ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 5, March 2017

Smart Healthcare And Smart Mobility That Governs It

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Abstract— Wellbeing of citizens is a core concern of Smart Cities ,Besides comfort, preference satisfaction, and personalized services, wellbeing is tightly related to health and its continued care. The concept of **"smart healthcare**" therefore emerges as one vital pillar of smart cities and is demanding great attention from governments, the industry, as well as from the scientific community. **Unmanned Aerial Vehicle commonly referred as 'Drones'** serves this purpose. Drones will vastly play its role in the medical field as "AMBULANCE DRONES" Sensors are used in electronics-based medical equipment to convert various forms of stimuli into electrical signals for analysis. Sensors can increase the intelligence of medical equipment, such as life-supporting implants, and can enable bedside and remote monitoring of vital signs and other health factors. In this paper it has discussed about smart health and smart mobility that governs it.

Keywords—*ambulancedrones,artificialPancreas,EMS,HEMAapp,infant incubator backpack,Tactile sensors , MEMS, optical sensors.*

INTRODUCTION:

A smart city paves way for smart development which in turn provides way for well sophisticated life style of smart citizens.

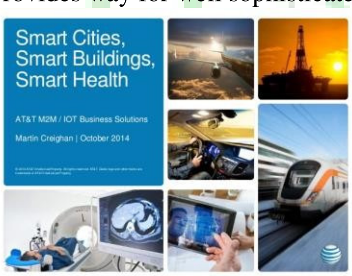

Figure 1:Introduction to smartness:

SMART CITY PARAMETERS:

The following are the parameters of smart cities:

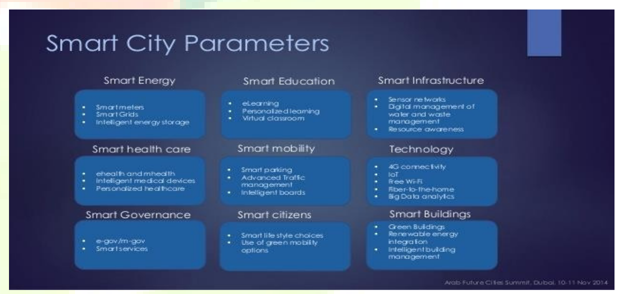

Figure 2:smart city parameters

- **ehealth and mhealth**
- **intelligent medical devices**
- **personalised healthcare**

I SENSORS:

A sensor is a translator which is translating a nonelectric value into electric value. The output of sensor in the form of amplitude, frequency, phases.

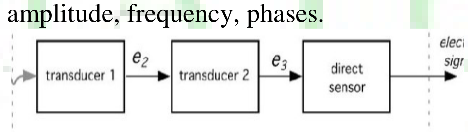

Figure 3: Sensor with various transducers

Many features are studied when a sensor is elected such as Accuracy, environmental condition, range, Calibration , resolution, cost, and repeatability.
Sensor is classified in following category:
1. Primary Input quantity

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2 .Transduction principles,
3. Materials and Technology
4. Property
5. Application.

Property based sensor: Temperature sensor, level sensor, and Pressure sensor, Bio sensor, Image sensor, Gas and chemical sensor [1].

Application based sensor: Industrial process control, Non-industrial area use in –Aircraft, Medical products, Automobiles, Consumer electronics, other type of sensors [1].

Power or energy based sensors: The power and energy sensor are active and passive sensor. The passive sensor does not need an external energy source. The passive sensor is also known as a direct sensor. The active sensor needs an external energy or power to perform their operation. Active sensor is also called a parametric since the property of active sensor is change by external energy or power.

Generally used materials in sensor:

- **Inorganic, Organic,**
- Conductor ,Insulator.
- Semiconductor Liquid, gas, or plasma.
- Biological substance other. [2].

