MEMS IN HEALTH CARE

Healthcare has emerged as one the biggest and fastest growing Industry around the World. The growing importance of Human life, increase in individual disposal income and awareness of preventative measures are driving the growth of this Industry. Increase in life expectancy and ageing of world population has made Healthcare as a very lucrative Industry.

MEMS has evolved as one of the most revolutionized Semiconductor components in personal Healthcare. The advent of MEMS is opening new ventures of application in Healthcare. This article will address some of the applications MEMS in medical electronics system design to serve the healthcare needs. Semiconductor are used in core medical electronic Instruments such as CT scan, X-ray machines, ECG, Ultrasound, Blood pressure and Glucose monitoring etc. Semiconductor plays function such as sensing, signal conditioning, data conversion & processing, controlling the machines & robots etc.

Bulky and centralized hospital equipments now have a new substitute – handheld personalized healthcare equipments. As firsthand healthcare is shifting from Hospitals to individual, the need of miniaturization, cost-effectiveness, robustness and battery operation has evolved. After creating a new wave of revolution in consumer and mobile phone Industry, MEMS is all set to give healthcare a new definition. Some typical applications of MEMS in Healthcare are pedometer, blood pressure monitoring, ECG, hearing aids etc. MEMS can also be used in complex procedures such as DNA Analysis.

Motions MEMS such as accelerometer have made it possible to accurately measure motion by consuming minimal power with a very compact form factor. As MEMS can detect both linear and angular motion in all 3-axis, a complete inertial state of body or body part can be detected. MEMS can be used in not only wearable device such as pedometer or mobile ECG machine but also penetrative gadgets such as blood pressure monitors or miniaturized robots.

APPLICATION OF MEMS

1.Pedometer

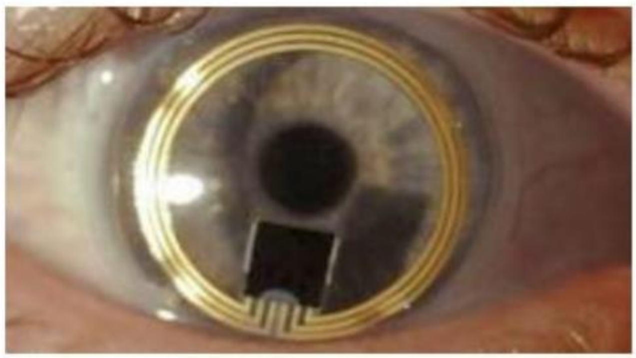
Pedometer is perhaps one of the simplest application yet very useful application of MEMS. MEMS can detect the jerk body is facing while a user is running or walking at each step. The jerk experienced by MEMS IC. This feature can be used to measure accurately number of steps taken. MEMS can be used to calculate Step count, Speed, Distance, Calories. Some parameters such as step length, height and weight may be needed for calibration. Accurately Pedometer can be developed keeping in mind the locations where user is wearing them (attached to belt, shirt/pant pocket etc). A 3-axis accelerometer can detect acceleration in all the three axis so a single MEMS can detect the change independent of the way pedometer is worn by the user. MEMS can also be used to detect the swing in centre of gravity of person. This data can be used by doctor to suggest the right posture or even wear right equipment to the patient.

2.HearingAid

MEMS microphone has made it possible to make small size hearing aid with high sound quality, reliability and affordability. MEMS microphones meet price points set by the traditional electret condenser microphones (ECM), while boasting superior reliability and robustness. MP45DT microphone is less susceptible to mechanical vibration, temperature variations and electromagnetic interference. The sensing element, capable of detecting acoustic waves, is manufactured using a specialized silicon micromachining process to produce audio sensors. MEMS microphone based hearing aid can be designed in such a way that it becomes invisible to external world thus avoiding apparent social issues.

3. Early Diagnosis of Glaucoma

MEMS microphone and a transmitter antenna when mounted on a 24-hour silicon disposable lens can be used for early diagnosis of glaucoma. As the MEMS sensor is ultra miniaturized, it can be mounted at the peripheral of lens without impacting normal viewing. Also a small antenna will transmit relevant data to the receiving station. The Sensor is capable of measuring cornea deformations due to Intra-Ocular-Pressure (IOP) variations. The IOP Sensor is a wireless sensor that acts as a transducer, antenna and mechanical support for additional read-out electronics. This information can be monitored and analyzed by Hospital to take necessary action and diagnose glaucoma in its early stage.

