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A Review: Integrating SUGAR simulating tool and MEMS sensor

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ABSTRACT
Micro-Electro-Mechanical Systems (MEMS) are forming the basis for a rapidly growing industry and fields of research, many MEMS designers still rely on calculations due to a lack of efficient computer-aided design (CAD) tools that can assist with the initial stages of design exploration. This paper review about the techniques to the design of MEMS and sugar simulating tool. SUGAR simulating tool utilizes past successful MEMS designs and sub-assemblies as building blocks stored in an indexed library, allowing reuse and modification of previous successful designs to help deal with the complexities of a new design tool. Reasoning tools find cases in the library with solved problems similar to the current design problem in order to propose promising conceptual designs. The paper recommends strategies for integrating the MEMS Design with evolutionary computation of SST.
***Keywords**:* MEMS (Micro Electro Mechanical Systems), SUGAR SIMULATING TOOL (SST), Hard Disk (HDD), Sensor/Data Fusion (SDF)

I. INTRODUCTION

a) Overview about MEMS

MEMS technology is enabling the development of inexpensive, autonomous wireless sensor nodes having nanometer size[1]. These tiny sensor nodes can form rapidly deployed, massive distributed networks to allow unobtrusive, spatially dense, sensing and communication. MEMS enable these devices by reducing both the volume and energy consumption of various components. This paper reviews some of the wireless sensor nodes under development and applicable MEMS devices for small and efficient optical communication, micro power generation, and sensing. In addition, CMOS post-process micromachining is discussed as a method of achieving low cost and high integration.

b) MEMS Network Sensors

A MEMS-based wireless sensor network (WSN) is developed for nondestructive monitoring of pipeline systems [11]. It incorporates MEMS accelerometers for measuring vibration on the surface of a pipe to determine the change in water pressure caused by rupture and the damage location. This system enables various sensor boards and camera modules to be daisy chained underground and to transmit data with a shared radio board for data uplink. Challenges include reliable long-range communication, precise time synchronization, effective bandwidth usage, and power management.

c) Overview about sugar simulation tool

SUGAR is an open source simulation tool for micro-electromechanical systems (MEMS) based on nodal analysis techniques from the integrated circuit simulation[10]. The circuits thus analysed and modeled by the differential equations [2].

In less than a decade, the MEMS community has covered nearly all the integrated-circuit and changes its fabrication techniques. The circuit designers regularly use circuit simulation tools like SPICE, while MEMS designers often resort to back-of-the-envelope calculations. Tools for simulation will play a similar role in future advances in the design of complicated MEMS devices [3].

The main idea of SUGAR inherits SPICE. MEMS designers can describe a device in a compact netlist format [6] and quickly simulate the device's behavior. Early in the design process, quick simulations help designers explore the solution space of their problem and prototype viable designs[4,5].

II. INTEGRATION OF MEMS WITH ELECTRONICS

Modular integration will allow the separate development and optimization of electronics and MEMS processes. There are three main integration strategies that have been presented in the literature: "Pre-CMOS", "Post-CMOS" and the "interleaved approach". A schematic description of these three basic approaches is shown in Fig.1.

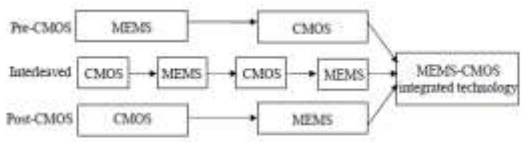

Fig 1: Schematic description of the three monolithic integration schemes approaches that could be used to integrate micro machined devices with CMOS electronics [12].

i) NANO-MODELING OF ELEMENTS [15]

Most of the research on MEMS enables devices in HDD has been on MEMS based actuators and heads. Silicon nitride cantilever integrated with silicon heater as shown in Fig.2 and piezoelectric sensor has been proposed for Nano data storage [13]. Modifying actuators to make them shock resistant has been explicated and the designing of active-passive hybrid piezo-electric actuators has been proposed where effect of shock impulse and vibration impulse has been studied [14]. Thus finite element modeling and modifying actuator design to improve the reliability of the HDD has been an area of high interest. The driving force is generated by electrostatic comb- drive actuators attached at the top and bottom of the moving stage.