FIBER OPTIC SENSORS

The fiber optic sensor is used to sense some quantity like temperature, pressure, vibration, displacement, rotations [3]

Figure 4: Fiber optic sensor

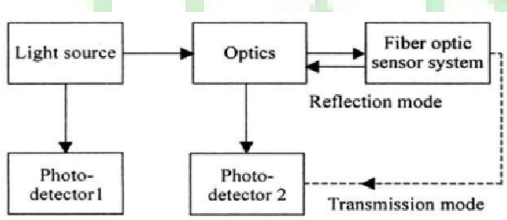

Figure 5: Block diagram of fiber optic sensor

FIBER OPTIC SENSOR HAS MANY APPLICATIONS IN MEDICAL AREA:

1. Dengue fever is disease, transfer by female "aedes aegypti mosquito"many laboratorial tests are available to detect this disease but all are taking a long time and need highly knowledgeable personnel. A fast good and simple method to diagnosis this diseases is optical fiber sensors. Localized Surface Plasmon Resonance (LSPR) phenomenon used in optical fiber sensors to detect dengue. When light influence on material enclosed by dielectric material spectral changes will occur change in refractive index .[6]

2. DNA oligonucleotides to immobilized DNA targets fluorescence optical sensor oligonucleotides join with optical fiber complementary sequence are diagnosis by using fluorescent double stranded specific DNA ligand.[7]

3. To measure Blood sample and sent into a laboratory to determine the content like sugar, protein cholesterol etc. its take a time because large no of measurement, laboratory far from test centre etc. to overcome this problem use a fiber optic sensors. It is fitted into catheter and place blood vessels and continually measurement are handled by the sensors.[5]

4. Physical sensors are used to measure a variety of physiological specifications, like body temperature, blood pressure, and muscle displacement. Imaging sensors encompass both endoscopic devices for internal observation and imaging, as well as more advanced techniques such as **optical coherence tomography. (OCT)[8] .**

5. Optical fiber sensor is measure carbon-dioxide pressure in the stomach. This sensor is based on color change of a CO2-sensitive indicator layer. The layer is connecting to the optical fiber placed in the stomach. The optoelectronics unit is attached to laptop which is used to data acquisition and processing, and for calibration. [9]

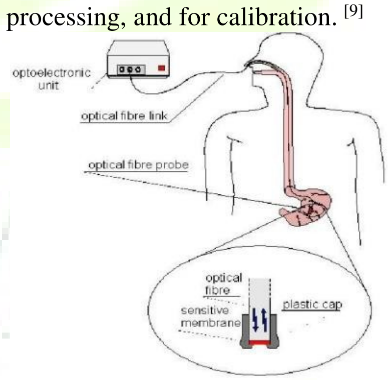

Figure 6:optical sensor for CO2 detection in the stomach

6. Glucose sensor: Optical sensor couple with Mach-Zehnder interferometric waveguide and optical fibers to measure slight changes of aqueous sugar concentrations. [10]. this sensor is of high sensitivity, simplicity, reliability and continuous monitoring. In this method the refractive index changes with concentration of sugar. In this method one arm of

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interferometer is covered with glue and isolated from sugar solution the other one is define sugar solution. If the concentration of sugar is change, the phase of propagating light is also change. Phase of other arm is not changed .It remains constant. Hence the output intensity from the interferometer is directly related to the concentration of the sugar solution.

7. MRI Fiber Optic Sensor for Brain Injury: A MRI fiber optic sensor is used to sense the angular position and captured the velocity and acceleration during the operation.

Figure 7:MRI-safe device brain injury

The data is corresponding to real time with MRI image. The sensor is to control a hardware function. The fiber sensor is high resolution of 8192 and fast update rate of 850µs allows a recording of some 500 data points for one event. [11].

MRI Fiber Optic Sensor for cardiac stress testing:
MRI Fiber Optic Sensor [4] used in cardiac imaging provides good image ,calculation and patient safety over ultrasound techniques. EXCM Inc. developed a MRI safe Treadmill in MRI suite. EXCMR is able to find cardiac imaging after exercise. When a treadmill and image system is located remotely instant results cannot be bought. The MRI Safe Treadmill is shown in Figure metallic material is used in MRI Scanner .

Figure 8:MRI-safe treadmill systems for improved heart imaging.

SENSORS IN MARKET:
Sensors are used in electronics-based medical equipment to convert various forms of stimuli into electrical signals for analysis. Sensors can increase the intelligence of medical equipment, such as life-supporting implants, and can enable bedside and remote monitoring of vital signs and other health factors.

