Design of Rectangular Slotted-Patch Antenna Array-Sensor for Breast-Tumor Detection

Divya Chaturvedi1, *SM, IEEE*, V L Bhavani Maddirala2, *Student Member, IEEE*, Arvind Kumar3, *SM, IEEE*

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|  |  |
| (a) | |
|  | |
| (b) | |

**Fig. 1.** (a) Schematic diagram of 1×2 array antenna and (b) Front view 1×4 array antenna, all dimensions (mm) *LT = 38, WT =92, lp* = 14.8, *wp* = 15, *ls* = 4, *ws* = 0.6, *lc* =5.5, *wc* = 0.6, *a* = 2.3, *g* = 10.4, *w100Ω =0.5, w50Ω* = *1.6*, *w70.7Ω* = 0.9.



**Fig. 2.** S11​ response of the proposed antenna: comparison between single-element configurations with and without slots, two- element and the four-element array with slots.

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| C:\Users\ok\Desktop\e-field (f=5.75) [1]_1.png | C:\Users\ok\Desktop\e-field (f=5.85) [1]_1.png |  |
| (a) | (b) |
| C:\Users\ok\Desktop\e-field (f=5.76) [1]_2.png | |
| (c) | |  |

**Fig. 3.** Scalar E-field distribution (a) Single patch antenna, (b) 1×2 antenna-array and (c) 1×4 antenna-array.

|  |  |
| --- | --- |
| (a) | (b) |
| (c) | (d) |

**Fig. 4**. S11 versus frequency response of the proposed antenna-sensor by varying (a) length (*ls*) of the slots, (b) width (*ws*) of the slots, (c) position *(a)* of the slots and (d) length of the patch (*lp*).

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| A diagram of a body part  Description automatically generated  (a) | (b) |

**Fig. 5.** Simulation setup: The proposed antenna-array in proximity of breast equivalent phantom with standoff distance *h* = 3 mm in presence of (a) Tumor and (b) Healthy tissues.



**Fig. 6.** The reflection coefficient vs frequency in free space, healthy breast, and with tumor.

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| A diagram of a cell  Description automatically generated A diagram of a human eye  Description automatically generated | |
|  |  |
| (a) | (b) |

**Fig. 7.** S11 vs frequency response for (a) Different location of tumor and (b) Different size of the tumors.



**Fig. 8.** Simulated gain and efficiency plots in free space and in the presence of phantom.



**Fig. 9.** 2D radiation pattern plots at 5.8 GHz in free space and in the presence of phantom at (a) ϕ = 0o and (b) ϕ = 90o.

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|  |  |
| (a) | (b) |

**Fig. 10.** (a) Phantom showing Skin and fat layers with tumor of radius 12.5 mm and (b) Variation of SAR concerning distance of tumor from antenna.

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| --- | --- |
|  | A container of food on a table  Description automatically generated |
| (a) | (b) |
| A bowl of orange liquid in front of a computer monitor  Description automatically generated |  |
| (c) | (d) |

**Fig. 11.** (a) Fabricated prototype, (b) materials used in phantom preparation along with different size of the tumors, (c) Antenna under test and (d) free space simulated and experimental S11 response for the proposed antenna-sensor.

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|  |  |
| (a) | (b) |

**Fig. 12.** Measured S11 vs frequency response (a) for various location of tumors towards ( *X* axis) and (b) for different size of tumors.