A STUDY ON MEMS WITH THEIR APPLICATIONS IN MICROWAVE AND ACCELERATION SENSOR

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Abstract All the microelectromechanical system (MEMS) devices can be combined with integrated circuits (ICs) for operation in larger electronic systems. While MEMS transducers having various advantages. MEMS accelerometers are very simple, but also most applicable micro-electromechanical systems. They are having various application areas like, automobile industry, computer and audio-video tech-nology. In this paper a detail review on MEMS application areas like microwave and acceleration sensor.

Keywords: Micro-electromechanical, Microwave, Acceleration Sensor.

I. INTRODUCTION

MEMS is a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components. They are fabricated using integrated circuit (IC) batch processing techniques and can range in size from a few micrometers to millimetres. These devices (or systems) have the ability to sense, control and actuate on the micro scale, and generate effects on the macro scale. MEMS are more and more reliable and their sensitivity better every day.

Aging research has taken the attention of researchers, scientists and clinicians due to the expected increase in elderly population in the upcoming years. A study conducted by the European Commission (EU) in 2012 [1] shows that, in Europe, the elderly population (above 65) is expected to raise from 87.5 million to 152.6 million during the period 2010 to 2060. Therefore, robust and adaptive health care systems are required for the larger community in order to provide them healthy and active life styles. For this purpose, physical activity (PA) monitoring is one of the most promising ways of determining the health and well-being in free living population. PA is defined as any bodily movement that results in energy expenditure (EE) [2]. Physical inactivity is highly correlated with the chronic diseases in the elderly population, and various lethal diseases such as cancer, diabetes and cardiovascular diseases can be controlled by the addition of PA and vigorous exercises in the daily life apart from medications [3]. Furthermore, incorporating PA in daily routine will decrease the medication’s cost and clinical expenditures. PA dimensions which are considered very essential while evaluating any system's performance. This includes; 1) Type, 2) Intensity, 3) Duration, and 4) Frequency of each activity[4]. The main objective of the study is to present a critical review on existing methodologies presented in the literature for the PA classification, their credibility and possible suggestions to propose a model for PA classification meeting daily life peculiar constraints. Wireless transmission, by reducing installation time and efforts, resolves many issues intrinsic to wire-based instrumentation. Such issues include: a) wire impedance and signal quality, b) mounting ease, and c) scalability and remote tasking abilities. The first issue is related to limitations due to cable length, which cannot exceed a few meters of extension and requires the installation of signal amplifiers.

Table 1. MEMS examples. The MEMS component divided in six categories [6].

Sensors	Examples
Pressure sensor	Manifold Pressure (MAP), tire pressure measurement in automobiles.
	Blood pressure measurement.
Inertia sensor	Accelerometer, gyroscope, crash sensor.
Microfluidics	Inkjet printer nozzle, micro-bio-analyzers.
	tems, DNA chips.
Bio-MEMS	
	Micro-mirror array for projection (DLP).
Optical MEMS	Micro-grating array for projection (GLV).
MOEMS	Optical fibre switch, adaptive optics.
RF MEMS	High Q-inductor, switches, antenna, filter.
Others	Relays, microphone, data storage, toys.

State of-the-art of wireless, MEMS-based systems for vibration monitoring and discusses the future research issues in this field.

Furthermore, the turboelectric noise produced by the wire itself, which creates problems when low-amplitude signals are of concern. Finally, the wires may mass load or interfere with the functions of the structure being tested. In the last few years after resolving sensor accuracy issues at low frequency and amplitude vibrations, these systems have proved their reliability for performing micro vibration measurements and SHM analyses. This paper provides a summary of the state-The MEMS component currently on the market can be broadly divided in six categories (Table 1), where next to the well-known pressure and inertia sensors produced by different manufacturer like Motorola, Analog Devices, Sensor or Delphi we have many other products.

The micro-fluidic application are best known for the inkjet printer head popularized by Hewlett Packard, but they also include the growing bio-MEMS market with micro analysis system like the capillary electrophoresis system from Agilent or the DNA chips. Optical MEMS (MOEMS) includes the component for the fibre optic telecommunication like the switch based on a moving mirror produced by Sercalo. Moreover MOEMS deals with the now rather successful optical projection system that is competing with the LCD (liquid crystal display) projector. RF (radio frequency) MEMS is also emerging as viable MEMS market. Next to passive components like high-Q inductors produced on the IC surface to replace the hybridized component as proposed by company MEMSCAP we find RF switches and soon micromechanical filters. But the list does not end here and we can find micro machined relays (MMR) produced for example by Omron, HDD (hard disk drive) read/write head and actuator or even toys, like the autonomous micro-robot EMRoS produced by EPSON [6].