An aging and expanding population is accelerating the development of new and different types of medical equipment, including various sensors used inside both equipment and patients' bodies. Healthcare organizations want real-time, reliable, and accurate diagnostic results provided by devices that can be monitored remotely, whether the patient is in a hospital, clinic, or at home.

For the purpose of this research it is examined that how pressure, temperature, flow, and image sensors, accelerometers, biosensors, SQUIDs and encoders are used in medical applications.

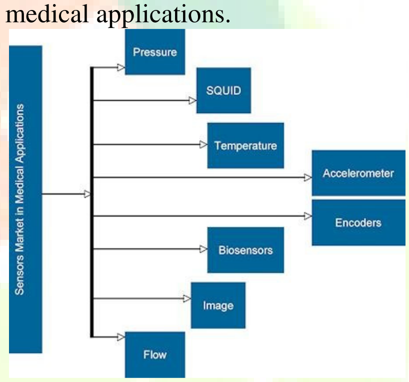

Figure 9:sensor market in medical applications

KEY SENSORS AND APPLICATIONS: PRESSURE SENSORS: They are used in anesthesia delivery machines, oxygen concentrators, sleep apnea machines, ventilators, kidney dialysis machines, infusion and insulin pumps, blood analyzers, respiratory monitoring and blood pressure monitoring equipment, hospital beds, surgical fluid management systems, and pressure-operated dental instruments.

TEMPERATURE SENSORS: They are used in anesthesia delivery machines, sleep apnea machines, ventilators, kidney dialysis machines, blood analyzers, medical incubators, humidified oxygen heater temperature monitoring and control equipment, neonatal intensive care units to monitor patient temperature, digital thermometers, and for organ transplant system temperature monitoring and control.

APPLICATIONS FOR FLOW SENSORS : It include anesthesia delivery machines, oxygen concentrators, sleep apnea machines, ventilators, respiratory monitoring, gas mixing, and electro-surgery, in which high-frequency electric current is applied to tissue to cut, cause coagulation, desiccation, or destroy tissue such as tumors.

IMAGE SENSOR APPLICATIONS: It includes radiography, fluoroscopy, cardiology, mammography, dental imaging, endoscopy, external observation, minimally invasive surgery, laboratory equipment, ocular surgery and observation, and artificial retinas.

ACCELEROMETERS: They are used in heart pacemakers, defibrillators, patient monitoring equipment, blood pressure monitor and other integrated health monitoring equipments.

BIOSENSORS: They find applications in blood glucose and cholesterol testing, as well as for testing for drug abuse, infectious diseases, and pregnancy.

MAGNETOENCEPHALOGRAPHY (MEG) AND MAGNETOCARDIOGRAPHY (MCG) systems use superconducting quantum interference devices or SQUIDs. These highly sensitive magnetometers measure extremely weak magnetic fields and are used to analyze neural activity inside the brain.

ENCODERS: They can be found in X-ray machines, magnetic resonance imaging (MRI) machines, computer-assisted tomography equipment, medical imaging systems, blood analyzers, surgical robotics, laboratory sample-handling equipment, sports and healthcare equipment, and other noncritical medical devices.

MEMSSensors:

MEMS sensors offer several benefits that support the increasing penetration of MEMS technology into the medical applications market (**Figure 8**). MEMS sensors are typically low power, their silicon interferes less with body tissues, integration permits a large number of systems to be built on a single chip, and their small size enables less invasive (and therefore less painful) instruments.

For instance, MEMS accelerometers can alert medical professionals when a patient falls. **Elderly patients, in particular, may suffer serious injuries from an unobserved fall. Wearable, intelligent devices equipped with MEMS inertial sensors can be used to detect and assess the severity of a fall and signal for help, aided by a GPS to provide location information.**

Precise control of the scalpel is an important requirement in any surgery. MEMS pressure sensors can be incorporated into the scalpel where they measure the force exerted on the tissues and provide feedback to the surgeon about scalpel pressure.

