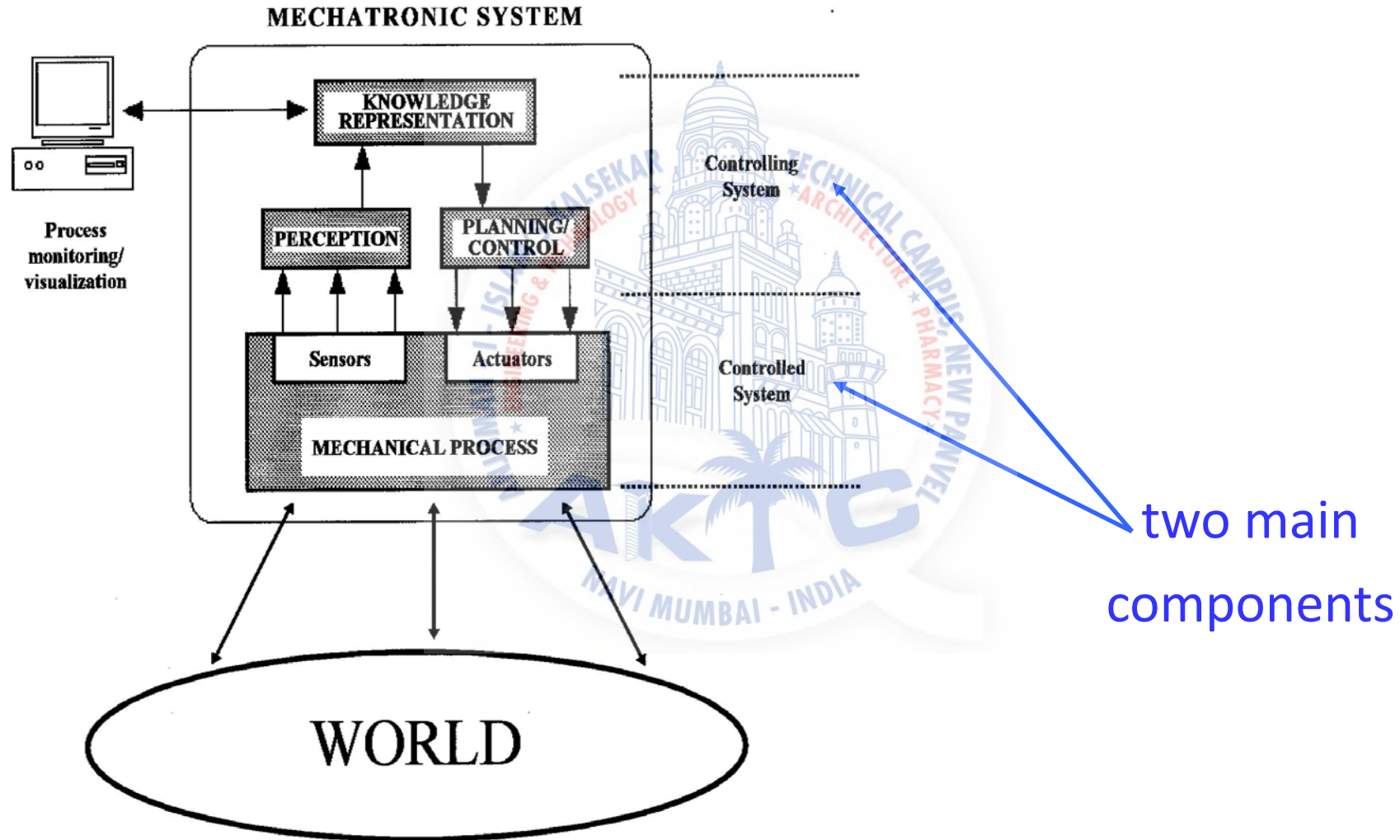




The Key Element of Mechatronic



Mechatronic System Architecture



Mechatronics Systems



Tools



Computers

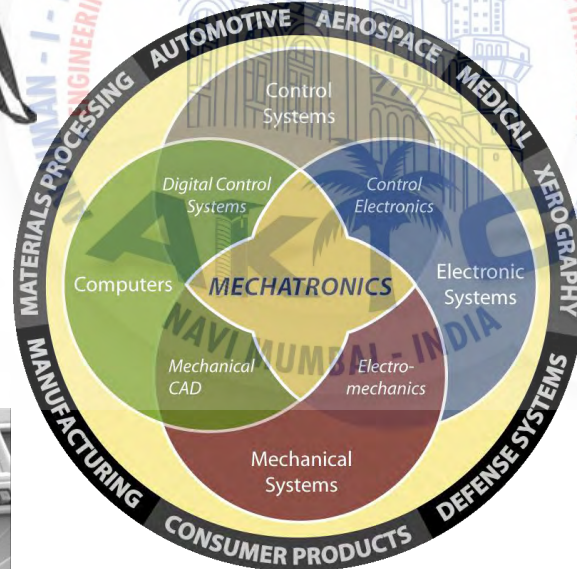


Cars

Consumer Electronics



Stealth Bomber



MEMS



High Speed Trains



Micro to Macro Applications

Mechatronics Systems

-Transportation Applications-

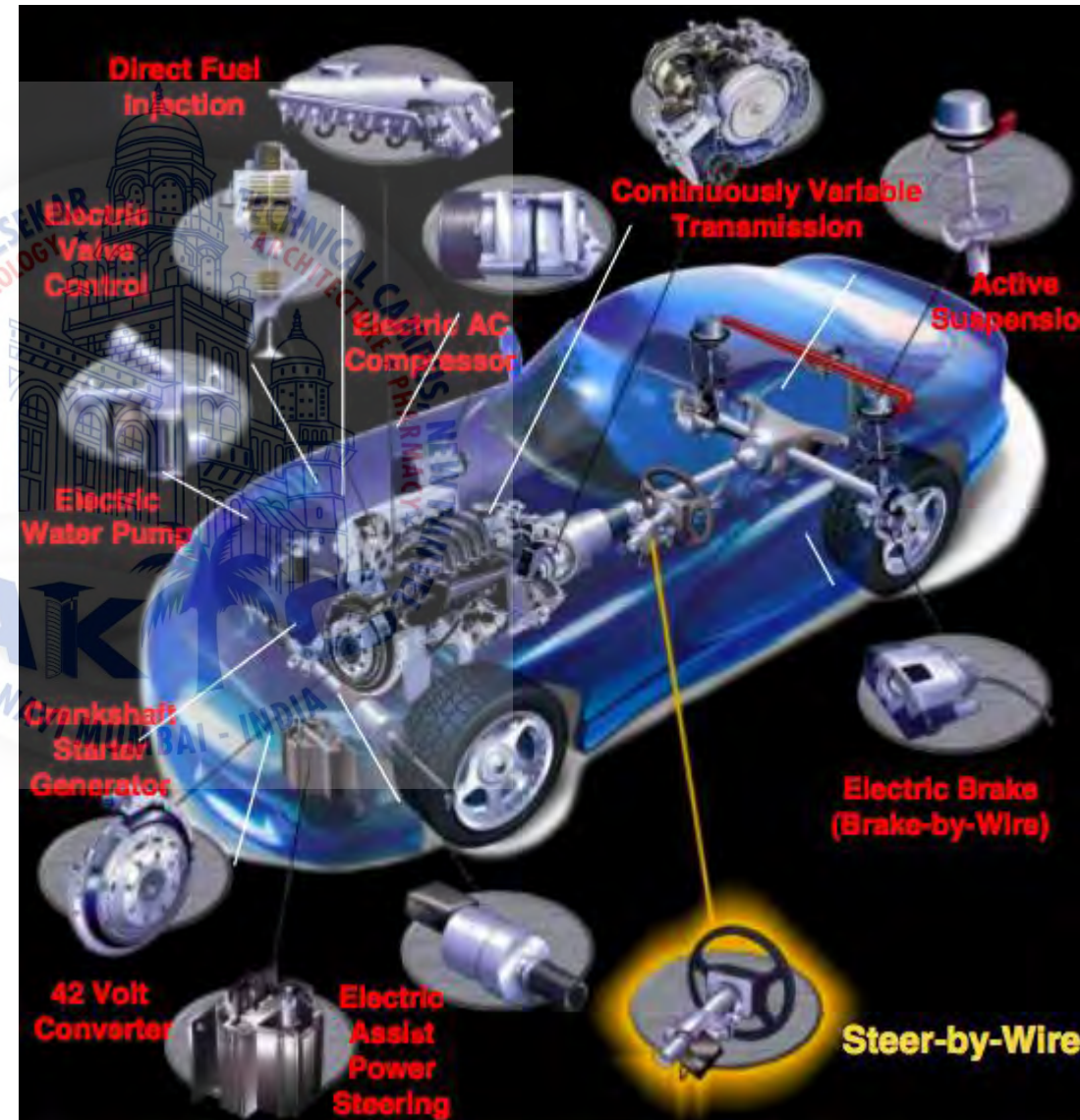
Automobiles

Typical Applications

- Brake-By-Wire system
- Steer-By-Wire
- Integrated vehicle dynamics
- Camless engines
- Integrated starter alternator

