Program

2013 7th European Conference on Antennas and Propagation (EuCAP)

EuCAP 2013 - Convened Sessions: 7th European Conference on Antennas and Propagation (EUCAP 2013) - Convened Sessions

Plenary Keynote Speaker 1

Meta-Waves and Meta-Structures
Nader Engheta (University of Pennsylvania, USA) 1

Plenary Keynote Speakers 2

How New Active Safety Systems and Always Connected Vehicles Leads to Challenges on Antenna Design and Integration in the Automotive Domain
Henrik Lind (Volvo Car Corporation, Sweden) 3

Plenary Keynote Speaker 3

Mikael Höök
Mikael Höök (Ericsson AB, Sweden) 7

Invited speaker 1

Multi-Dimensional and Multi-Functional Substrate Integrated Waveguide Antennas and Arrays for GHz and THz Applications: An Emerging Disruptive Technology
Ke Wu (Ecole Polytechnique (University of Montreal), Canada) 11

Invited speaker 2

Compact Multiport Antennas for High Spectral Efficiency
Rodney Vaughan (Simon Fraser University, Canada) 16

Breast-Tumor Shape Estimation Using the Jump- Diffusion Algorithm
Marija Nikolic (University of Belgrade, Serbia), Arye Nehorai (Washington University in St. Louis, USA), Symeon Nikolaou (Frederick Research Center, Cyprus), Antonije Djordjevic (University of Belgrade, Serbia) 1124

Novel Rapid Detection of Different Viruses in Blood Using Microimmuno-sensor
Dalia Elsheakh, dalia (Electronics Research Institute, Egypt) 1128

Design of an Implantable Broadband Antenna for Medical Telemetry Applications
Neus Vidal (University of Barcelona, Spain), Jose López-Villegas (University of Barcelona, Spain), Sergio Curto (University of Barcelona, Spain), Jordi Colomer (University of Barcelona, Spain), Saiyd Ahyoune (University of Barcelona, Spain), Aleix Garcia (University of Barcelona, Spain), Javier Sieiro (University of Barcelona, Spain), Francisco Ramos (Francisco Albero S.A., Spain) 1133

UWB Loop Antenna for In-Body Wireless Body Area Network
Kamya Yekeh Yazdandoost (National Institute of Information and Communications Technology, Japan) 1138

An MR-compatible Printed Yagi-Uda Antenna for a Phased Array Hyperthemia Applicator
Bedilu Adela (Eindhoven University of Technology, The Netherlands), A. B. (Bart) Smolders (Eindhoven University of Technology, The Netherlands), Maarten Paulides (Erasmus MC Daniel den Hoed Cancer Center, The Netherlands), Rob Mestrom (Eindhoven University of Technology, The Netherlands) 1142

On the Impulse Response of the Folded Dipole
Renata Valério de Freitas (University of São Paulo, Brazil), Silvio E. Barbin (University of Sao Paulo, Brazil) 1147

Nonorthogonal FDTD for SAR Estimation in Case of Body Deformation
Mame Diarra Mbaye (Université Paris-Est Marne-la-Vallée, France), Shermila Mostarshedi (Université Paris-Est Marne-la-Vallée, France), Stéphane Protat (Université Marne La Vallée, France), Joe Wiart (France Telecom R&D, France), Odile Picon (Université Paris-Est Marne-la-Vallée, France) 1152

Heating Control Method for Resonant Cavity Applicator Using Divided Type of Dielectric Bolus for Effective Hyperthermia Treatment
Yuya Iseki (Meiji University, Japan), Yasuhiro Shindo (Meiji University, Japan), Kazuki Watanabe (Meiji University, Japan), Jiro Arakawa (Graduate School of Meiji University, Japan), Kazuo Kato (Meiji University, Japan) 1157

Investigation of Small Tumor Response in Microwave Tomographic Sensing of the Breast
Seong-Ho Son (ETRI, Korea), Laxmikant Minz (Member Of engg. Staff, India), Nikolai Simonov (ETRI, Korea), Soon Ik Jeon (ETRI Radio Technology Group, Korea), Hyung Do Choi (ETRI, Korea) 1162

