NOVEL WEARABLE RADIO-FREQUENCY ANTENNAS BASED ON WOVEN CONDUCTIVE FABRICS

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OUTLINE

- **Introduction**
- Proposed Materials and Fabrication Process
- Dipole and Bowtie Antennas
- Genetically Optimized Cage-Dipole Antennas
- Further Work
- Conclusion

INTRODUCTION

- Antennas fabricated with traditional materials and methods don't respond the needs of some new applications.
- These applications include
  - activity and health monitoring,
  - energy harvesting,
  - body centric communications,
  - identification.
- This presentation focuses on radio-frequency identification (RFID) applications.

CASHIER-LESS STORE WITH RFID STICKERS

[Inside the RFID Stickers from a Chinese Cashier-less Store, Strange Parts Youtube Channel]

WHAT IS RFID?

- It is a very low-cost solution to identify the objects.
- System includes readers, which reads the data declared by the RFID IC's.
- To read an RFID tag, reader activates the IC by sending a signal.
- RFID tag transmits a signal by taking the energy from the signal that reader sends.
- Each IC has a different ID, which makes possible to differentiate tags from each other.
- Generally, they are used between 860-960MHz.

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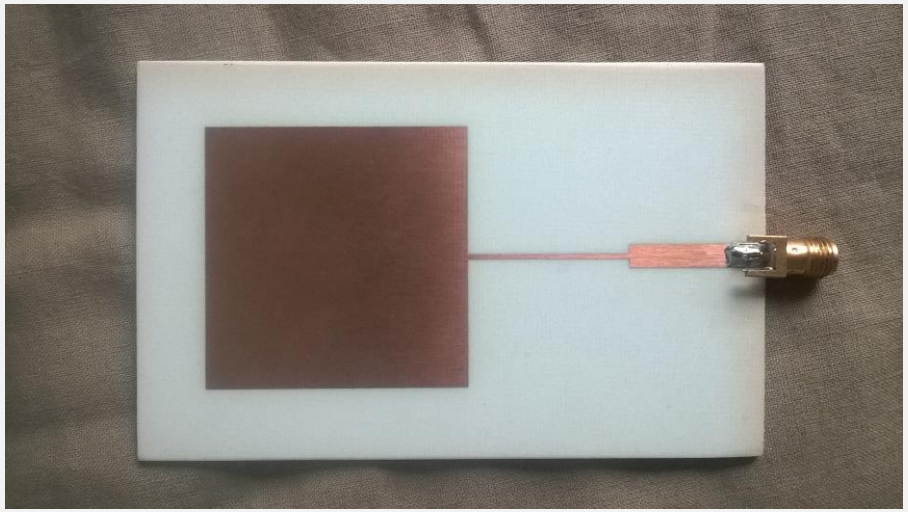
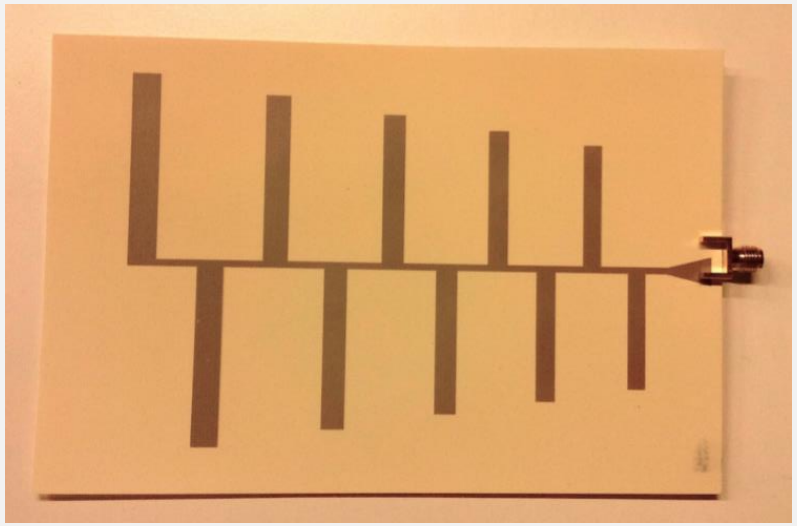
TRADITIONAL VS PROPOSED MATERIALS
A-*INKJET PRINTED PAPER ANTENNAS*

PCB ANTENNA



INKJET PRINTED PAPER ANTENNA



T. Dolapçı, F. Mutlu and Ö. Ergül,
"Design, simulation, and fabrication of broadband inkjet-printed log-periodic antennas,"
2017 IV International Electromagnetic Compatibility Conference (EMC Turkiye), Ankara, 2017, pp. 1-6.