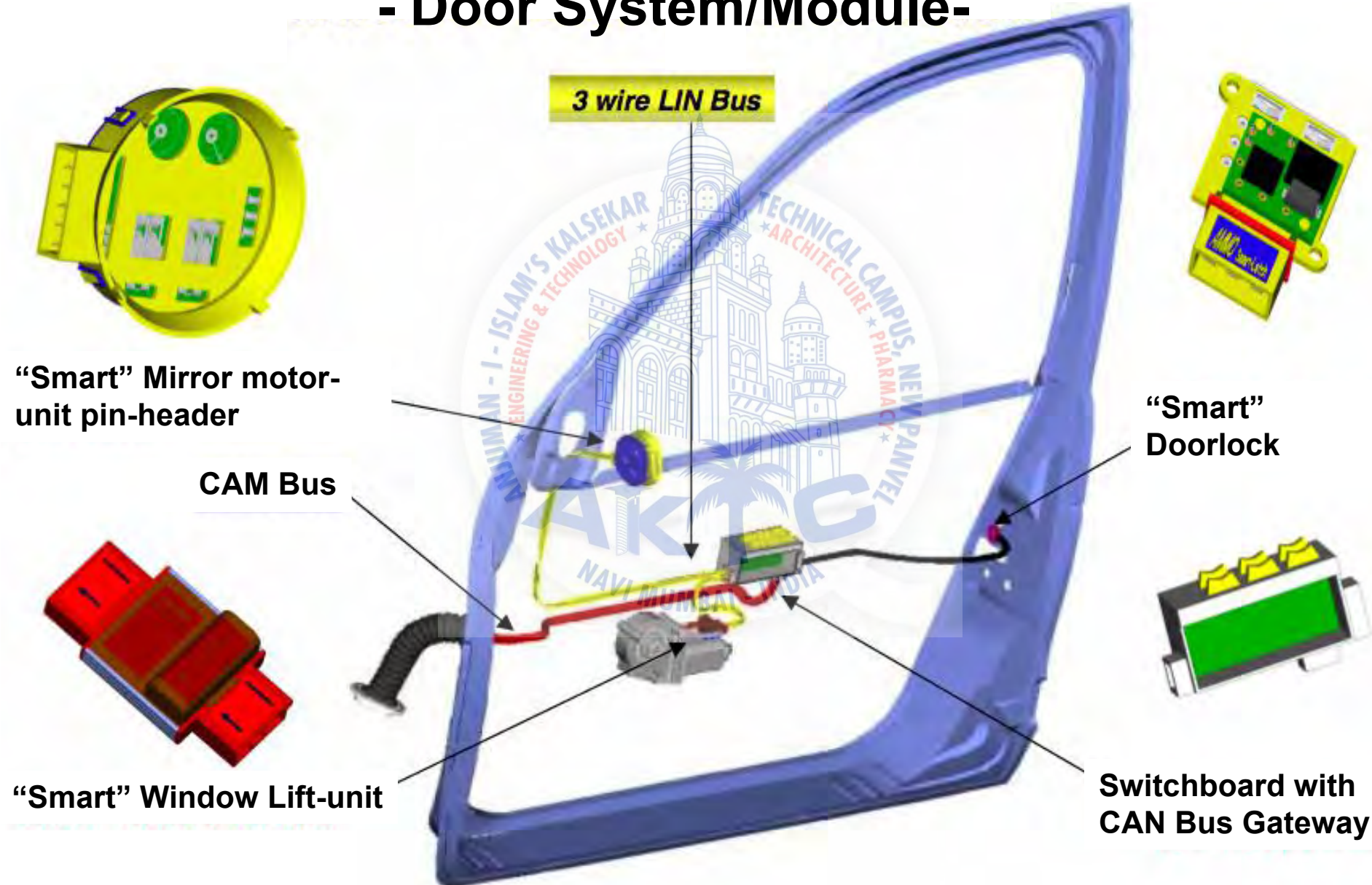
OEM Driven

- Reliability
- Reduced weight
- Fuel economy
- Manufacturing flexibility
- Design freedom
- Advanced safety features
- Cost



Mechatronics Systems

- Door System/Module-



Mechatronics Systems

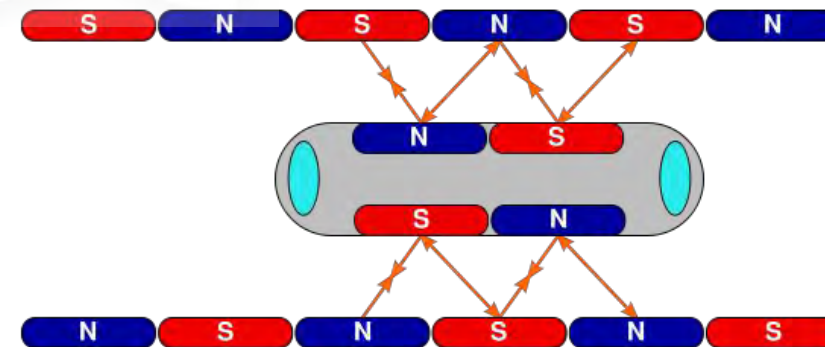
-Transportation Applications-

High Speed Trains

- Train Position and Velocity constantly monitored from main command center.
- Error margin in scheduling no more than 30 seconds
- Fastest trains use magnetic levitation



Magnetic Levitation



Mechatronics Systems

-Transportation Applications-

Systems Uses

- Tilt and pressure sensors
- Microcontroller
- Motors
- Onboard power source



Segway

Advantages

- Simple and intuitive personal transportation device



Mechatronics Systems

-Smart Robotics Applications-

- Robots can vacuum floors and clean gutters **so you don't have to.**

Vacuum Floors

Cleans Gutter

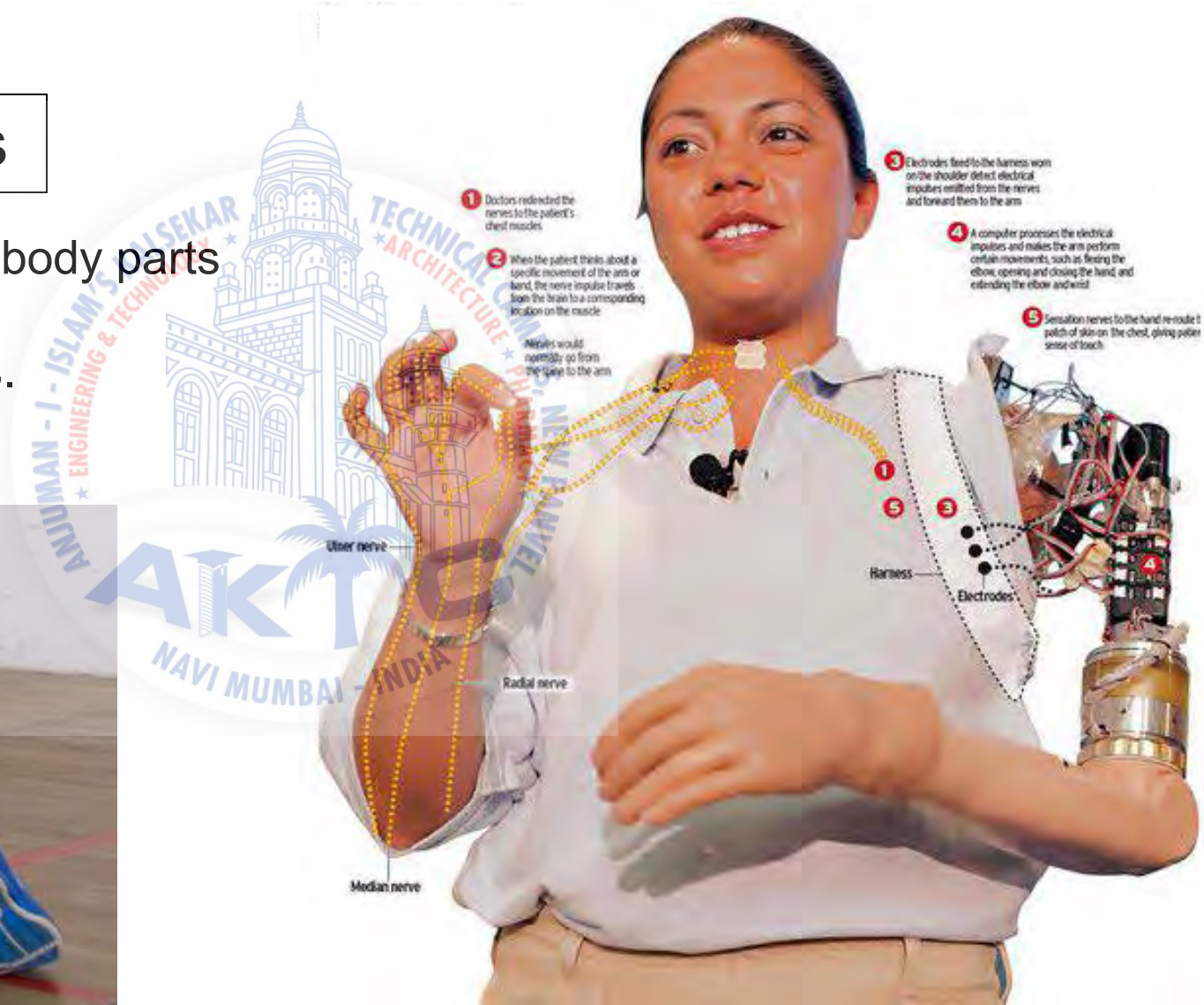


Mechatronics Systems

-Medical Applications-

Prosthetics

- Arms, Legs, and other body parts can be replaced with electromechanical ones.



