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Micro Strip Patch Antenna Array and Its Applications in Remote Health Monitoring - A Review

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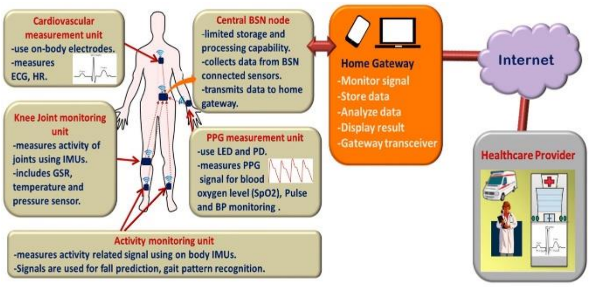
Abstract: ***Wireless communication technology has gained most popularity in the technology advancements. This has led to vast applications in the day-to-day life including the health monitoring system. Health care monitoring system is revolutionized cause of microstrip antennas. Microstrip antenna plays pivotal role in designing these. Microstrip patch antenna takes major role in this regard because of their simple structure, easy to fabricate and advantages like low profile, light weight, easy to design with high performance ability. The most important parameters are high gain and wide band width. It is possible to enhance gain by increasing elements of antenna (array). Researchers are focusing on the same and gave some fruitful results from the last four decades in microstrip patch antenna array.***

Keywords: Gain, Bandwidth, micro strip, wireless, health care monitoring system

1. Introduction

Microstrip patch antenna acquires a special importance in the field of wireless communication, fromthe last four decades because of its low profile, light weight and easy to design. It consists of only three elements ground plane, substrate and patch [1][2]. But it suffers from low gain and narrow bandwidth because of their small aperture and surface wave excitation in their dielectric [1][2]. This motivated researcher to work in this regard in order to improve these parameters for wireless communication. Recent investigations now reveal the importance of Microchip antenna in the wearable health monitoring system[3]. Wearable sensor-based health monitoring systems may comprise different types of flexible sensors that can be integrated into textile fiber, clothes, and elastic bands or directly attached to the human body [4]. The sensors can measure blood pressure (BP), respiration rate (RR), arterial oxygen saturation (SpO2), heart rate (HR), body temperature, electrodermal activity (EDA), electrocardiogram (ECG), electromyogram (EMG), and other physiological indicators [5]. As bandwidth is crucial in making these sensors, several number of attempts have been made to increase gain and bandwidth using single or set of microstrip patch antennas. [6]. It is very common to enhance gain and bandwidth of microstrip patch antenna by connecting multiplepatches in series or parallel or any desired type due to its simplicity and cost effectiveness of this approach [7]. There is lots of advancement in technology because of the smart, creative and genius researchers. Now we are in such position that everything is available in our palm. All of us are in such a position that our day-today works are carried out safely in this tough pandemic. This happens becauseof rapid growth and fast development in wireless communication and its remarkable applications. Mobile technology is improving and achieving the set goals nowadays like anything. So it is essential to design high gain and large bandwidth microstrip patch antenna for wireless application that is very essential and to reach 5G standards.



Overview of remote health Monitoring system (adapted from Majumdar, 2017)

2. Overview: MPA antenna array

Microstrip patch antennas (MPA) can be used as a single element or a set of elements, called array [1][2]. Antenna array has 100 years of history. MPA array or antenna array are several identical antennas connected to form a single antenna of particular shape, these are used in almost all fields ofwireless communication, medical field, military systems and wireless local area network (WLAN) and the 4G radio communication system [8] [14].MPA array takes major role in improvement of gain andbandwidth enhancement.

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Comparsion Table with Applications						
Sl No.	Ref.	Array type	fr	Achieved Gain	BW	Application
1	13	**16-element Parallel series fed patch antenna**	62.2	17.62	55 to 68 GHz	60-GHz wireless application
2	14	**3x3 RMPA**	13	17.29	-	ku band applications
3	15	**2X2** Square dense dielectric patch antenna	28	16	26.5 GHz to 30.8 GHz.	**(5G) millimeter wave (MMW)**
4	16	**Array of slitted and square shaped patch array**	2.4	7.3139 to 9.22dB	-	wireless application
4	17	**4x1 circular**	2.4	8.2572	80M	Industrial, Scientific and Medical (ISM) Systems
6	19	**8x1 RMPA**	10.01	R03006-12.30 FR4-10.47	-	**x-band application**
8	21	**1x4**	2.45	14.45	-	ISM applications
9	22	**4x4 stacked**	5.5	>20	increases	ISM and WLAN application
10	24	cascaded antenna array	2.4	3.49	-	wireless local area network (WLAN)[21]