2-D Scattered Field Analysis of Four Breast Types in Microwave Tomography System
Bo-Ra Kim (ETRI, Korea), Taek kyung Lee (Korea Aerospace University, Korea), Soon Ik Jeon (ETRI Radio Technology Group, Korea) 1166

Thermotherapy for Rheumatoid Arthritis Using Resonant Cavity Applicator
Yasuhiro Shindo (Meiji University, Japan), Kazuki Watanabe (Graduate shool of Meiji University, Japan), Yuya Iseki (Meiji University, Japan), Kazuo Kato (Meiji University, Japan) 1168

The Effect of Arm Movement on Walking Action in Wireless Body Area Network Channel
Srijittra Swaisaenyakorn (University of kent, United Kingdom), Kruthi Chitradurga-Nanjaraj (The University of Kent, United Kingdom), Steve Kelly (University of Kent, United Kingdom), John Batchelor (University of Kent, United Kingdom) 1173

Inspecting Safety Level of Bluetooth Headset Radiation in the Vicinity of Human Head: A Numerical Study
Reza Aminzadeh (Sharif University of Technology-International Campus, Iran), Mehrangiz Ashiri (Sharif University of Technology International Campus, Iran), Khosrow Sadeghi (Sharif University of Technology, Iran), Sarah Naghedi Hosseinzadeh (Sharif University of Technology-International Campus, Iran), Hadi Hosseinzadeh Khaligh (University of Waterloo, Canada) 1178

Antenna Design for Tongue Electrotactile Assistive Device for the Blind and Visually-Impaired
Thanh Huong Nguyen (Grenoble Institute of Technology, France), Thi-Lan Le (MICA, HUST, Vietnam), Thi-Thanh-Hai Tran (Hanoi University of Science and Technology, Vietnam), Nicolas Vuillerme (University of Grenoble, France), Tan Phu Vuong (Grenoble INP, France) 1183

Browse Conferences > Antennas and Propagation (EuC...

Antenna Design for Tongue electrotactile assistive device for the blind and visually-impaired

5 Author(s)

Thanh Huong Nguyen ; Thi Lan Le ; Thi Thanh Hai Tran ; Nicolas Vuillerme ; Tan Phu Vuong

View All Authors

Abstract:
Various types of medical and biomedical applications have been widely used antenna as a vital supporting part for their wireless communication. Since these antennas are used in and around a human body, their size must be small and their shape must be conformed to the human organism where they are placed. This paper describes a miniature dipole antenna for a tongue-placed electro-tactile device which is designed to support the blind and visually-impaired people in information transmission and mobility assistance. In order to check the performance of our antenna, the design parameters such as shape, length, and size and substrate material are evaluated by doing simulation. Due to the cable effect to small antenna in measurement, a Bazooka balun will be used for measurement. The measurement results suggest that the dipole antenna could provide a good reference for designed an antenna in tactile display applications.

Published in: Antennas and Propagation (EuCAP), 2013 7th European Conference on

Date of Conference: 8-12 April 2013

INSPEC Accession Number: 13597735

Date Added to IEEE *Xplore*: 25 June 2013

Publisher: IEEE

ISBN Information:

Conference Location: Gothenburg, Sweden

Keywords

IEEE Keywords

Antenna measurements, Dipole antennas, Impedance matching, Antenna radiation patterns, Tongue

INSPEC: Controlled Indexing

INSPEC: Controlled Indexing
wireless sensor networks, biomedical telemetry, dipole antennas, touch (physiological), vision defects

INSPEC: Non-Controlled Indexing
Bazooka balun, antenna design, blind patient, visually-impaired patient, wireless communication, human organism, dipole antenna, tongue-placed electro-tactile device, information transmission, mobility assistance

Author Keywords
small antenna measurement, miniaturized antenna, electro-tactile device, tongue, medical application, balun

Abstract

Authors

Figures

References

Citations

Keywords

Back to Top

Authors

Thanh Huong Nguyen
IMEP-LAHC, Grenoble Institute of Technology (GINP), France

Thi Lan Le
International Research Institute MICA, Hanoi University of Science and Technology (HUST), Vietnam