Mechatronics Systems

-Defense Applications-

- Advanced technology is making our soldiers safer.
- Some planes can now be flown remotely.

Unmanned Aerial Vehicle



Stealth Bomber



Mechatronics Systems

-Medical Applications-

Pace Maker

- Used by patients with slow or erratic heart rates. The pacemaker will set a normal heart rate when it sees an irregular heart rhythm.



Implantable Defibrillation

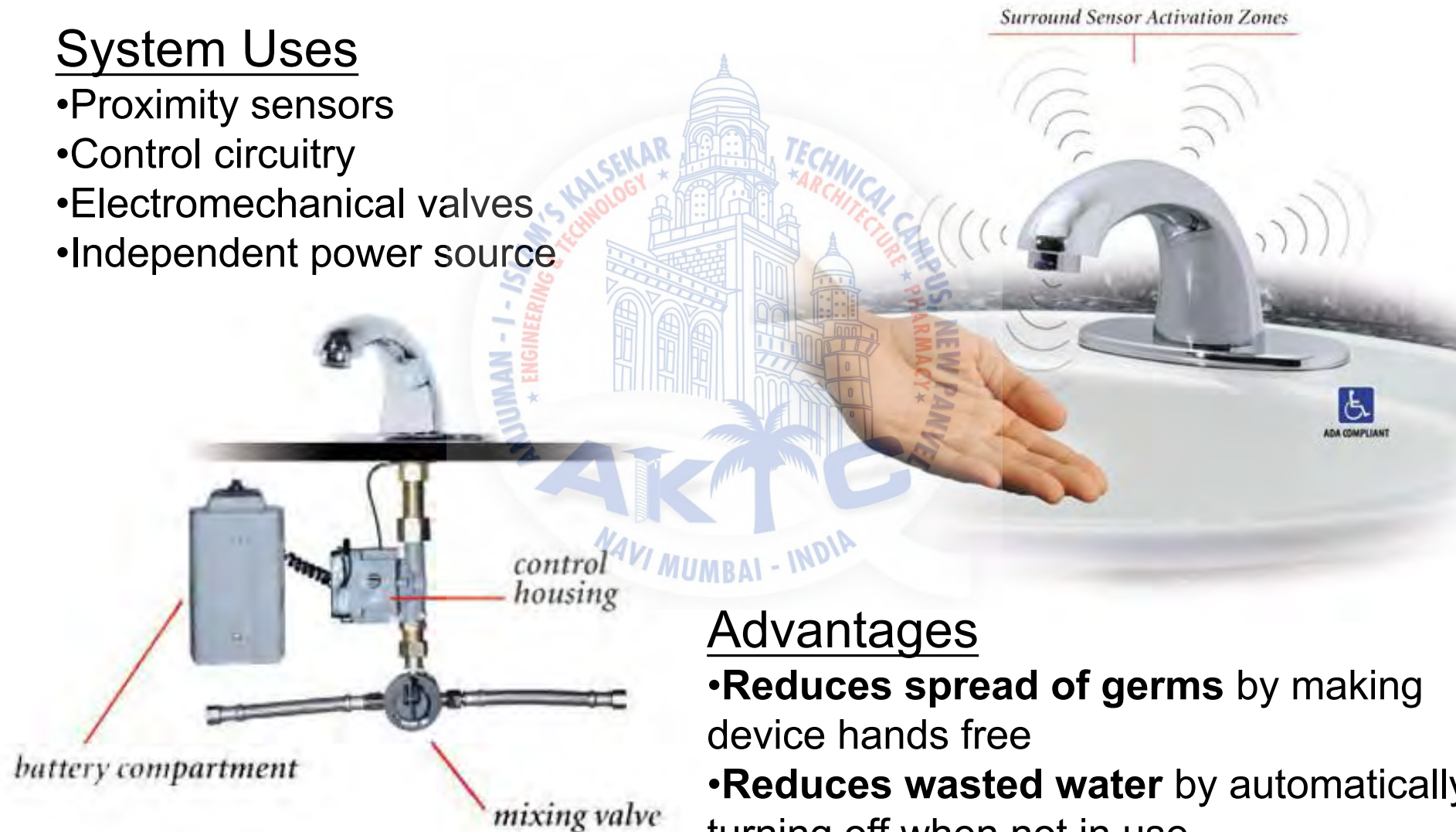
- Monitors the heart. If heart fibrillates or stops completely it will shock the heart at high voltage to restore a normal heart rhythm.

Mechatronics Systems

-Sanitation Applications-

System Uses

- Proximity sensors
- Control circuitry
- Electromechanical valves
- Independent power source



Advantages

- **Reduces spread of germs** by making device hands free
- **Reduces wasted water** by automatically turning off when not in use

Mechatronics Systems

-Sanitation Applications-

Systems Uses

- Motion sensors
- Control circuitry
- Electromechanical actuators
- Independent power source

