Profile

Dr. P A Manoharan
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P A Manoharan studied, Electrical Engineering from BMS College of Engineering, Bangalore University and obtained Bachelor Degree in the year 1992. PG M. Tech. on Polymer Science & Engineering, was obtained from Anna University, Chennai, during 1999. He also did his research program (2007-2013) and awarded Ph. D. (Technology), "MEMS - Pressure Sensor", University of Madras, Tamilnadu, during May 2013.

Dr. P A Manoharanstarted his carrier as Senior Scientific Assistant in the year 1984 in Aeronautical Development Establishment, Bangalore Lab, DRDO. He iscurrently positioned as Technical Officer in Research & Innovation Centre, IIT Madras Research Park, Chennai. H has expertised in the field of Electronics Instrumentation System, MEMS based pressure sensor and piezoelectric sensor based Digital Pressure sensor, Robotics, embedded system design, Sensors design.

Project Activities:

- **Engine Monitoring System (EMS)** - 20 Channel Data logger for T72.
- **Design Evaluation of Electronically Controlled Vehicle Module (ECVM)**- Unmanned Ground Vehicle for Border area Surveillance
- **PZT sensor Design, Simulation and Fabrication-Arjun fuel level sensin**g
- **MEMS capacitive sensor** design and development- Pressure Sensor
- **Development of Piezo patterning technology suitable for MEMS devices**- Acoustic sensor application.

1984-2007

Involved in research projects Mini Recovery project Vehicle, Pilot less Target Aircraft in the domains of computerized design modeling, Instrumentation and control system.

P A Manoharan's contributionsfor the period of 2007-15 during my service. The following activities are carriedout by me during my residential period of present category.MBT Arjun was fitted with fuel level sensor to shut of the engine by sensing minimum fuel level 1.5 m water column. This sensor was failed and the engine was not shutting down at the threshold limit, since the sensor was not operative beyond 70 ºC and require replacement. Additionally it was giving a tough task of minimum four soldiers to demount the engine compartment for priming.

Research Work Part I

The research work was to develop a novel support structure and PZT sensing element for capacitive sensor for pressure sensing applications. Withthis goal, the research work was attempted in two stages.In the first stage, a doubly supported serpentine shaped support structuremicro-sensing membrane (MSM) based capacitive sensor was modelled, simulated andanalyzed for milli-bar pressure sensing applications. The model was validated for the spring constant and sensitivity ofthe support structure and also compared with FEM analysis. Pull-in, hysteresis anddynamic analysis of the designed model were evaluated with the required boundaryconditions. Further, the identification of suitable materials for the fabrication ofefficient pressure sensor from Silicon (Si), Gold (Au) and Platinum (Pt) wereconducted. For the simulation and the analysis of the model COVENTORWARE,Intellisuiteand NISAsoftware tools were employed in this work.From this simulation study, it was found that the geometrical and dimensionalintegrity was maintained throughout the operating range with in-plane, which in turnimproved the accuracy and life expectancy of the sensor. The dynamic responsecharacteristics study of the materials showed that the Si was found to be a suitablematerial for the designed serpentine MSM capacitive model and well agreed with theactual sensor application. Also, the serpentine MSM capacitive sensor was testedwith the power supply of 5 V, thus, the designed model can be easily accommodatedin the form of IC for smart sensor applications. Further, the designed model took intoaccount the fringing field capacitance effects in the range of 17.1 % of the capacitanceof parallel plate membrane for the tested operating range. Thus, this model can besuggested as suitable model for the development of RF switches and other milli-barsensing devices of Bio-medical applications.