Thi Thanh Hai Tran
International Research Institute MICA, Hanoi University of Science and Technology (HUST), Vietnam

Nicolas Vuillerme
Universitaire Grenoble-Alpes, AGIM FRE 3405, CNRS-UJF-UPMF-EPHE, France

Tan Phu Vuong
IMEP-LAHC, Grenoble Institute of Technology (GINP), France

Related Articles

Design and setup of a short pulse simulator for susceptibility investigations
F. Sabath; D. Nitsch; M. Jung; T.H.G.G. Weise

An examination of the performance of backward wave CFA's in simulation and experiment
L.D. Ludeking; R.S. Smith; W.R. Wortman

The characteristics of the starting potential of barrier discharge
S. Nakahara; N. Shiiba; K. Itoyama

Antenna Design for Tongue electrotactile assistive device for the blind and visually-impaired

Conference Paper · January 2013

Huong Thanh Nguyen
Hanoi University of Science and Technology

Thi Lan Le
Hanoi University of Science and Technology

Nicolas Vuillerme
Institut Universitaire de France & Université ...

Tan-Hoa Vuong
University of Toulouse

Antenna Design for Tongue electrotactile assistive device for the blind and visually-impaired

Thanh Huong NGUYEN[1,2,3], Thi Lan LE[2], Thi Thanh Hai TRAN[2], Nicolas VUILLERME[3,4], Tan Phu VUONG[1]

[1]*IMEP-LAHC, Grenoble Institute of Technology (GINP), Grenoble, France*

[2]*International Research Institute MICA, Hanoi University of Science and Technology (HUST), Hanoi, Vietnam*

[3]*Universitaire Grenoble-Alpes, AGIM FRE 3405,CNRS-UJF-UPMF-EPHE, Grenoble, France*

[4]*Institut Universitaire de France*

Abstract—**Various types of medical and biomedical applications have been widely used antenna as a vital supporting part for their wireless communication. Since these antennas are used in and around a human body, their size must be small and their shape must be conformed to the human organism where they are placed. This paper describes a miniature dipole antenna for a tongue-placed electro-tactile device which is designed to support the blind and visually-impaired people in information transmission and mobility assistance. In order to check the performance of our antenna, the design parameters such as shape, length, and size and substrate material are evaluated by doing simulation. Due to the cable effect to small antenna in measurement, a Bazooka balun will be used for measurement. The measurement results suggest that the dipole antenna could provide a good reference for designed an antenna in tactile display applications.**

Index Terms—miniaturized antenna; electro-tactile device; tongue; medical application; balun; small antenna measurement

I. Introduction

For the last few years, various types of medical and biomedical applications have been reported of using antenna for wireless communication such as treatment, diagnosis and information transmission [1]. The blind and visual-impaired people have been so far attached to bulky and complicated system such as wheelchair [2], the cone or Personal Guidance System [3]. A theory which is called "neuroplasticity", which is a property of the human brain to reorganize itself due to changes in behavior, environment and neural processes as well as changes resulting from injury, was first studied by Professor Bach-y-Rita [4]. After different works on vibrotactile stimulators, developed a novel system, the Tongue Display Unit, which allows information from external device to be sensed by humans via neuro-stimulation of the tongue. Bach-y-Rita et al. applied such system to aid the blind and visually-impaired people in navigation through their tongue [5]. However, the system was still bulky with cable and handheld system.

In the present project, we would like to reduce and minimize the system of Paul Bach-y-Rita into a compact and tiny system. One of the ideas is using wireless communication to make the whole system wireless. Antenna frequencies ranging from 434 MHz to a few GHz have been reported to be usable in human body [6]. As for our case, 2.4 GHz frequency is applicable to some wireless protocols, especially for the visually-impaired people who are in need of navigation at short distance.

In our project, we proposed a design of a tiny dipole antenna working at 2.4 GHz. All proper antenna parameters were first simulated via the Computer Simulation Technology (CST) Microwave Studio. In order to investigate the effect of the antenna on human body and to check the antenna performance, antenna parameters will be measured and compared to the above theoretical simulation.

II. DESCRIPTION OF THE TONGUE TACTILE SYSTEM

Based on the pioneering work of Professor Bach-y-Rita [5], a prototype system is proposed by our group.