Soap Dispenser



Paper Towel Dispenser



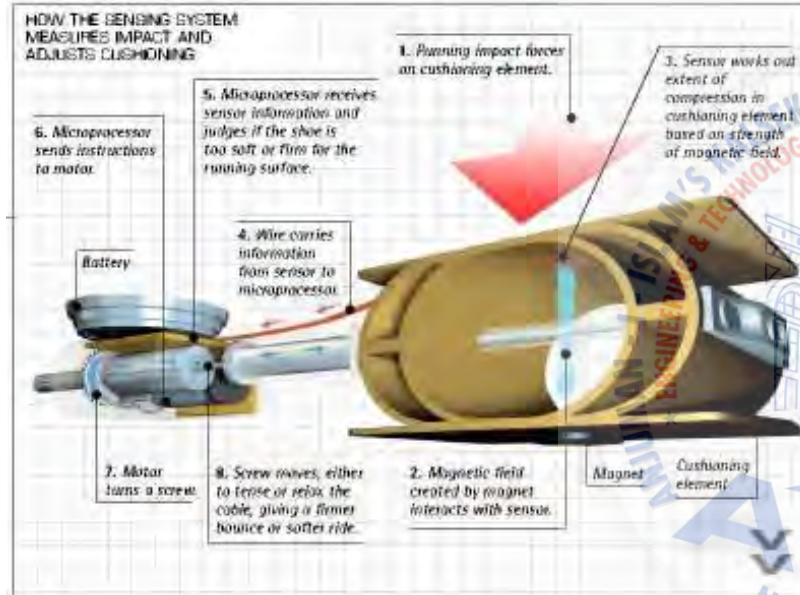
Advantages

- Reduces spread of germs** by making device hands free
- Reduces wasted materials** by controlling how much is dispensed