Qing Song in 1995 proposed an antenna array gap coupled patches as elements of array for improvement of bandwidth (7.2%) [10]. **Ghosh in 2009** designed multi element 2x2 rectangular microstrip patch antenna to increase gain but this antenna suffers from side lobes. This finds application in WLAN and MIMO application [12]. **Yang in 2015** Designed arrays for improvement of gain and impedence bandwidth.a)Array 1: Designed two-element series-fed patch antenna array with inset feed and shows gain (9.77dBi) and impedence bandwidth(2.4GHz). (b) Array 2: By putting two array1 in opposite direction, by both side feeding they achieved gain (12.32). c)Array3: This connects four identical two-element series-fed sub-arrays in parallel by a one-to-four parallel-feed network. And achieved gain(14.98dBi) and bandwidth(9.2GHZ). d) Array 4: This connected as 16-element parallel-series-fed patch antenna array with differential inputs and achieves good enhancement in wide impedance bandwidth and high peak gain of 17.62 dBi at 62.2 GHz. This is designed for 60GHz wireless application [13]. **Midasala Vasujadevi (2016):** studied 3x3 rectangular microstrip patch antenna array with high gain (17.29dBi) and also achieved low side lobe and good cross polarization for frequency 13GHz useful for ku band applications [14]. **Muftah Asaadi in 2017** designed Square dense dielectric patch antenna (2*2) using holey superstrate is proposed. A conventional power divider is used to feed this aperture coupled antenna. The antenna gain is enhanced (about 16dBi) using a dielectric superstrate. The antenna bandwidth is improved (15.35 % from 26.5 GHz to 30.8 GHz) with decrease in side lobe level (-15.8 dB in E-plane and -21 dB in the H-plane) by drilling a set of identical circular holes in the superstrate layer. Radiation efficiency increases 92%. This antenna meets some requirements in fifth generation 5G millimeter range (MMW) [15] **Kumar, m. Kishore in 2017** Designed single square patch, slitted and four element array square patch antenna and proposed that gain increasing from single to four element square patch (7.3139 to 9.22dB) at 2.4GHz for wireless applications [16]. **Qurratul Ayn (2017):** Proposed high gain single, 2x1 and 4x1 circular patch array antenna. And achieved gain is increasing from single (0.72935dBi) to 2x1(5.7414dBi) to 4x1(8.2572dBi) array by using probe feeding for single and edge feeding for 2x1 and 4x1. This proposed frequency used by the Industrial, Scientific and Medical (ISM) Systems [17]. **Chirag Arora (2017):** Proposed metamaterial inspired patch antenna array for increment gain (12.1dBi) and bandwidth(780MHz). This antenna array useful for applications, like broadband connections, hotspots, cellular backhauls, smart grids, medical and metering etc. [18]. **Patel Madhukant in (2017)** Proposed 8x1 rectangular microstrip patch antenna array for high gain with different substrate designed and compares results. Achieved high gain (12.30) for RO3006 then gain (10.47) FR4 substrates. This type of antennas is suitable for x-band applications [19]. **Sonal N. Dahake in (2017):** For satellite application he developed Synthetic aperture radar 2x2 microstrip patch antenna array for 2.4GHz. He started designing with single element,1x2 and achieved high gain at 2x2 array(11.42dB) [20].**Sham Datto in 2017:**Proposed optimized 1x4 rectangular microstrip patch antenna for high gain(14.45dBi).He started designing for resonant frequency 2.45Ghz with single, optimized and converted to 1x2 and 1x4 achieved high gain for ISM applications[21].**Chandrahasa R. Salian in 2017:** High gain (more than 20dB) 4x4 microstrip stacked patch antenna designed for ISM and WLAN application for resonant frequency greater than 5.2GHz. Bandwidth also increases by this method[22]. **Ningning Yan in 2018**: Designed novel stacked patch antenna by using substrate integrated suspended line (SISL)technology, this antenna is made of self-package of five substrates with embedded air cavity and its resonant frequency is 5.2GHz. For impedance matching U shaped slot is etched in driven patch. And achieved 6.2GHZ resonant frequency by introducing a slant slot with stacked patch. The antenna element achieves a bandwidth of 17.5 % from 5.2 to 6.2 GHz and gain of 9.7 dBi [23]. **Nitesh Baja and Chakresh Kumar in 2018:** Designed cascaded MPA for improvement in gain (3.48dBi) compared with single MPA(1.93dBi), and it also minimize radiation loss. This is designed for wireless

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local area network (WLAN)[24] **Nikita M. Tarpara in 2018:** Proposed a slotted (slots on radiating patch) rectangular MPA for 5.6GHz to improve gain and bandwidth. For 1x2 array and slot is used to increase gain(5.72dBi) and bandwidth (672.8MHz) respectively. But it decreases resonant frequency. This can be used for 5G application,medical aplication.[25].

3. Conclusion

Health care monitoring system has become the need of hour. Usage of sensors acts as ready reckoner to monitor biophysical parameters of the body. This has led to immediate action by health professional's boon to the patients. Microstrip patch antenna array plays an important role in medical field by enhancing gain and bandwidth. And it is the best solution in design of low profile with high performance antenna. All presented above papers are to enhance gain and bandwidth. It's observed that if element of antenna increases the antenna gain also increases and is useful for medical and 5G applications. Some proposed works reduces side lobes.

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