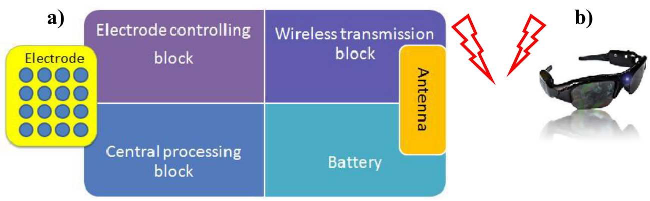

Figure 1. Tongue-placed electro-tactile system consists of: a) Tongue-placed electro-tactile device and b) A pair of sunglasses including camera.

In our system, a person can wear a pair of sun-glasses (b) which includes a camera detecting objects from the environment. From the camera, the signal will be sent wirelessly to the tongue electro-tactile device (a) (TED), a matrix of 4x4 electrodes. A circuit is integrated in the device to process the signal from the camera and control the most important part which can help blind people sense through the tongue, that is a matrix of electrodes. The circuit contains four functioning blocks: (1) a battery providing energy to raise the whole circuit, (2) a central processing block processing the image signal into a encoded signal, (3) the electrode controlling block processing the encoded signal to control signal to be sent to the electrodes and (4) the wireless transmission block that receives the wireless signal from the camera. The antenna is an important part which supports wireless communication in our system.

III. DESIGN OF THE ANTENNA MINIATURIZATION

The antennas integrated in wireless applications for human body have to be taken into consideration the environment around them, hence, are certainly different from the antennas in common systems in terms of dimension and power. The TED mentioned above is placed inside the mouth and is designed to electrically stimulate the dorsal part of the tongue. Therefore it has the dimension that fits human mouth and the antenna should be small enough to be placed on such device.

Our proposed antenna is of the dipole type, which is not only easy to modify but also radiates radio waves power uniformly in all directions, which well supports for the blind who cannot direct themselves in advance. The antenna is designed to operate at 2.4 GHz, as a result, the dimension of the antenna will be equal to λ/2. That means it is about 12.5 cm in air. This quantity is too large to put inside the human mouth. Method to reduce the size of the antenna by folding up the two branches of the dipole is applied (Figure 2).

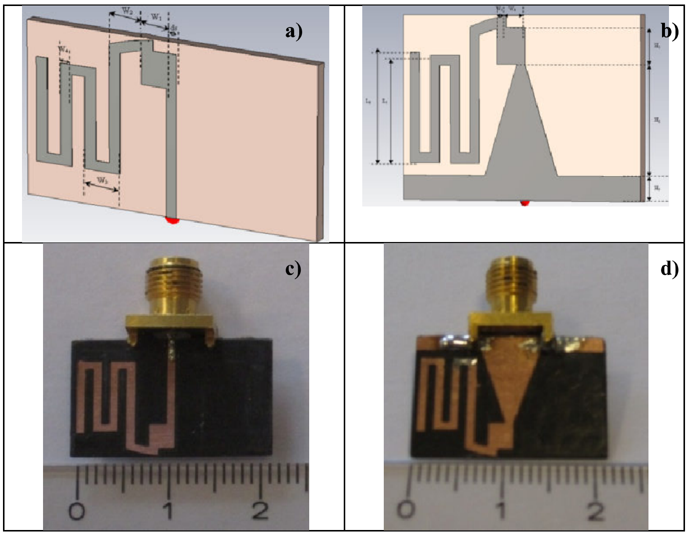

Figure 2. Dipole antenna for tongue-placed electro-tactile device: Design model for the antenna at the a) front and b) back; Fabricated antenna at the c) front and d) back.

The polymer substrate Roger 5880, ε_r=2.2 and tanδ=0.0009 is used for future integrating to the device because the device is required to be soft to avoid damage the mucous layers inside the mouth. The dimensions of this designed antenna are listed in Table 1.