Mechatronics Systems

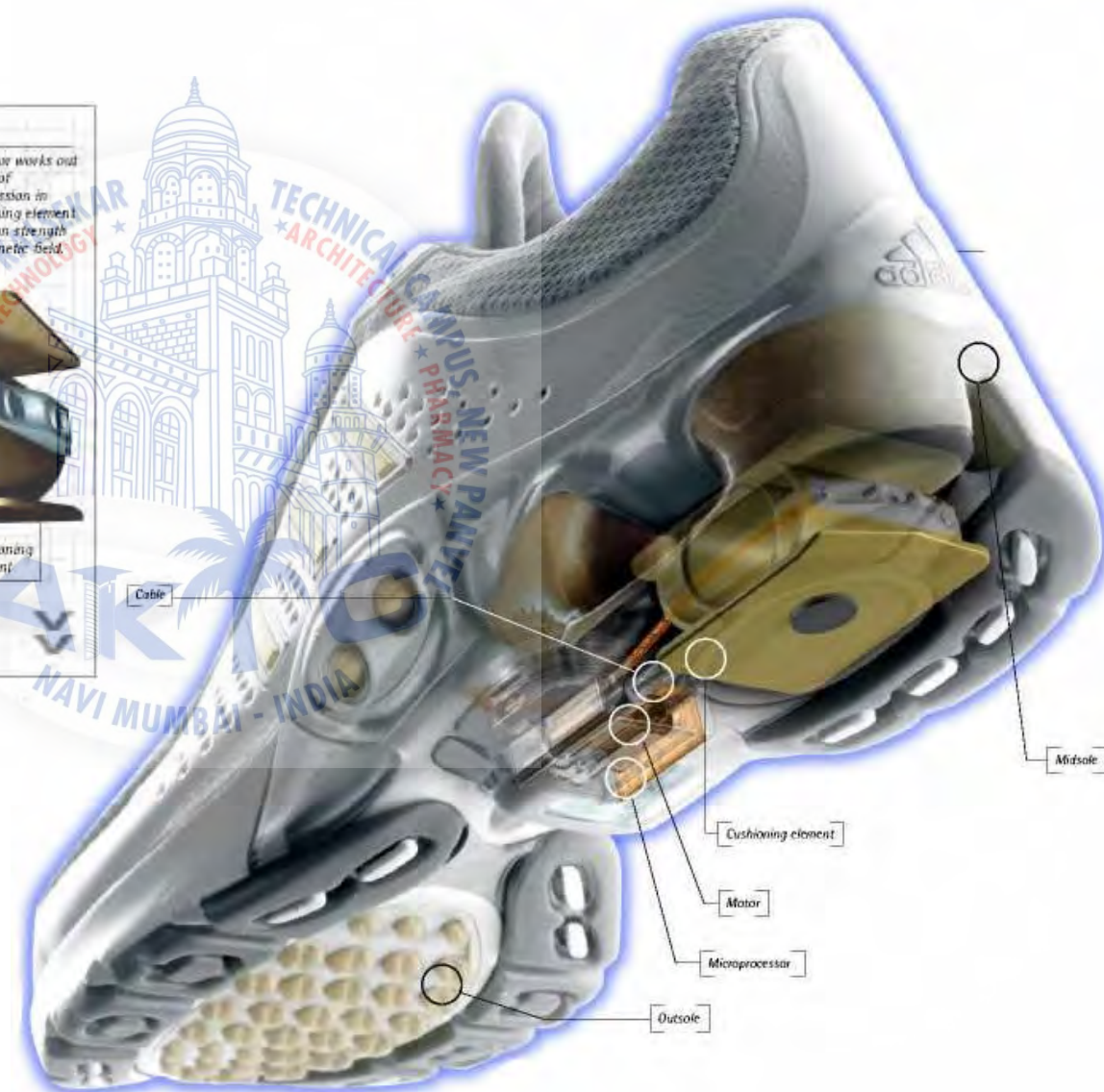
-Sports Applications-

Running Shoes



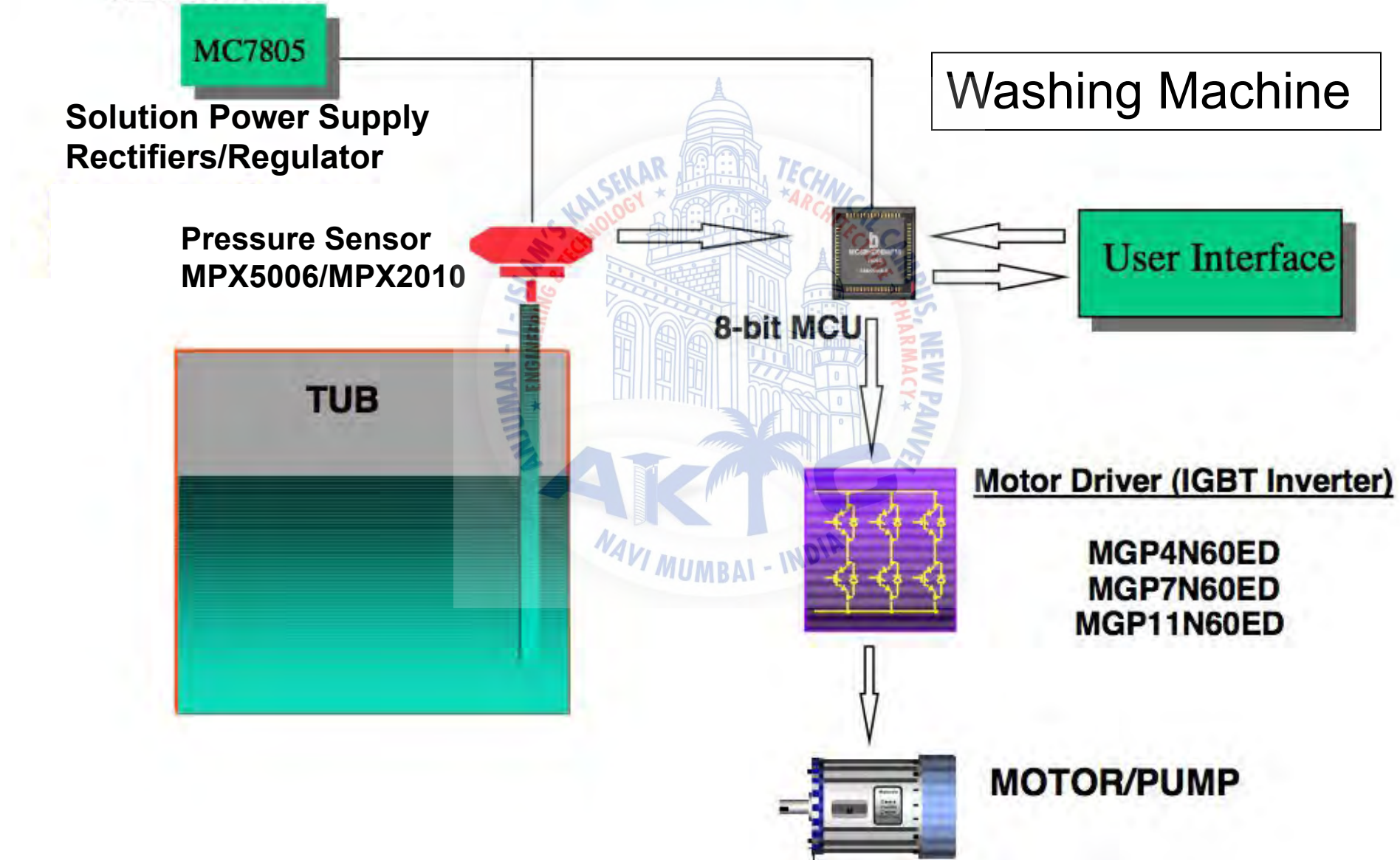
Advantages

- **Automatically changes cushioning** in shoe for different running styles and conditions for improved comfort



Mechatronics Systems

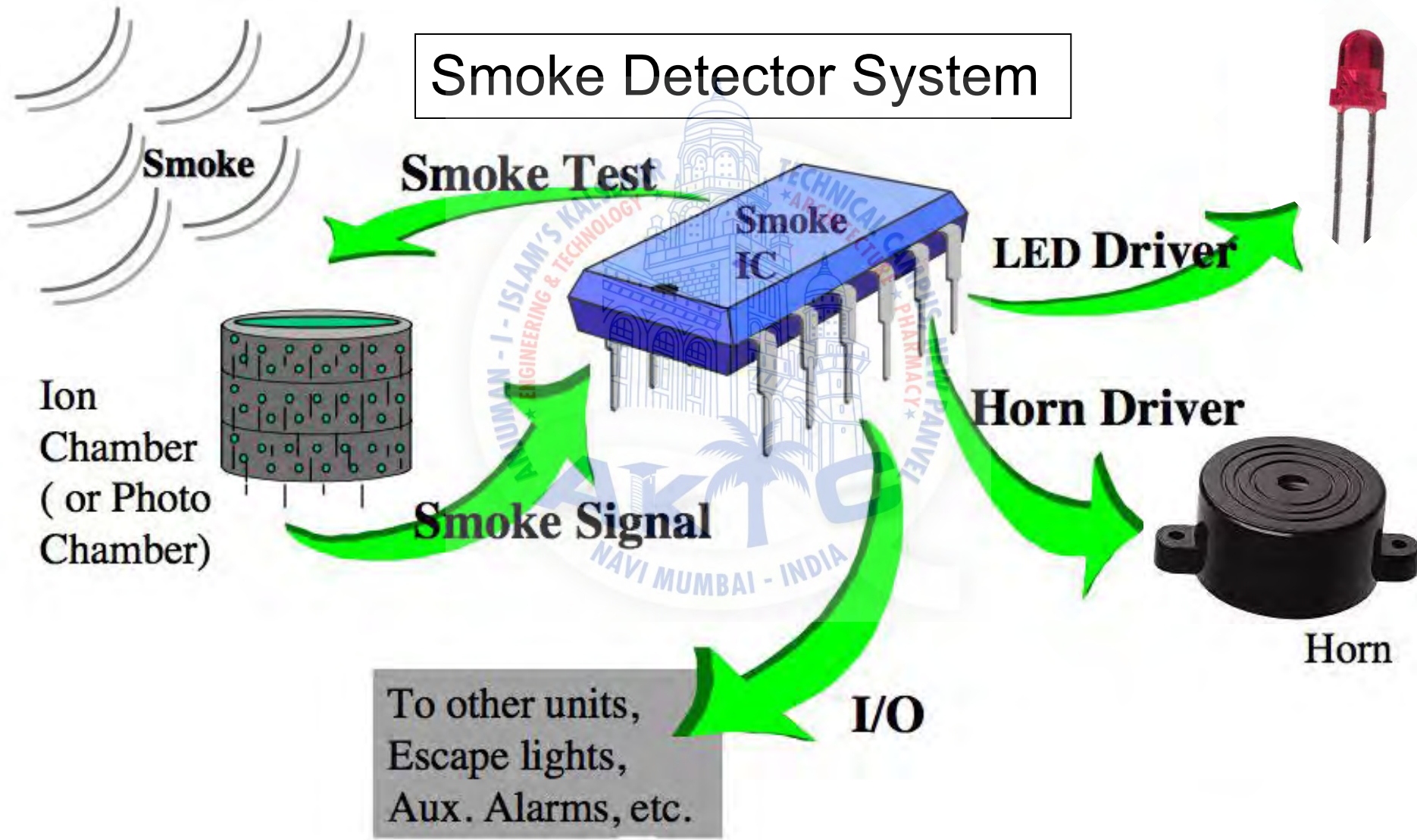
-Smart Home Applications-



Mechatronics Systems

-Smart Home Applications-

Smoke Detector System



Modern Trends of MS Development



- Machine-tool construction and equipment for automation of technological processes;
- Robotics;

- Office equipment;
- Computer facilities;
- Photo and video equipment;



Modern Trends of MS Development

- Micro machines;
- Control and measuring devices and machines;
- Simulators for training of pilots and operators;
- Non-conventional vehicles.