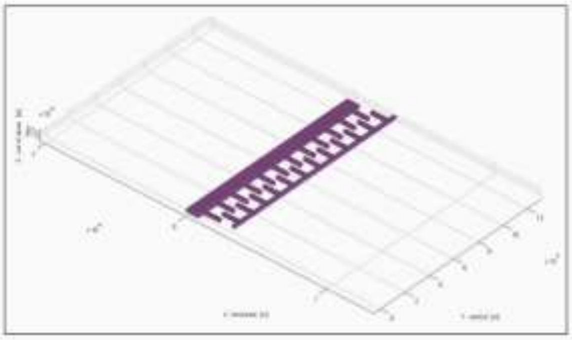

Fig.2. Modeling of comb drive actuator in SUGAR for HDD applications.

III. SIMULINK MODELLING APPROACH

Simulink in MATLAB will able to model the MEMS Sensor in such a way that we can simulates it. In this part, the SDFTool is illustrated as a design pattern as shown in Fig.3.Design patterns are recurring solutions to design problems you find again and again in real-world application development. Design patterns are about design and interaction of systems, as well as providing a communication platform concerning elegant, reusable solutions to commonly encountered system development challenges. The Gang of Four (GOF) patterns are generally considered the foundation for all other patterns. They are categorized in three groups: Creational, Structural, and Behavioral.

The blockset that makes up the first version of the toolbox include over 10 functional blocks each performing specific tasks related to data fusion[7,8]. Furthermore, since the data structures used by all blocks are well defined and standardized, the blocks can be replaced in or added to designs without the need for scenario-based modifications. There are three standard alternatives for data fusion, which are data level fusion, feature level fusion and decision level fusion. In all these levels, Information might be in discrete or continuous form. In higher levels of fusion, discrete or label output fusion will be more important.

Fig. 3: Schematic of SDF Toolbox installed in Simulink Library browser

i) Implementation:

The toolbox was developed on the graphic user interface design features of the Simulink platform using Matlab S function technique [16] as shown in Fig.5. Simulink is widely used in various fields of science and engineering. The graphically based software breaks away from the traditional methods of formulating mathematical model in computer code and allows system design by connecting modular blocks as shown in Fig.4. The interface of SDF Toolbox allows parameter setting with maximum flexibility[9,10]. In the case where many parameters are defined for a single block, intuitive GUI functions are designed so that the user may keep track of the exact operations intended. In addition, Data ranges and types have been defined for all the block parameters, and prevent users from defining non-sensible parameters for block algorithms.

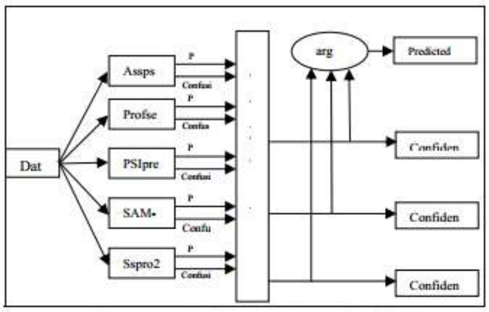

Fig 4: Design approach

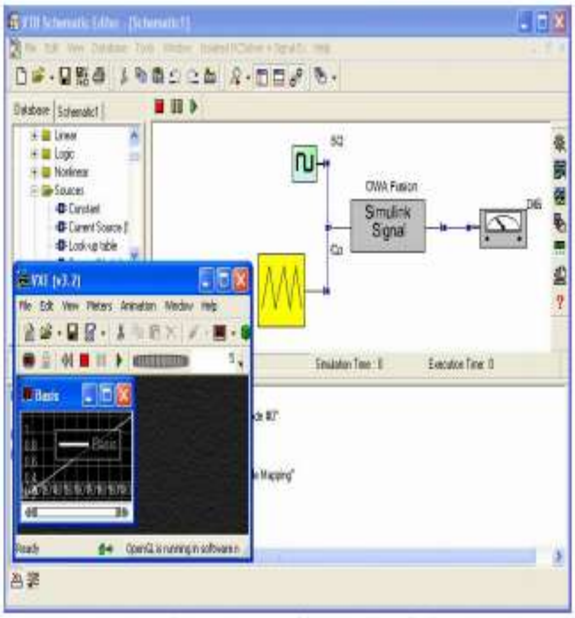

Fig 5: Simulink Virtual test bench

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