

A Low Cost CMOS Compatible MEMS based Fingerprint Sensor Design

Adarsh Venkataraman Ganesan¹, Sundaram Swaminathan², Nitin Nipun Sharma³

1&2. BITS Pilani, Dubai Campus, Dubai International Academic City, Dubai, U.A.E., P. O. Box No. - 345055 ;

3. BITS Pilani, India, Pilani, Jhunjhunu, Rajasthan, India - 333031

Introduction: User identification by fingerprint in practical situations is required for better security. As a key device in small and thin fingerprint identification systems, semiconductor MEMS sensors have been used. The objective is to design an economically realizable fingerprint sensor with higher sensitivity.

Computational Methods: The design is composed of a 2D array of piezo resistive micro beams and post processing circuits comprising of A/D converter, needed to digitalize the amplified signal.

In order to determine the behavior of the micro beams, FEM mechanical analysis performed using COMSOL Multiphysics 4.2a software.

We have designed two models for the micro beams and analyzed the same. Based on the results, as shown in the figures 1 and 2, for the same force on the sensor, the strain in the circular beam is larger compared to that in the rectangular beam. Hence, we have used the circular micro beams for the use.

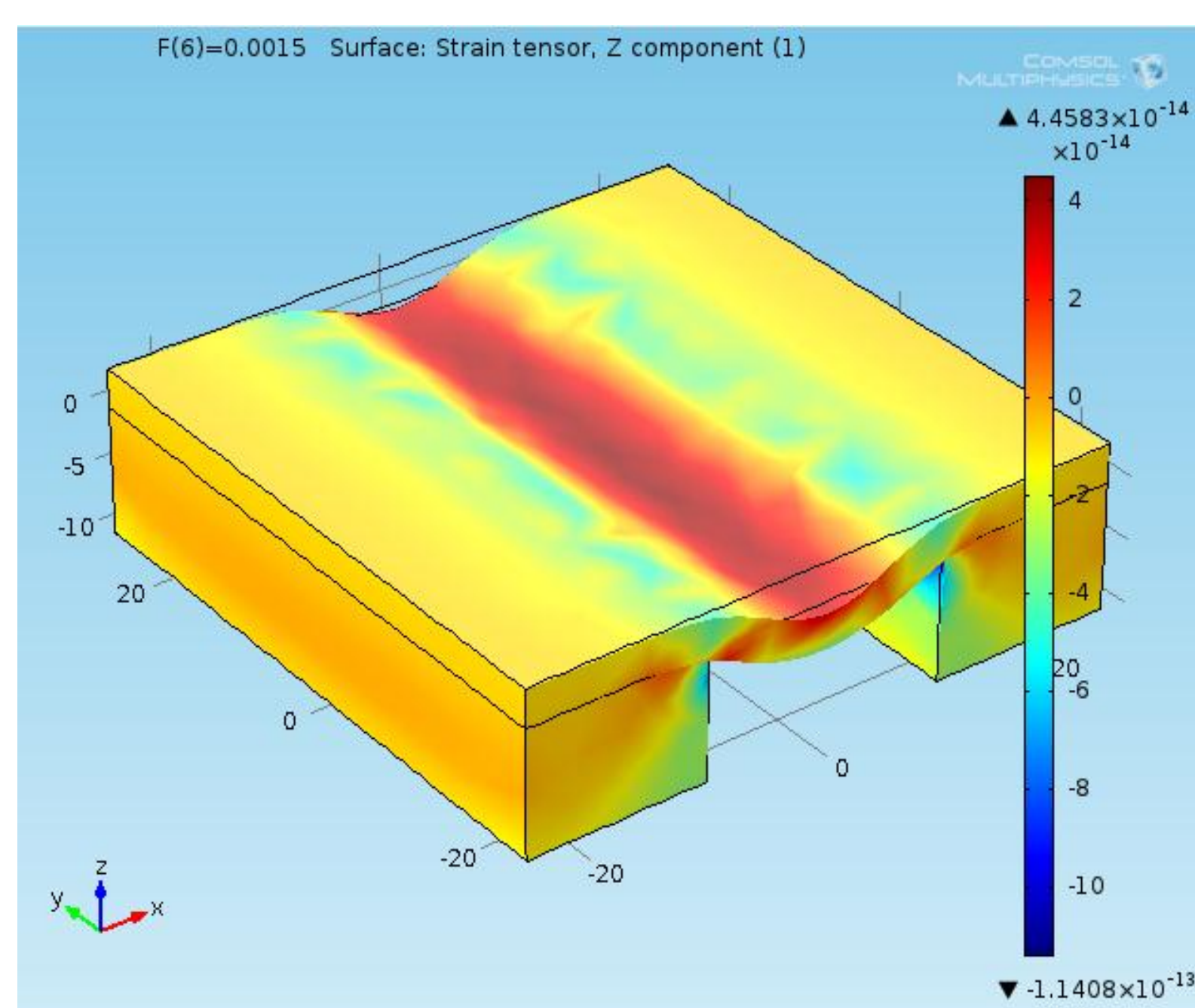


Figure 1. Rectangular Micro beam

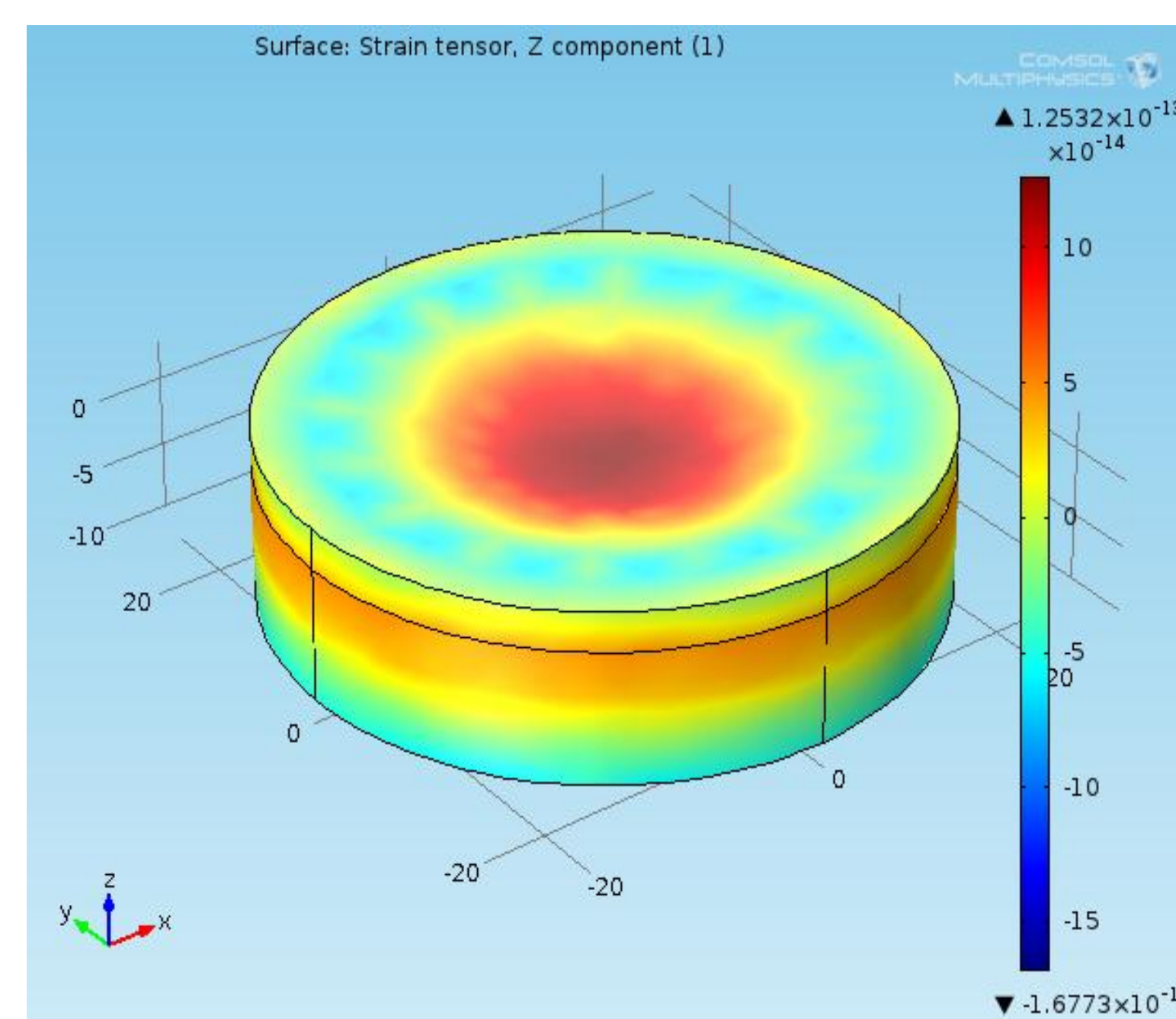


Figure 2. Circular Micro beam

Electronic Control: The microbeam which acts as a piezo-resistor forms a branch of Wheatstone bridge circuit. The output is passed as an input to the amplifier, whose output is fed to an 8-bit ADC. The pixel of the fingerprint image is represented by 256 gray scales.