TABLE I. DIMENSION PARAMETERS OF SIMULATION MODEL OF THE DIPOLE ANTENNA

Parameters	ds	W_1	W_2	W_3	W_4	W_5
Length(mm)	0.375	1.000	3.320	2.700	0.800	3.000
Parameters	W_6	L_1	L_2	H_1	H_2	H_3
Length(mm)	7.625	8.750	8.980	3.000	9.000	2.000

IV. RESULTS AND DISCUSSION

The effect of miniaturization on the performance of the proposed antenna was investigated through the simulation and measurement results. Figure 3 shows the $S_{1,1}$ curve of the antenna simulated in CST Microwave Studio in logarithmic scale which represents how much power is reflected from the antenna.

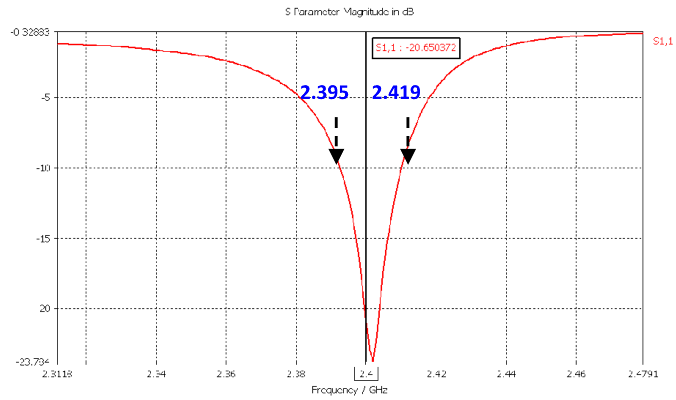

Figure 3. Parameter $S_{1,1}$ of the dipole antenna

In Figure 3, the simulated antenna has the $S_{1,1}$ parameter at −23 dB at 2.4 GHz. The value of $S_{1,1}$ is under -10 dB. Figure 3 also shows that the bandwidth of the simulated antenna is around 24 Mhz (because the S11 curve cuts the −10dB line at 2.395 GHz and 2.419 GHz) which exceeds the lowest bandwidth (5 MHz) of the Bluetooth protocol.

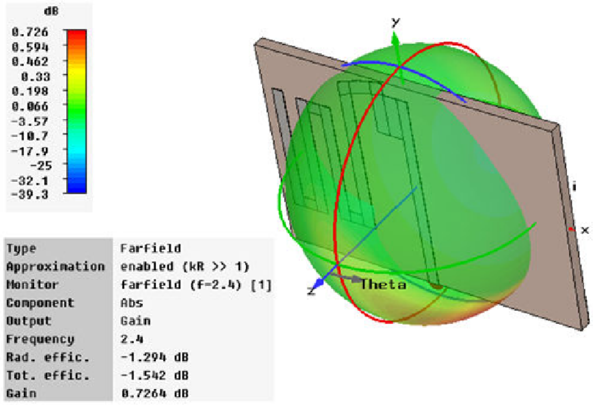

Figure 4. Radiation pattern of the dipole antenna

In Figure 4, the radiation pattern of the antenna is nearly an isotropic pattern with 0.7264 gain and -1.542 dB of total efficiency. The result shows that the radiation pattern is nearly the same in every direction, which means it is able to transmit/receive signal from every direction. Besides, the pattern on the front and on the back of the antenna is not symmetric due to the designed structure standing on two planes.

To assess and validate the calculations and simulations, the dipole antenna was measured. However, while doing measurement on $S_{1,1}$ parameter, the $S_{1,1}$ curve from 0 to 3 GHz did not show any value below -10dB and all the $S_{1,1}$ values were even around zero. Hence, the measurement results for this small antenna did not agree with the simulation.

According to the report of the IKERLAN Technology research centre during CST 2012 workshop [7], this problem could stem from the outer currents on the measurement cable. This leakage current coming from the outer surface of the coaxial cable which is the connector between the antenna and the measurement equipment (Vector Network Analyzer) created a very big effect on the antenna characteristic. In order to mitigate the cable effect, the well-known Bazooka balun was chosen for this antenna to match the simulation and measurement [8]. A Bazooka balun is a quarter wave length metal sleeve shorted at one end which encapsulates a coaxial line. In this way the input impedance at its open end is very large, which suppresses the above-mentioned outer current. In our project, the CST MWS software was used to design the metal sleeve. Figure 5 shows the typical geometry and configuration of a Bazooka balun and the designed one. Table 2 gives the exact dimensions of the balun configuration.