PROPOSED FABRICATION PROCESS FOR INKJET PRINTED PAPER ANTENNAS

INKJET PRINTER

SINTERING OVEN

TRADITIONAL VS PROPOSED MATERIALS
B-WEARABLE TEXTILE ANTENNAS

COPPER WIRE/PLATE

CONDUCTIVE FABRIC

PROPOSED FABRICATION PROCESS FOR WEARABLE TEXTILE ANTENNAS

LASER CUTTER

CONDUCTIVE GLUE

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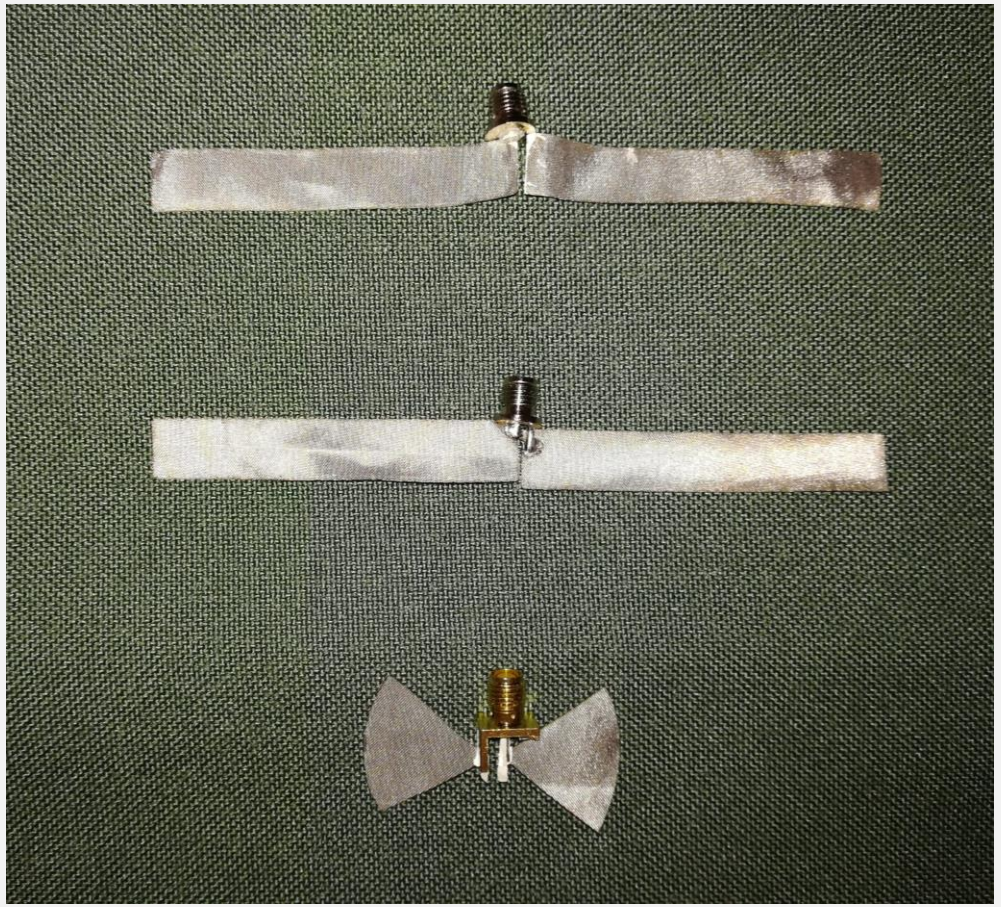
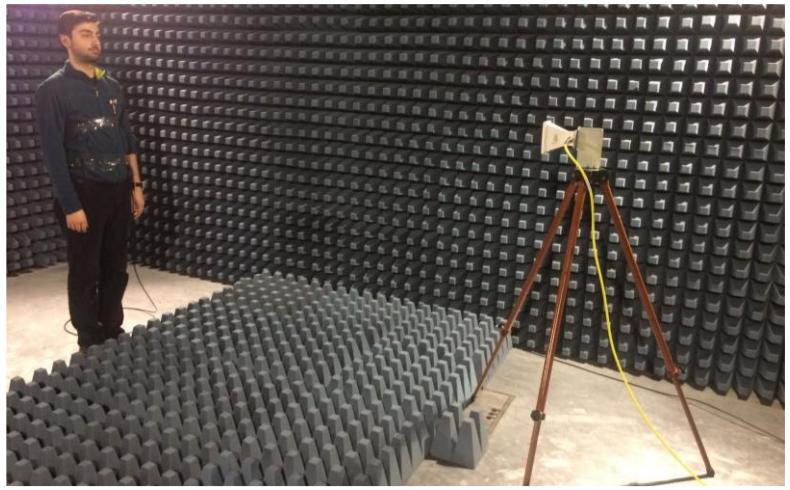
DIPOLE AND BOWTIE ANTENNAS