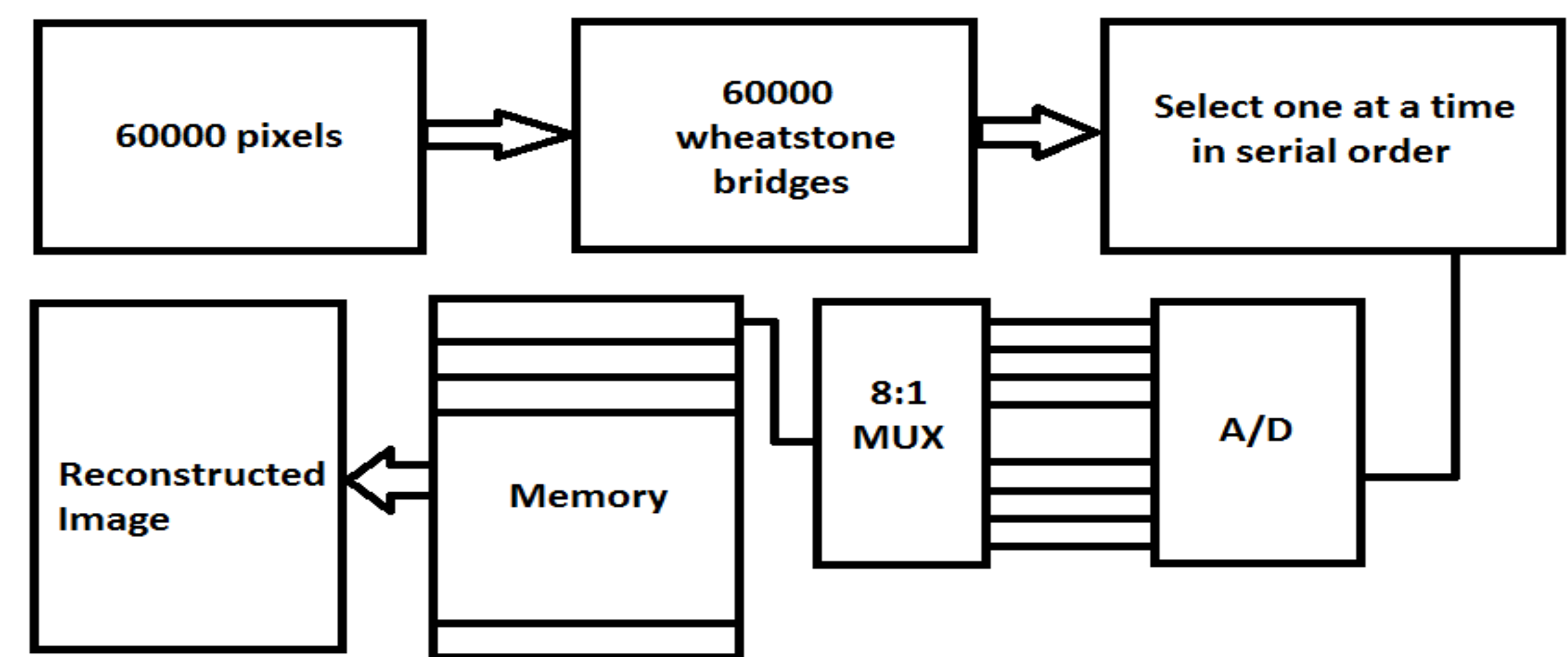


Figure 3. The Schematic of the fingerprint sensor

Results: A sample data resulting from an array of 17x13 microbeams located within the image boundary is as shown in the figure 4. The final fingerprint image, that is got using circular microbeams is shown in figure 5.

26	71	94	178	252	239	173	83	11	0	13	68	144
0	1	0	70	173	236	242	175	75	2	0	7	100
68	67	8	7	76	190	247	234	178	80	3	1	84
226	189	83	11	0	56	192	249	248	164	66	11	113
248	255	192	99	22	6	61	188	253	244	182	69	2
148	245	250	181	88	12	0	77	172	254	251	174	126
32	166	245	255	196	80	28	0	63	191	235	250	255
40	36	174	244	245	206	74	18	7	61	185	244	247
152	30	47	148	243	254	205	81	11	7	67	185	252
247	140	49	35	156	234	252	200	91	0	10	161	251
246	226	139	32	50	153	154	219	190	90	26	110	203
197	230	244	111	5	23	41	143	237	201	35	9	103
37	60	187	128	16	0	0	147	255	220	75	0	20
17	27	200	200	117	36	8	161	241	217	170	53	1
78	28	190	252	217	93	26	87	188	255	243	89	14
191	32	151	228	254	220	48	14	93	249	230	120	40
207	47	22	146	253	203	55	0	81	228	255	224	130



Figure 5. The fingerprint image generated by circular microsensor

Figure 4. The schematic of the fingerprint sensor

Conclusions: The circular micro beam based design of fingerprint sensor has higher sensitivity and can be realized by economical micro-fabrication techniques.

References:

1. Norio Sato et al., Novel Surface Structure and Its Fabrication Process for MEMS Fingerprint Sensor, IEEE transactions on Electronic Devices vol. 52 pp. 1026-1032 , May 2005
2. Matthew A. Hopcroft et al., What is the Young's Modulus of Silicon?, Journal of Microelectromechanical Systems, Vol. 19, No. 2, April 2010
3. Hossain Saboonchi and Dr. Didem Ozevin, Optimization of Design Parameters of a Novel MEMS Strain Sensor Used for Structural Health Monitoring of Highway Bridges, 2011 COMSOL Conference in Boston.