Research Work Part II

The serpentine support MSM structure capacitive sensor modeled, simulatedand analyzed in this research work exhibited excellent characteristics suitable formany milli-bar pressure sensing

applications. For the fabrication of this model, approached several fabrication centres available in India. Due to the novelty of thesupport structure and limitation in fabrication tools, it is not feasible to fabricate thedesigned serpentine support structure model. Device fabrication has the limitationand constraints in the packaging facility of parallel plate capacitor model due to itelectromagnetic interference (EMI) and electromagnetic compatibility (EMC),increase in the cost of manufacturing. As a result, the design of MEMS pressuresensor is confined to PZT based pressure sensor, since piezoelectric materials in theform of mono-crystalline silicon and poly-silicon have established thin film, bondedmetal foil, thick film and sputtered thin film technologies for the fabrication of highdynamic pressure measuring devices. In the second stage of this research work, the PZTSP pressure sensor wasdesigned, simulated, analyzed, fabricated and tested. The complete details of theactual PZTSP pressure sensor fabricated have been narrated in Chapter VI. For testing he PZTSP pressure sensor and measuring the direct piezoelectric output voltage, testing setup as well as signal processing circuitry with related software modules weredeveloped. The actual sensor was also tested in commercial pressure sensing setup forthe validation of the results obtained. ComsolMultiphysics and Intellisuite softwaretools were employed for simulation and analysis work.The direct voltage output characteristics of the actual, simulated andanalytically modelled PZTSPs for the pressure load of 0 kPa to 5 kPa were studied.From this study, direct piezoelectric output voltage of 4.2 V, 5.4375 V, and 5.0 Vwere observed for the actual, simulated and analytically modelled PZTSP sensor,respectively for the maximum pressure load of 500 kPa. Also, the actual PZTSPsensor output characteristic was found to be 22.76 % and 16.00 % less than thesimulated and analytical model, respectively. This variation may be due to variation inmaterial properties, environmental effects, fabrication flaw, etc. Further, thesimulation model output voltage was found to be 8.75 % more than its analyticalcounterpart, which may be attributed to the limitation in the simulation software tools.With all these limitations and variations, the designed PZTSP model fulfilled theobjective of fabricating a pressure sensor. As a result, the actual PZTSP sensoroptimally behaved in comparison with simulated and modelled designs. The variationin the output voltage characteristic of the actual PZTSP sensor may be reduced bysuitable mounting and metallization techniques. Further, the simulation error may beeduced by suitably changing the mesh type and size. Aging characteristics study ofthe fabricated PZTSP pressure sensor exhibited that the output voltage of directpiezoelectric for the testing period is well matched with TEDS specification.

Research & Innovation Centre (RIC):

Currently involved in a project2015-16

1.Development of Piezo patterning technology Suitable for MEMS devices.

2. Humanoid Robot

3. Unmanned Aerial Vehicle '**dovbot**'

Advisory Committee:

1. **Departmental Advisory Board Member** (Information Technology), KumaraguruIntstitute of Technology, Coimbatore.
2. Nuclear Physics Department: Board of Studies member, Anna University Campus, Guindy, Chennai.

3. **Chair (Robotics & Automation Society)**, IEEE Madras Section,

4. **Chair- IEEE Student Project Funding** 2010-16

Invited Talks / Society Activities: I am representing as the Chair, Robotics & Automation Society (RAS), IEEE, Madras Section. There were around 50 events participations during international conferences as the Chief guest, key note addressing, technical talk, conference chair. In addition, I have organised workshops in the domains of embedded system design at various engineering colleges of Tamilnadu.

Journal Papers:

1. Manoharan P. A., and Nedumaran D, Modeling-Simulation and Analysis of MEMS Capacitive milli-Bar Pressure Sensor. ASME/JNEM Vol.1, No.04, pp.1-8, November 2010.
2. Manoharan P. A., and Nedumaran D Design and Modeling of MEMS Based Nano Displacement of PZT Sensing Element. International Journal of Computer Applications Vol. 40, No.13, pp.34-41, February 2012.
3. P.A Manoharan, , P Mohan Reddy and S Akash, "Bio-Metric Attendance System using Mobile Wi-Fi Hotspot", Journal of Electrical Engineering and Science, Vol. 2(2) 2016, pp. 24-31

Research & Innovation Centre (RIC):
Currently involved in project titled "Development of Piezo patterning technology Suitable for MEMS devices".

Advisory Committee:
Departmental Advisory Board Member (Information Technology), KumaraguruIntstitute of Technology, Coimbatore.

Nuclear Physics Department: Board of Studies member, Anna University Campus, Guindy, Chennai.

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