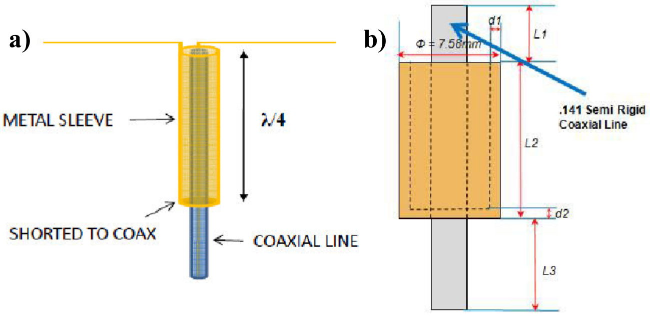

Figure 5. Geometry and configuration of: a) typical Bazooka balun; and b) the designed balun with dimension.

Parameters	d1	d2	L1	L2	L3
Length(mm)	1	2	10	31	16

TABLE II. DIMENSION PARAMETERS OF BAZOOKA BALUN

The fabricated balun was made based on the ".141 TIN-W-P-50" according to the RF Cable list of Jyebao company [9], which has the dimensions of 0.91 mm; 2.98 mm and 3.58 mm of center conductor, dielectric and outer conductor diameter, respectively. Besides, this coaxial line has the 50 Ohm load impedance which can totally match the impedance of the antenna. The balun was then soldered with the antenna and measured to validate the design. Figure 6 displays the antenna with the balun in CST MWS simulation and in real device.

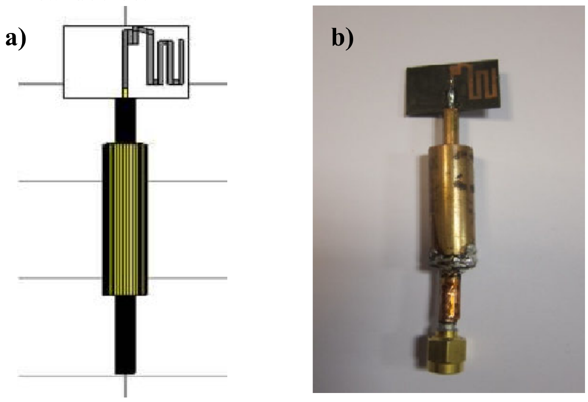

Figure 6. Dipole antenna with balun in: a) Simulation and b) real device

First the antenna with balun was simulated in CST and compared with the old result of the case without balun. In Figure 7, the simulated graphs of the two cases were displayed.

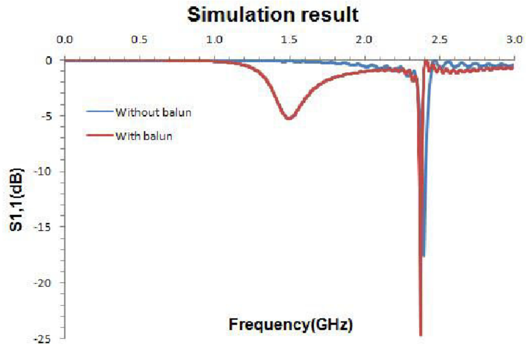

Figure 7. Simulation results of antenna with and without balun

The simulation result of the case with balun does not totally match well with the simulation result of the antenna on its own. The bandwidth is smaller, the value of $S_{1,1}$ is smaller (around -25dB) and there is a small peak at -5dB at 1.5 GHz. When we did the simulation with the dimension of balun, the result was affected by all values of the balun. The value L2, which is the metal sleeve length was quarter wave. Hence, 31 mm is appropriate for this case and when doing simulation, this value is very good to make the $S_{1,1}$ below -10dB. The sensitivity to variations of d1 and d2 is small. In order to make a better balun and put the form of the $S_{1,1}$ curve as much like the case without it, L2 and L3 can be changed. Certainly, all the dimensions can be optimised and tested with more sets of values to investigate their applicability [10][9].

After simulation and design, the measurement was performed to evaluate the performance of the antenna with the designed balun. Measurement results were obtained and compared in the two cases: (1) with and (2) without balun.

