



Cyber-physical systems

In 2020, computers evolve into connected systems that sense, monitor, and control human and physical environments.

Geospatial technology

Location becomes an integral dimension of data, allowing information patterns and decisions to be viewed through the lens of place. Since entities on earth can be tagged by location, geographic information systems (GIS) find varied applications, ranging from movement of weather patterns to traffic management in crowded cities to location-based services to forming the backbone for the Internet of Things. The use of GIS in the field of medicine and infrastructure planning grows as governments open up their GIS databases for public use.

Geospatial technology in 2020

- Geomedicine aids clinical diagnosis by providing a more precise understanding of the links between patient health and contextual factors, such as where they live, work, and play.
- Indoor GIS enables navigation in large covered areas such as stations and airports by relying on indoor systems such as Wi-Fi retransmitters used to receive GPS satellite signals.
- Passive GIS syncs vast amount of spatial-related information from social networks with satellite-generated location to enhance location and user activity information.
- Multisource geofencing provides spoof-proof user location and authentication by relying on multiple methods for verifying a user's location and identity.
- The Internet of Things with a geolayer provides a vital link between the sensors that generate the uniform resource identifier (URI) assigned to a thing or an object.
- GIS-enabled intelligent infrastructure helps create safer and more energy-efficient infrastructure, especially in the transportation and energy sectors.

- Open government geospatial data, including light detection and ranging (LiDAR) and high-resolution aerial imagery, are made available and consumable via application program interfaces to power multiple applications.

Geographer jobs grow 35 percent per annum, while those of cartographers and photogrammetrists grow 22 percent between 2010 and 2020.

In 2020, use of geolocation data, including GPS, generates \$500 billion in consumer value.

In 2020, the location-based service market is a \$1.3 trillion industry.

Sensors

Networks of sensors measure and record everything from temperature, light, and motion to biohazards and physical indicators from the body. Sensor-enabled devices communicate with each other through the Internet of Things, ingestible sensors monitor the body from the inside, and intelligent swarms of sensors coordinate with each other to collect data. Declining costs and advancements in sensor technology make it accessible, widely used, and an integral part of 2020's digital ecosystem.

Sensor technology in 2020

- **“Unobservable” sensing** breaks new ground in sensing biohazards, smells, material stresses, pathogens, level of corrosion, and chemicals in material.
- **Microsensor implants** in patients track the healing process for internal injuries and enable health care professionals to take remedial action based on continual data from the system.
- **Biodegradable sensors** monitor soil moisture and nutrient content for optimum crop production.
- **Self-powered sensors** that are powered using the heat difference between the patient's body and surrounding air find applications in medical care.
- **Self-healing sensors** repair themselves in the event of disaster or other structural disruptions.
- **Live cell-based sensing**, an amalgamation of sensor technology and living cells, allows scientist to understand the biological effect of medicines, the environment, and biohazards.
- **Sensor swarms** coordinate their activities, deciding what to measure and where through a self-learning system directing their movements and data collection.
- **Smart dust**, microscopic sensors powered by vibrations, monitors situations such as battlefield activities, the structural strength of buildings, and clogged arteries.

The market for printed and flexible sensors reaches \$7.3 billion in 2020.

In 2020, 300 billion sensors are making lifestyle enhancements in our daily lives.

The intelligent sensor market is a \$10.5 billion industry in 2020.

The Internet of Things

As the size and cost of sensors and communication technologies continue to decline, the Internet of Things (IoT) grows by leaps and bounds. In 2020, more than 30 billion devices are connected to the Internet. Businesses and governments struggle to integrate this evolving technology, using analytics to winnow insights from the treasure trove of data that improve delivery models in health care, transportation, security and defense, infrastructure management, and many other areas. The exponential growth of the IoT proves to be a regulatory headache, forcing governments to keep pace with the ever-changing technology.

The IoT in 2020

- **Privacy takes center stage** as the multitude of “things” become sources of data; a new pay-for-privacy model emerges that protects data and allow consumers control over their data.
- **Intervention applications** materialize as the advent of smart sensors and advanced analytics enables IoT applications to move beyond just monitoring.
- **Standardization of IoT** objects, sensors, systems, and processes begin as large players in the industrial Internet marketplace converge to evolve industry standards.

In 2020, up to 30 billion devices with unique IP addresses are connected to the Internet.

The “Internet of Everything” has an economic impact of more than \$14 trillion by 2020.

By 2020, the IoT is powered by a trillion sensors.

Augmented reality

Augmented reality (AR) allows users to augment physical, real-world environment elements with computer-generated sensory inputs such as sound, video, graphics, or GPS data. As information becomes more and more pervasive, overlaying information on reality becomes the norm for enhanced decision making. The future promises radical improvements in AR technology with the introduction of gestural interfaces and sensory feedback that fuse the physical world with digital information.

Augmented reality in 2020

- **Screenless future** becomes a reality as wearables become ubiquitous; any flat surface doubles as a screen.
- **3D visualization and mapping** capabilities in conjunction with AR technology help navigate places with updated situational awareness.
- **Visualization of data** becomes seamless as users can access centralized data on the go through wearable technologies; it finds application in law enforcement, emergency response, and human services.

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- **Gestural interfaces**—ways for humans to use body language and actions to control technology—begin to redefine the human-technology relationship, ushering in a sort of omnipresent “sixth sense.”
- **Haptic (tactile) technologies** redefine training in key government mission areas including defense, law enforcement, and health care.

AR reaches 1 billion users worldwide by 2020.

More than 2.5 billion mobile AR apps are downloaded each year in 2017.

In 2018, enterprise and general entertainment application sectors generate annual mobile AR revenues in excess of \$1 billion each.

Unmanned aerial vehicles

Remote-controlled or autonomously flying aircrafts inhabit the skies in 2020. These unmanned aerial vehicles (UAVs) or drones contribute to domestic policing, geographical surveys, maritime patrol, and delivery of goods, among multiple other commercial and military applications.

UAVs in 2020

- **Multifunctional drones** allow multiple features to be assembled on a single drone; for instance, a single drone can be used to monitor local traffic and the environment and in local law and order.
- **Self-learning drones** equipped with artificial intelligence make autonomous navigation decisions, allowing them to fly with minimal human intervention.
- **Micro-UAVs** (smaller drones) work in swarms to provide surveillance in the battlefield; the US Air Force has experimented with “flybots” that can hover, stalk, and kill targets.
- **Solar-powered drones** mitigate range issues and allow batteries to recharge in a network of solar-powered charging stations.
- **3D-printed drones** help develop lightweight, rigid UAV structures that improve performance and cut costs.

Global military unmanned aerial systems generate \$7.3 billion in revenue in 2020.

In 2020, the worldwide drone market is an \$11.3 billion industry.

The small UAV market grows at a CAGR of 21.7 percent between 2013 and 2019.

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