Fundamental Problems

- Structural integration of mechanical, electronic and information departments into a uniform creative staff;
- Education and training of engineers specialized in mechatronics and managers able to organize integration and supervise work of strictly specialized experts with different qualifications;
- Integration of information technologies from various scientific and technical fields into a uniform toolkit to provide computer support of mechatronic problems;
- Standardization and unification of all used elements and processes at designing and manufacturing MS.

Levels of Mechatronic Systems' Integration

The First Level



Levels of Mechatronic Systems' Integration

The Second Level

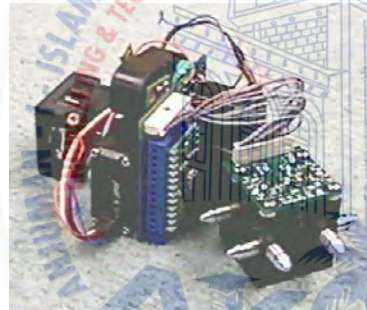


- operated power machines (turbines and generators),
- machine tools and industrial robots with numerical program management

Levels of Mechatronic Systems' Integration

The Third Level

Synthesis of new precise, information and measuring high technologies gives a basis for designing and producing intellectual mechatronic modules and systems.



Career Paths in Mechatronics

- mechatronics is seen as a prime career path for mechanical engineers of the future;
- mechanical engineers with a mechatronics background will have a better chance of becoming managers;
- classically trained mechanical engineers will run the risk of being left out of the interesting work.

Robot Platforms (1)



Indoor Robots



DLR Gripper



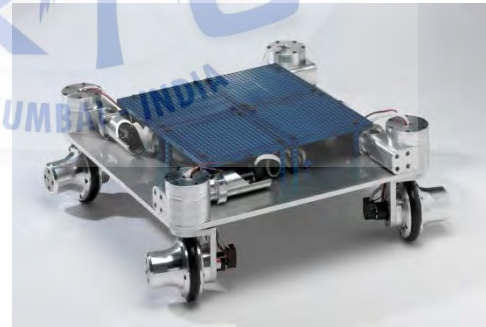
NASA Mars Rover



Asimo Humanoid



Outdoor Robots



Robot Base Station



KUKA Manipulator

Robot Platforms (2)