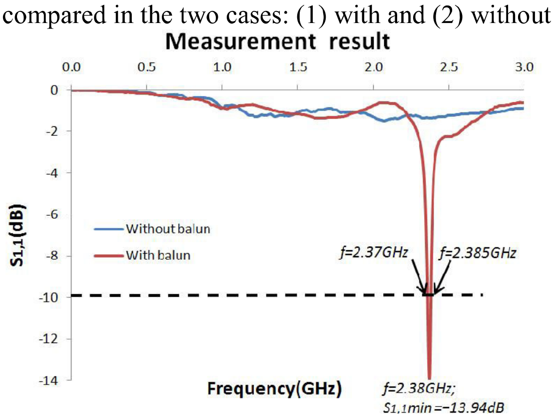

Figure 8. Measured $S_{1,1}$ of the antenna with and without balun

As we can see from Figure 8, if there is no balun, there is no peak or remarkable change at around 2.4 GHz. When the balun is added, the measured $S_{1,1}$ displays a peak at 2.38 GHz at the value of -13.94dB, which is much better than the case without balun. This proves clearly the impact of RF feed to our small antenna and the Bazooka balun can efficiently prevent the outer current effect. The bandwidth here is only 0.015 GHz which is smaller than the simulation case without balun because the bandwidth was changed due to the balun. Typically a balun can be used at 10% relative bandwidth [8].

The radiation pattern of the corrected antenna with balun was simulated at 2.4 GHz, which is shown in Figure 8.

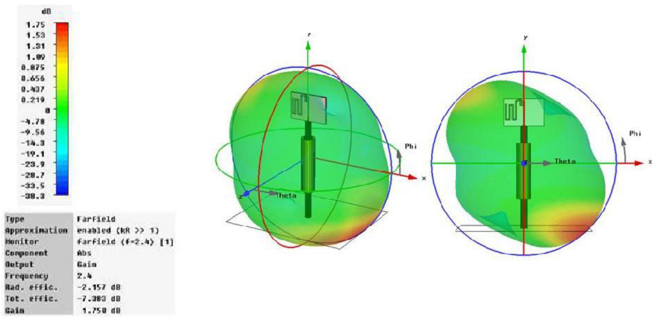

Figure 9. Radiation pattern of the dipole antenna with Bazooka balun

Figure 9 shows 3D of the power radiation pattern of the antenna in terms of Theta angle. The form of the pattern is nearly omnidirectional around the antenna; however, the balun here covers a large sector of the pattern. Although the balun was used to reduce the cable effect, due to the short-circuited part of coaxial line on the balun and the near field coupling into the cable which is the connector to the measurement setup, the radiation pattern can be affected significantly. Besides, any cables and lines has their own electromagnetic fields, which is able to contribute to the total radiated power.

The measurement of the three dimensional (3D) farfield radiation pattern of the antenna was implemented in a scanning system in an anechoic chamber in our IMEP-LAHC laboratory. As a result of preventing all electromagnetic fields, in the measurement setup, all the cables and lines which are made of metal were tried to be masked by the carbon-pearmeated pads in order to be absorbed all unnecessary fields and radiation. The balun was still used to connect with the radio frequency (RF) cable in order to keep the antenna from outer current. Only the antenna was illuminated by the plane wave from farfield. A vector network analyzer placed outside the chamber was connected to the antenna to measure. Three dimensional measurement results were displayed in Figure 10.