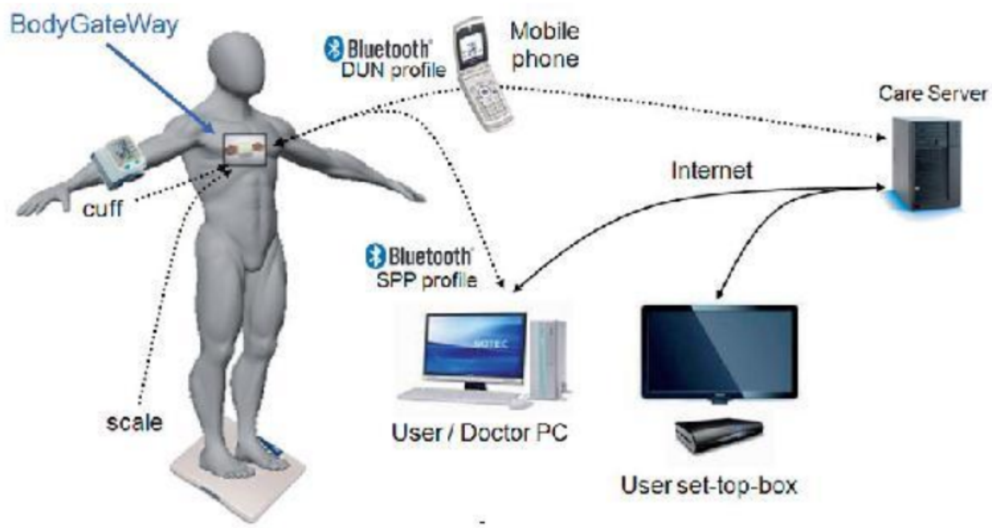


4.Blood Pressure

The human circulatory system generates pressure which can be measured by miniaturized and biocompatible BioMEMS. The generated pressure is complex and varies by a large value and change by the current situation of human body so it require very specific MEMS to do the task. The BioMEMS can be inserted into the body and moved to the specific places near the heart. By measuring pressure gradients across heart valves, doctors can access valve disease. It will be to diagnose and monitor heart failure and measuring cardiac output.

5. Body Gateway

Body gateway is a wearable device used for measuring physiological parameters such as ECG, heart rate, breathing rate etc. It can also detect person's movement and if there is a abnormal movement such as falling down on floor can be detected. The measured data or alarms can be sent via Bluetooth to internet gateway device which can send the data to Hospital control rooms. MEMS is the key enablers for this, it can detect person movement and change is blood pressure to measure the breathing rate. The small size and ultra low power consumption has made it possible. This application of MEMS can also lead to revolution of telemedicine where hospitals can monitor patients in real time scenario and take necessary action remotely. It can also reduce the cost of treatment drastically as patients no longer have to admit in Hospitals for monitoring reliable information.



5. Lab on Chip

Lab-on-a-chip allows small amounts of bodily fluids to be tested in seconds. All chemical reactions occur inside the biochip's buried channels or on its surface. And because the cartridge that carries the chip is self-contained and disposable, the system strongly reduces the cross-contamination risks of conventional multi-step protocols. The ST Lab-on-chip is designed to handle micro fluidics and some of the knowledge is based on expertise in MEMS inkjet printer chips. The Lab-on-chip can amplify or multiply DNA sample in approx 15 minutes thus requires very small amount of fluid, saves time and is economical.

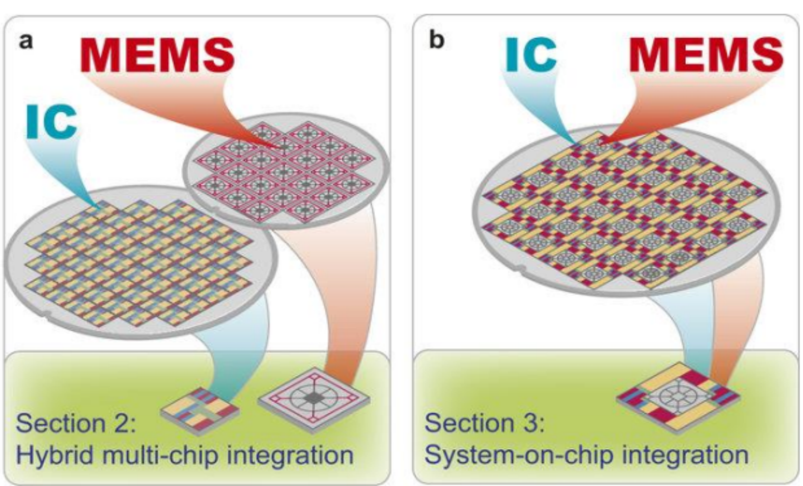
INTEGRATED MEMS

The majority of microelectromechanical system (MEMS) devices must be combined with integrated circuits (ICs) for operation in larger electronic systems. A MEMS device typically interacts with a physical, chemical or optical quantity and has an electrical interface to the outside world. For MEMS sensors, the electrical output signal correlates with the physical, optical or chemical input quantity that is sensed. In the case of MEMS actuators, an electrical input signal is used to control one or more physical, optical or chemical quantities. To enable the MEMS transducer to perform useful functions, the electrical interface with the outside world is, in most cases, realized through integrated circuits (ICs) that provide the system with the necessary intelligence. ICs may provide signal conditioning functions such as analog-to-digital conversion, amplification, temperature compensation, storage or filtering as well as system testing and logic and communication functions

MEMS and ICs can be integrated using two basic methods:

(1) In the general approach referred to here as a multi-chip solution, MEMS and IC components are manufactured on separate substrates using dedicated MEMS and IC processes and are subsequently hybridized in the final system. Two-dimensionally or side-by-side integrated systems are often referred to as multi-chip modules. When chips are vertically stacked in a package in this way, such a system is also referred to as a system-in-package or a vertical multi-chip module2. Devices created through vertical stacking of several IC chips are also referred to as three-dimensional integrated circuits (3D ICs).