Aibo 4 legged Robot



Qurio Humanoid

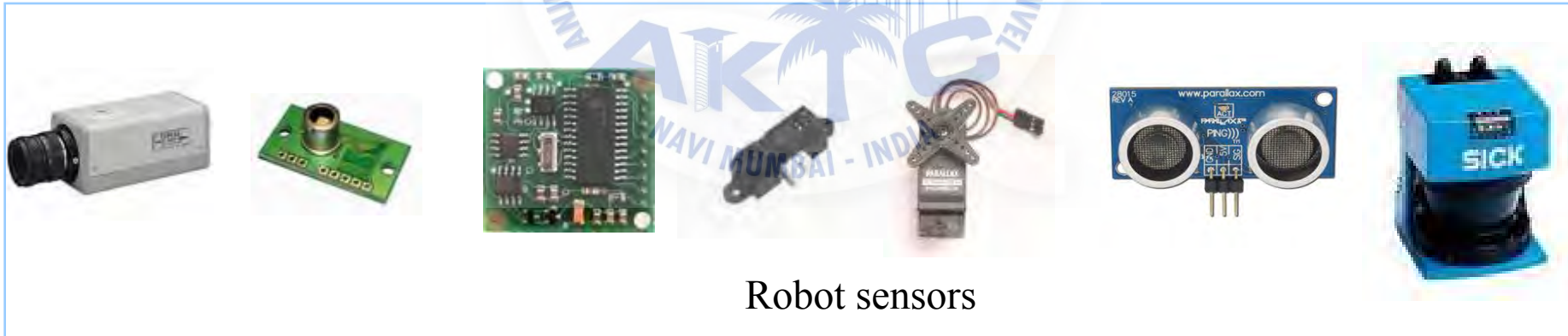


Robocup Team

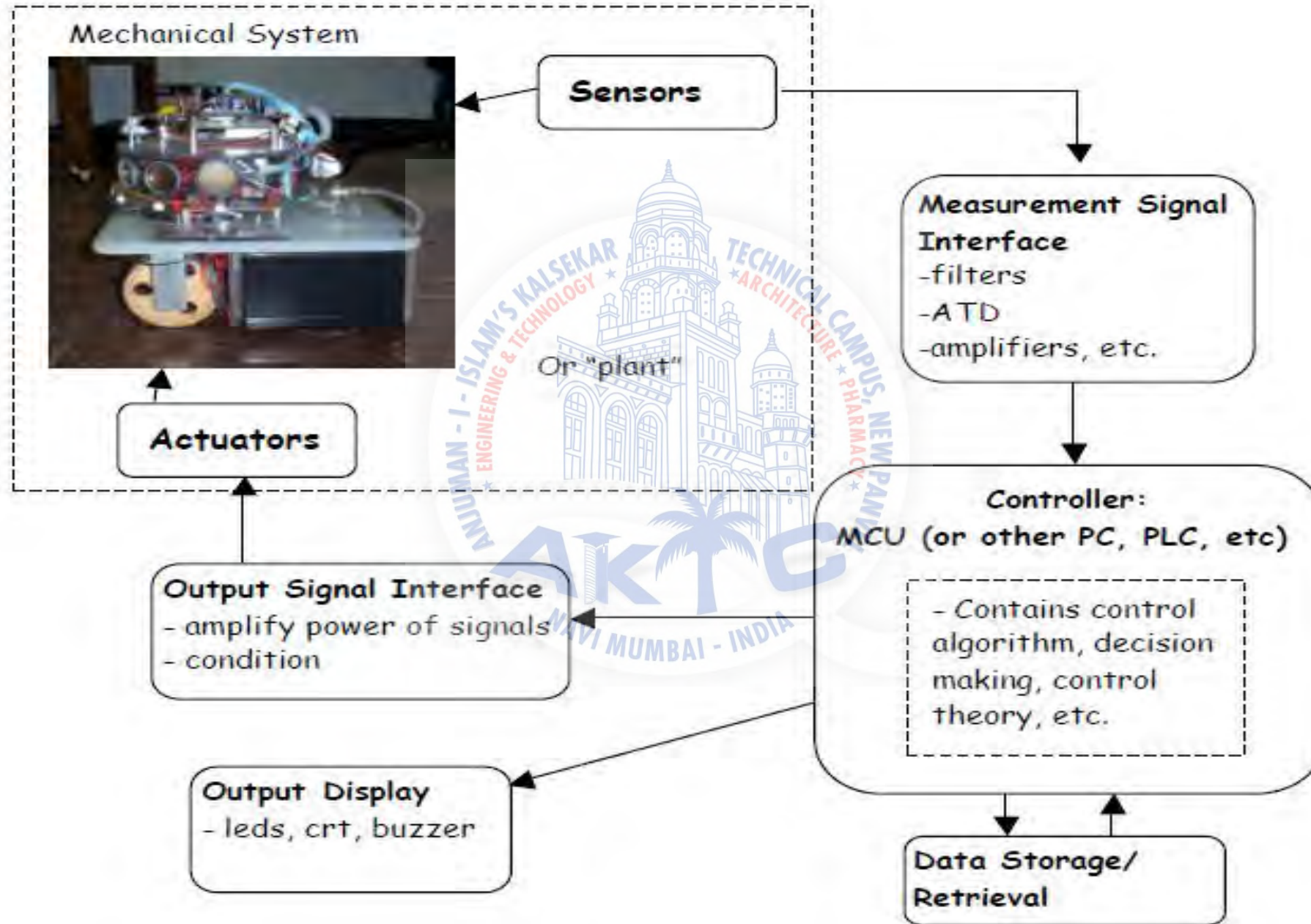
Robot Platforms (3)



Robot educational kits



Robot sensors

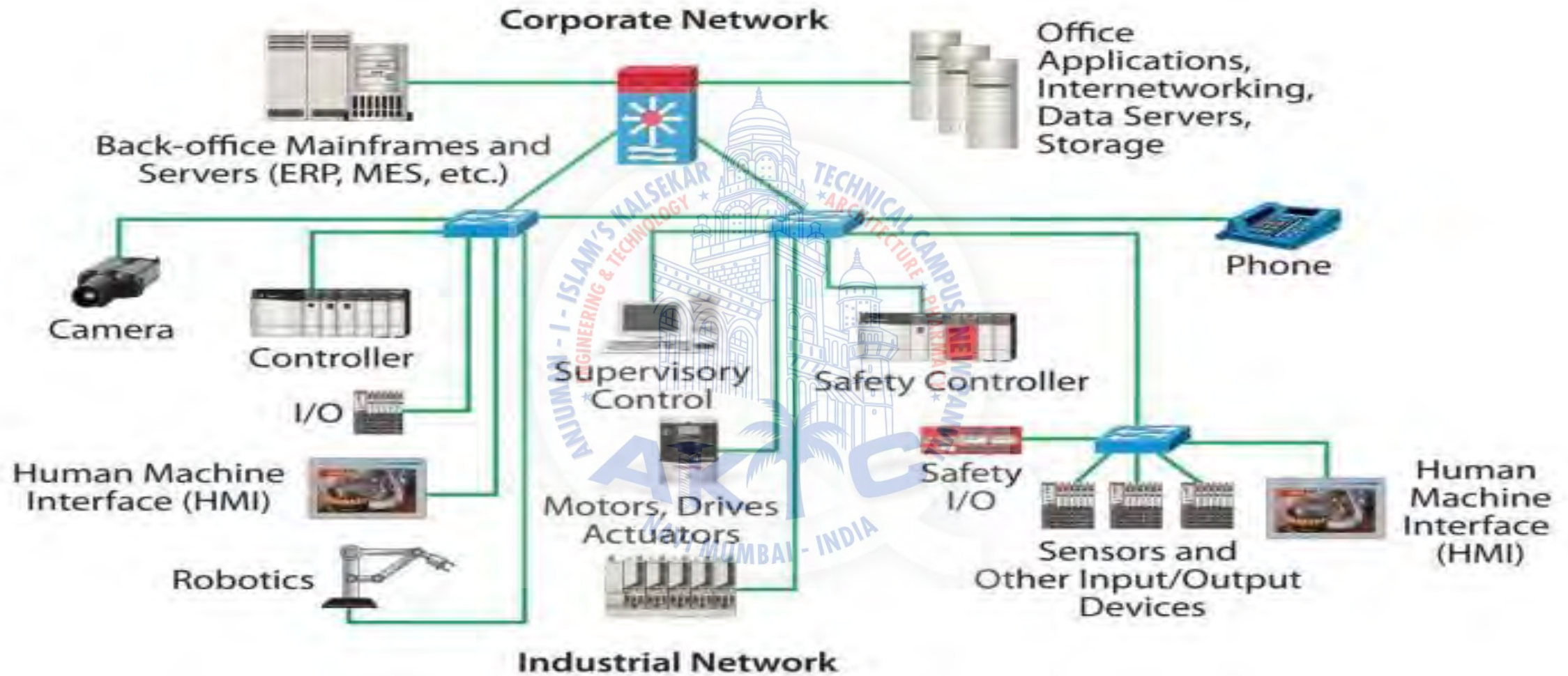




Ambient Assisted Living (AAL)



Converged Plantwide Ethernet Industrial Network Model



Industrial automation