NEW TACTILE SENSOR LIGHTER THAN A FEATHER:

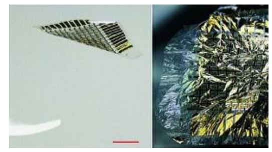

Figure 10:TACTILE SENSORS

- Tactile sensors appear in everyday life such as elevator buttons and lamps which dim or brighten by touching. The Tactile sensors could be bent, twisted, crumpled, submerged in liquid, stretched, and more--and they're lighter than a feather.
- Tactile sensors pick up on touch, force, or pressure for example think of the way your car responds when you step on the brake, or (a more complex version) your touchscreen phone--but most existing sensors are silicon-based and therefore bulky. The latest innovation could lead to better and cheaper medical instruments and new health monitoring systems. It could also, eventually, advance consumer electronics, displays, and robotics.
- The tactile sensor is made of organic transistors, which use a carbon-based semiconductor as well as an aluminum oxide and self-assembled monolayer dielectric. The **electroplated aluminum oxide dielectric, which measures just in 20 nanometers, was one of the major accomplishments that allowed them to get the complete sensor so thin. [20]**
- The transistors are deposited onto a special foil with a very rough surface. The foil is five times thinner than saran wrap, and even more compliant its rough texture allows the circuitry to remain very secure in the "nanotized grooves and valleys and allows the product to adhere to almost any surface.[20]
- The spatial resolution required for tactile sensors depends on the location in human body. A number of receptors are embedded into the skin, associated to either myelinated or unmyeliated fibers - mechanoreceptors for pressure/vibration, and thermalreceptors for temperature.[20]

Compression Of The Sensor:

Stretching and compression hardly impact performance.It has 3d shape It is also resilient,The sensors maintain functionality up to **170 degrees C** (though beyond 100 degrees C their efficiency gradually tapers off) they are nearly unaffected when immersed in saline solutions and they can be crumpled up, flattened back out, and even placed on rubber

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and stretched out--none of which drastically impacts performance.

APPLICATIONS: The researchers envision several potential applications. In a medical setting, place the sensors on skin to monitor vital signs like temperature and heart rate. Eventually place them on muscles or organs for either monitoring purposes or electrical stimulation (of muscles along the heart, for example).It can be used in wearable's and can also be used as medical sensors.

II DRONES

Drones have been deployed by the U.S. military since the 1970s, for purposes ranging from providing bird's eye surveillance of troop movements and weapons facilities to launching attacks on terrorist organizations.

Figure 11:drone

Figure 12:picture taken by drone

However, the same technology can also be used to help save lives. Thankfully, a growing number of commercial, non-profit, and government scientists and laboratories are working towards that goal.

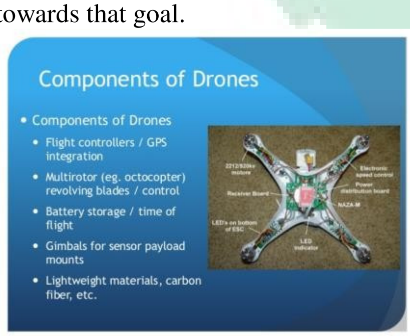

Figure 13:components of a common UAV.

FEATURES OF DRONES:

Within the health and safety space, there are a number of powerful applications for drones that show great promise:

- Dropping off emergency equipment or medication. Poison antidotes, EpiPens, and oxygen masks are just a few of the lifesaving possibilities.[19]
- Conducting search and rescue operations. Lost or injured people could be located at sea, in the mountains, or in a forbidding desert or jungle.[19]
- Responding to natural disasters. Fire, flood, hurricanes, tornados, earthquakes, or severe drought can delay or prevent on-site intervention by humanitarian or medical personnel. Drones could provide help when and where none would have been available.
- Delivering aid to refugees and victims of war or military conflict. Manmade disasters can be just as deadly as natural ones, and drones could deliver aid across hostile borders.
- Even in safe, peaceful situations, patients can be in locations that lack the infrastructure for effective emergency or ongoing care. Drones could be deployed to provide telemedicine, vaccines, prescription drugs, or medical supplies for home healthcare.
- Collection of blood and tissue samples. As well as delivering goods and services, drones could provide quicker return transport to fully equipped labs.
- findings in the journal Transfusion in November that showed no biological change to blood packed in specially refrigerated coolers during test flights, which lasted about 26 minutes and covered 12 miles at 328 feet above ground.[21]

AMBULANCE DRONE :

Figure 14: Ambulance drone giving first aid to a trauma patient.