(2) In the general approach referred to here as a system-on-chip (SoC) solution, MEMS and IC components are manufactured on the same substrate, using consecutive or interlaced processing schemes.

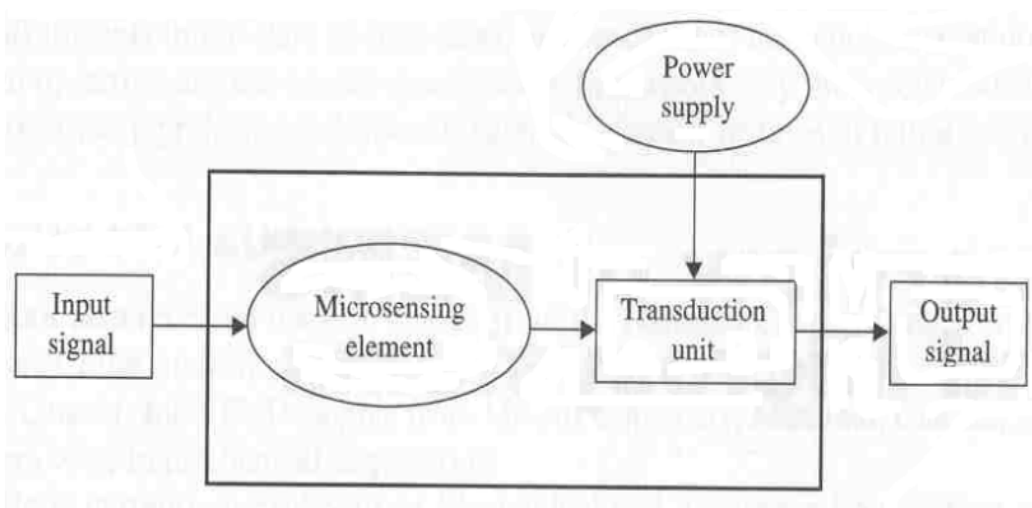


MICROSYSTEMS

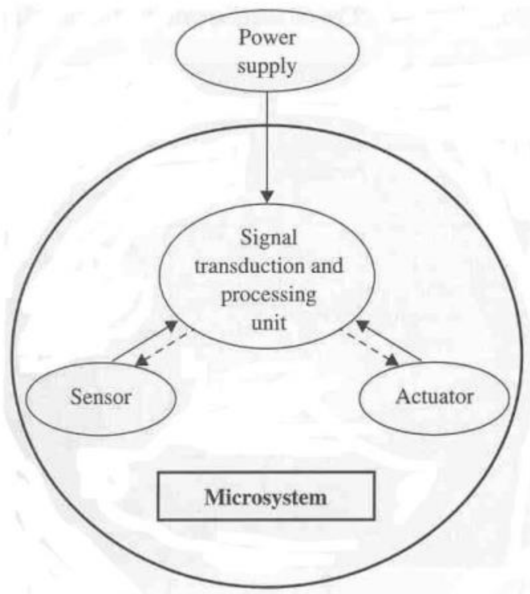
Microsystems are miniaturized (silicon or polymer) devices which perform non-electronic functions: typically sensing and actuation. Typical microsystems have mechanical parts, like microbridges in RF switches or bending cantilevers in atomic force microscopes (AFMs); electrical parts like piezoresistors in airbag sensors or capacitors in pressure sensors; or thermal, optical and fluidic structures like heaters and nozzles in inkjet printer or flow sensors. In biomicrosystems (BioMEMS) cells or microbeads are handled by fluidic streams, magnetic and electric fields, thermal gradients etc. In chemical microsystems operations like sample pretreatment, separation and detection are built on microchips. This field is also known as microfluidics or lab-on-a-chip. Today it is possible to build up microsystems without any tooling needed by computer-aided direct parallel batch processing technologies called RMPD Rapid Micro Product Development.

A microsystem is an engineering system that contains MEMS components that are designed to perform specific engineering functions.

3 components : micro sensors, actuators, and a processing unit.



Components of a Microsystem



An intelligent microsystem incorporates signal processing and closed-loop feedback control systems into a microsystem.

Examples – Micro gears, Micro mixer, Micro mirrors