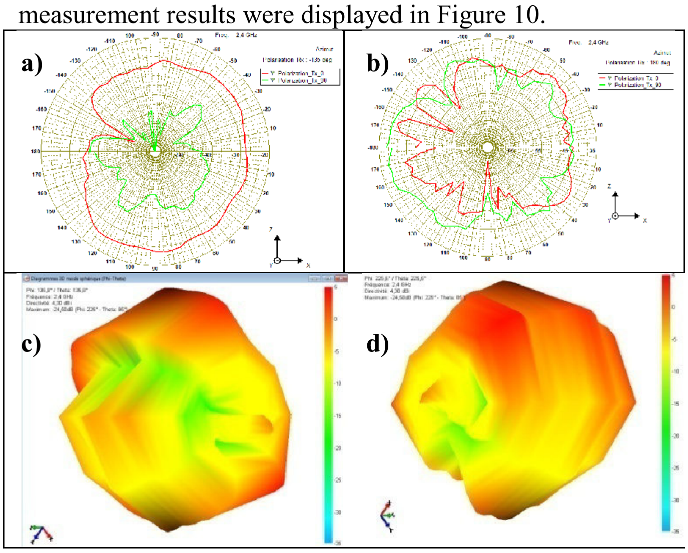

Figure 10. Measured radiation patterns of the dipole antenna in : 2D (a and b); and 3D (c and d)

In Figure 10, the radiation pattern was measured at 2.4 GHz. The form of the radiation pattern measured shows that it is nearly but not totally omni-directional. The measurement result is not as perfect as the radiation pattern of the simulation of the case without balun, which could be due to the design of the antenna having 2 geometries in 2 sides. However, the pattern as a whole is nearly spherical like in simulation. As compared to the simulation of the case with balun, the measured radiation pattern looks much better. Despite searching any methods to reduce all electromagnetic effects, the bulky cables inside the chamber connecting with the outside machines can be a problem. Still, the system needs to be optimized and tested for better applicability and utilisability.

V. CONCLUSION

A printed small dipole antenna on polymer substrate was designed, simulated and successfully fabricated. For the case of small antenna, it is common that the cable effects have impact on the measurement. In our project, a solution based on the quater wave length balun was used. With such balun, $S_{1,1}$ and radiation pattern parameters were successfully measured. The results obtained from simulation and measurement shows that this antenna is a good candidate for applications on the tactile display devices.

VI. ACKNOWLEDGEMENT

The authors would like to thank Antoine Gachone of IMEP-LAHC laboratory for the fabrication of the antenna and construction of the Bazooka balun. They would also like to thank Nicolas Corrao for kind help and useful comments in their practical measurements.

REFERENCES

[1] K. Ito, “Keynote 2: Microwave antennas for medical applications,” presented at the RF and Microwave Conference, 2008, Kuala Lumpur, 2008, pp. 2–2.

[2] P. Morgan, “Laser-Equipped Wheelchairs Let the Blind ‘See’ Obstacles in Their Path | Discoblog | Discover Magazine.”[Online]. Available: http://blogs.discovermagazine.com/discoblog/2011/05/19/laser-equipped-wheelchairs-let-the-blind-see-obstacles-in-their-path/. [Accessed: 28-Oct-2012].

[3] H. Morgan, “Blind person with GPS navigation system.” [Online]. Available: http://www.sciencephoto.com/media/267008/view. [Accessed: 28-Oct-2012].

[4] P. Bach-y-Rita, “Theoretical basis for brain plasticity after a TBI,” *Brain Injury*, vol. 17, no. 8, pp. 643–651, Jan. 2003.

[5] P. Bach-y-Rita and K. A. Kaczmarek, “Tongue-Placed Tactile Output Device,” U.S. Patent 6430450.

[6] J. L. Silberberg, “Radio frequency interference with medical devices: A Technical Information Statement.,” *IEEE Engineering in Medicine and Biology Magazine*, vol. 17, no. 3, pp. 111–114, 1998.

[7] F. C. Andres, “Practical considerations for PCB Antenna simulation in CST MWS.” http://www.cst.com/Content/Events/workshop_documents/2012/CST-WSHP_2012_Barcelona_Ikerlan_f-Casado_Redsize.pdf, 2012.

[8] C. Icheln, J. Krogerus, and P. Vainikainen, “Use of Balun Chokes in Small-Antenna Radiation Measurements,” *IEEE Transactions on Instrumentation and Measurement*, vol. 53, no. 2, pp. 498–506, Apr. 2004.

[9] “RF Cable.” http://www.jyebao.com.tw/files%20download/SEMI-RIGID.pdf.

[10] C. Icheln, J. Ollikainen, and P. Vainikainen, “Reducing the influence of feed cables on small antenna measurements,” *Electronics Letters*, vol. 35, no. 15, p. 1212, 1999.