This past October a prototype drone that delivers a defibrillator to a heart attack victim was developed.[17] To address the reality that the victim's chance of survival decreases dramatically with each passing minute. The drone uses live streaming audio and video to allow emergency personnel to provide instructions on how to use the defibrillator correctly, and transmit the patient's vital signs.

WORKING: The ambulance drone will be able to track emergency calls from the control room. Using the GPS

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system, it will be easy to navigate to the area where medical attention is required. The paramedics in the control room will issue instructions to the person assisting the patient. This will be possible via a live stream webcam.

EMS INTERLINKED WITH DRONES:

Emergency Medical Services, more commonly known as EMS, is a system that provides emergency medical care. Once it is activated by an incident that causes serious illness or injury, the focus of EMS is emergency medical care of the patient(s).

EMS is most easily recognized when emergency vehicles or helicopters are seen responding to emergency incidents. But EMS is much more than a ride to the hospital. It is a system of coordinated response and emergency medical care, involving multiple people and agencies.[12]

EMS COMMUNICATION AND AMBULANCE DISPATCH TECHNIQUES:

- Differentialequations-Castilo-Benitezspeed density model[15]
- Probability-Scott FactoerGorry Model[18]

Based on these mathematical modeling following processes takes place:

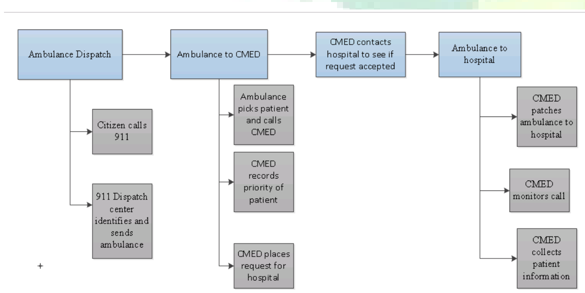

Figure 15:ambulance dispatch process[13]

By combing NEWTON-EULER FORMULATION along with these EMS communication techniques AMBULANCE drones can discharge its duties effectively.

CASE STUDY: BLOOD DELEVERING DRONE:

Figure 16:blood delivery by drone.

A small drone can safely transport a small amount of blood without damaging it.

The study was a proof of concept, with perhaps the secondary goal of getting “blood” and “drone” into a headline together. It is also potential good news for patients who need medical care in rural areas, as safely transporting blood through the sky spares the dangers or delays due to impassable roads.

Of particular concern related to the use of drones the sudden acceleration that marks the launch of the vehicle and the jostling when the drone lands on its belly. Such movements could have destroyed blood cells or prompted blood to coagulate, and they thought all kinds of blood tests might be affected, but the study shows they weren't.[21]

To test the impact of travel in a drone on the blood 300 samples of blood (six each from 56 volunteers) have taken, and drove them to a site an hour away. Then half the blood samples were packaged for drone flights, and flown in the air between six and 38 minutes in a hand-tossed drone.

After their flights the samples were unloaded, then all the samples-including the ones that didn't take a trip in the drone--were driven back to the hospital for testing, where they were tested normally. No meaningful differences were found between flown and not flown samples.
With the proof of concept done, future research could test the idea in rural areas, where drones could deliver medicine to testing centers faraway, and more quickly than by car or on foot.

INFANT INCUBATOR BACKPACK:

Figure 17:infant incubator backpack

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Neonatal Transport Incubator

The neonatal transport incubator is designed to reduce infant deaths by helping safely piggyback sick babies to medical facilities.