The remainder of the paper is organized as follows. In Section II, PA validation measures are summarized along with existing PA classification approaches. Relevant studies will be presented in tabular form in order to facilitate a comparative analysis across studies. Section III offers a critical analysis on the studied methodologies and highlightscurrent knowledge gaps between the existing approaches and real life conditions. Section IV provides concluding remarks and describes the future possibilities to further develop research in this field. Proposed Algorithm

II. MEMS ACCELEROMETERS

There are many different ways to make an accelerometer. Some accelerometers use the piezoelectric effect - they contain microscopic crystal structures that get stressed by accelerative forces, which causes a voltage to be generated. Another way to do it is by sensing changes in capacitance [7]. This seminar is focused on the latter.

Capacitive interfaces have several attractive features. In most micromachining technologies no or minimal additional processing is needed. Capacitors can operate both as sensors and actuators. They have excellent sensitivity and the transduction mechanism is intrinsically insensitive to temperature. Capacitive sensing is independent of the base material and relies on the variation of capacitance when the geometry of a capacitor is changing. Neglecting the fringing effect near the edges, the parallel-plate capacitance is [8]:

$$C_0 = 0\frac{A}{d} = A\frac{1}{d}; \qquad (1)$$

Where, A = 0, and A is the area of the electrodes, d the distance between them and the permittivity of the material separating them. A change in any of these parameters will be measured as a change of capacitance and variation of each of the three variables has been used in MEMS sensing

III. MEMS MATERIALS

The choice of a good material for MEMS application is no more based like in microelectronics on carrier mobility, but on more mechanical aspect: small or controllable internal stress, low processing temperature, compatibility with other materials, possibility to obtain thick layer, patterning possibilities [6].

From microelectronics' root MEMS has retained the predominant use of silicon and its compounds, silicon (di)oxide (SiO2) and silicon nitride (Six Ny). It is an excellent mechanical material. Silicon is almost as strong but lighter than steel, has large critical stress and no elasticity limit at room temperature as it is a perfect crystal ensuring that it will recover from large strain. Unfortunately it is brittle and this may pose problem in handling wafer, but it is rarely a source of failure for MEMS components. For sensing application silicon has a large piezo resistive coefficient, and for optical MEMS it is transparent at the common telecommunication wavelengths. Silicon nitride is even stronger than silicon and can be deposited in thin layer with an excellent control of stress to produce 1 m thick membrane of several cm2. There is also silicon carbide (SiC) in use. SiC has unique thermal properties (albeit not yet on par with diamond) and has been used in high temperature sensor[6]. But silicon and its derivative are not the only choice for MEMS, many other materials are also used because they possess some unique properties. For example, quartz crystal (strong piezoelectric effect), glass (forms tight bond with silicon, bio-compatibility), polymers (biodegradability and bio absorbability, versatility, thermoplastic property), metals (conductivity, ability to be grown in thin-films) [6].

IV. Latest Application Areas

(i) BioMEMS

BIO MEMS device eliminating the need of needles or injections to release drugs into the body. The delivery of insulin is one such application, as is the delivery of hormones, chemotherapy drugs and painkillers. First generation devices are being developed which release their medication upon signals from an outside source, wired through the skin. Proposed second generation devices may be wireless and third generation MEMS chips could interact with MEMS sensors embedded in the body to respond to the body's own internal signals.

(ii) MOEMS

Micro-opto-electromechanical systems (MOEMS) is also a subset of MST and together with MEMS forms the specialized technology fields using miniaturized combinations of optics, electronics and mechanics. The most significant MOEMS device products include waveguides, optical switches, cross connects, multiplexers, filters, modulators, detectors, attenuators and equalizers. Their small size, low cost, low power consumption, mechanical durability, high accuracy, high switching density and low cost batch processing of these MEMS-based devices make them a perfect solution to the problems of the control and switching of optical signals in telephone networks.

(iii) RF MEMS

RF MEMS is one of the fastest growing areas in commercial MEMS technology. RF MEMS are designed specifically for electronics in mobile phones and other wireless communication applications such as radar, global positioning satellite systems. MEMS have enabled the performance, reliability and function of these devices decreases their size and cost at the same time. RF MEMS components continue replace traditional components in today's mobile phones, and then phones could become extremely small, require little battery power and may even be cheaper.

V. Conclusion

MEMS will undoubtedly invade more and more consumer products. Size of MEMS is getting smaller, frequency response and sense range are getting wider. Prices of MEMS accelerometers and other MEMS devices aren't excessive, but they still have to drop a lot if we want to expand massive consumption. In this paper review on MEMS has been presented. Specifically materials used for MEMS, accelerometers and latest application areas.

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