The project in response to the dire infant mortality rate in developing countries is considered. Many regions not only lack the resources for timely infant care, but their rough terrain and poor roads make it difficult for medical responders to transport babies to safety .[14]

ARTIFICIAL PANCREAS:

Figure 18:artificial pancreas

An artificial pancreas that automatically senses and regulates glucose throughout the night was tested and found it worked better than a traditional insulin pump. Twelve patients were hooked up to a glucose monitor manufactured by Medtronic Inc., which sent signals to a laptop, where algorithms calculated how much insulin to administer. The system is simple enough that it could eventually be integrated into a wearable device, according to the researchers

Insulin Pump:

An artificial pancreas that accounts for slight, low-intensity physical activities that can impact blood sugar levels was developed. The researchers are developing a closed-loop system that includes a glucose monitor, automatic insulin pump, activity monitors that attach to the body and a central computer that uses an insulin-delivery algorithm to determine how much of the hormone to dispense.

Diabetic patient with accelerometers to measure slight movements are hooked up, and tracked their blood sugars while they moved around after eating a meal. They found that even limited, basic movements had a major impact on blood sugar levels, bringing them close to those of people with normally functioning pancreases. But insulin pumps and glucose monitors don't account for those slight differences.

HEMOGOBIN MEASUREMENT -USING SMARTPHONES:

They developed an app called HemaApp that uses the phone's built-in light and camera to detect the color intensity of blood passing through a finger. The user simply places a finger over the camera lens, making a solid contact, and runs the app to do its thing. The app turns on the nearby LED light, which shines light through the finger, and uses the camera to detect specific features that point to the amount of hemoglobin.

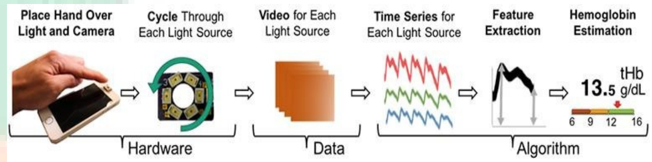

Figure 19:various steps in HemaApp.

While the built-in light is not too bad, the app is also tested while using a nearby incandescent bulb in addition to the camera light, as well as with the help of a small accessory light attached to the phone. The amazing thing is that in a small study on 31 patients, the HemaApp with the attached light accessory was as accurate (82%) as Masimo's Pronto (81%) in estimating hemoglobin count. The app without any accessories, and relying only on its own light, had an accuracy of 69%, which is pretty impressive as well.[22]

ARTIFICIAL INTELLIGENCE SYSTEM TO DETECT SKIN CANCER:

A deep convolutional neural network that can diagnose skin cancer by examining images of skin lesions was developed. Neural networks are computer algorithms inspired, on a high level, by a rudimentary understanding of how neurons in the human brain work.

They are composed of layers of simple computational units, called as neurons which perform very basic mathematical functions. When a neural network has multiple layers, we call it 'deep', and if the data processing from layer to layer involves performing convolutions on the data, we call it a convolutional neural network.[23].

DISCUSSION AND CONCLUSION:

Thus unmanned aerial vehicles will play a prominent role in the health sectors of smart cities consists of great blooming technologists and researchers.

Medical devices are taking advantage of the technology convergence. MEMS sensors made for automobiles are now being used for healthcare devices such as **heart monitors and 3D motion tracking.**

There is a great interest in trying to monitor the activity of people who are at medical risk using remote or implantable

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sensors, and the insertion and management of artificial devices implanted within the human body is expected to become increasingly common.

Sensors for medical applications are expected to see developments in the following areas: inherent accuracy, intelligence, capability, reliability, small size, power consumption, packaging, cost, and the elimination of lead. Developments are expected to be mainly in the areas of MEMS and nanotechnologies.

Medical device design often is centered on the integration of some novel sensor and application of the acquired data. As medical monitoring and treatment equipment shrink for use in the home, even to wearable or implanted form factors, sensors will also shrink in size, and fixed and durable medical sensors will gradually give way to disposable ones.

FUTURE SCOPE:

This market undergoes constant R&D work. For instance, the National Institute of Health (NIH) Roadmap of Nanomedicine Initiative expects that, in the next 20 to 30 years, nanosized implantable solutions will be developed with the ability to receive, store, transmit, and act on information.

Continued innovation in sensor components and technology, such as **packaging design and device** miniaturization, enables a host of new medical applications that save lives and improve quality of life.

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