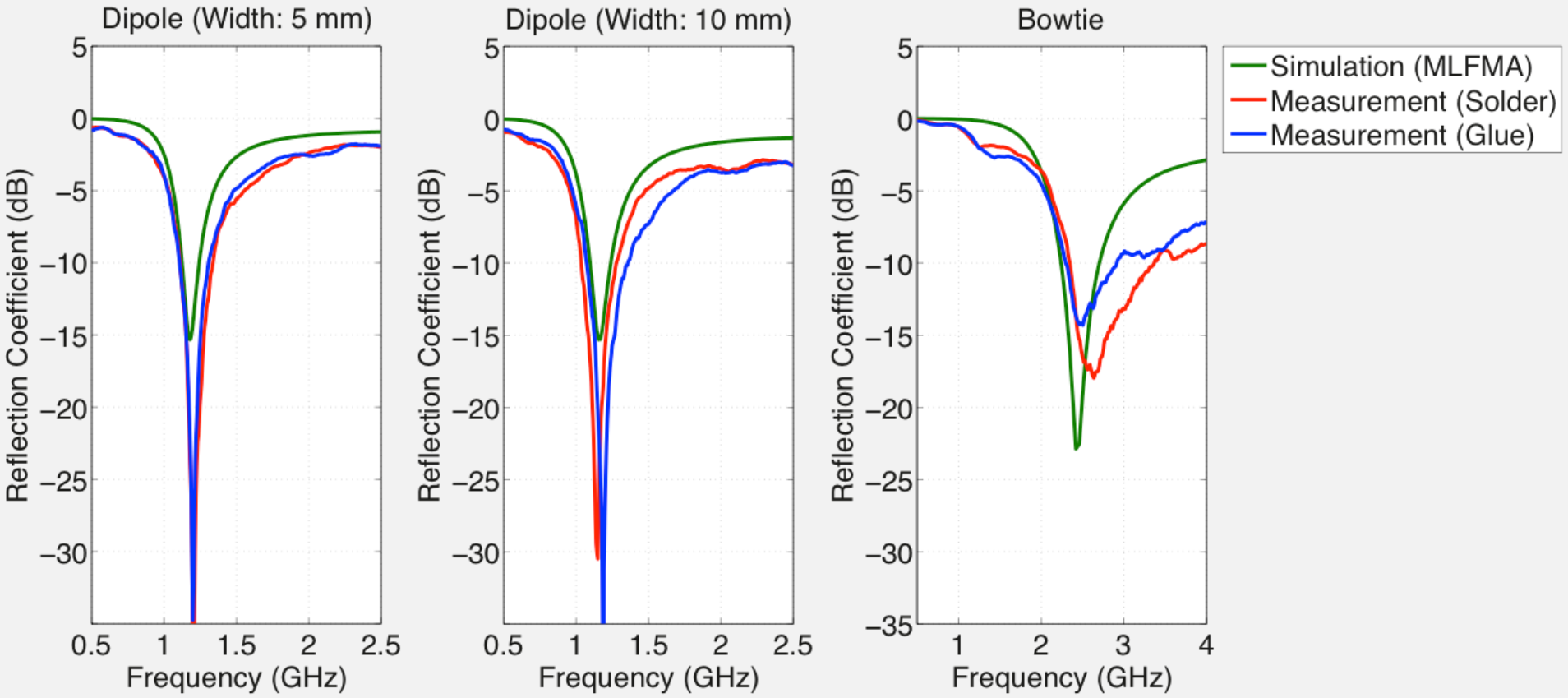
- Simple antennas designed and fabricated with proposed materials and method.
- Adafruit woven conductive fabric is used as conductive material.
- Soldering damages the fabric most of the times.
- Instead of soldering, silver alloyed PCB repair glue is used.



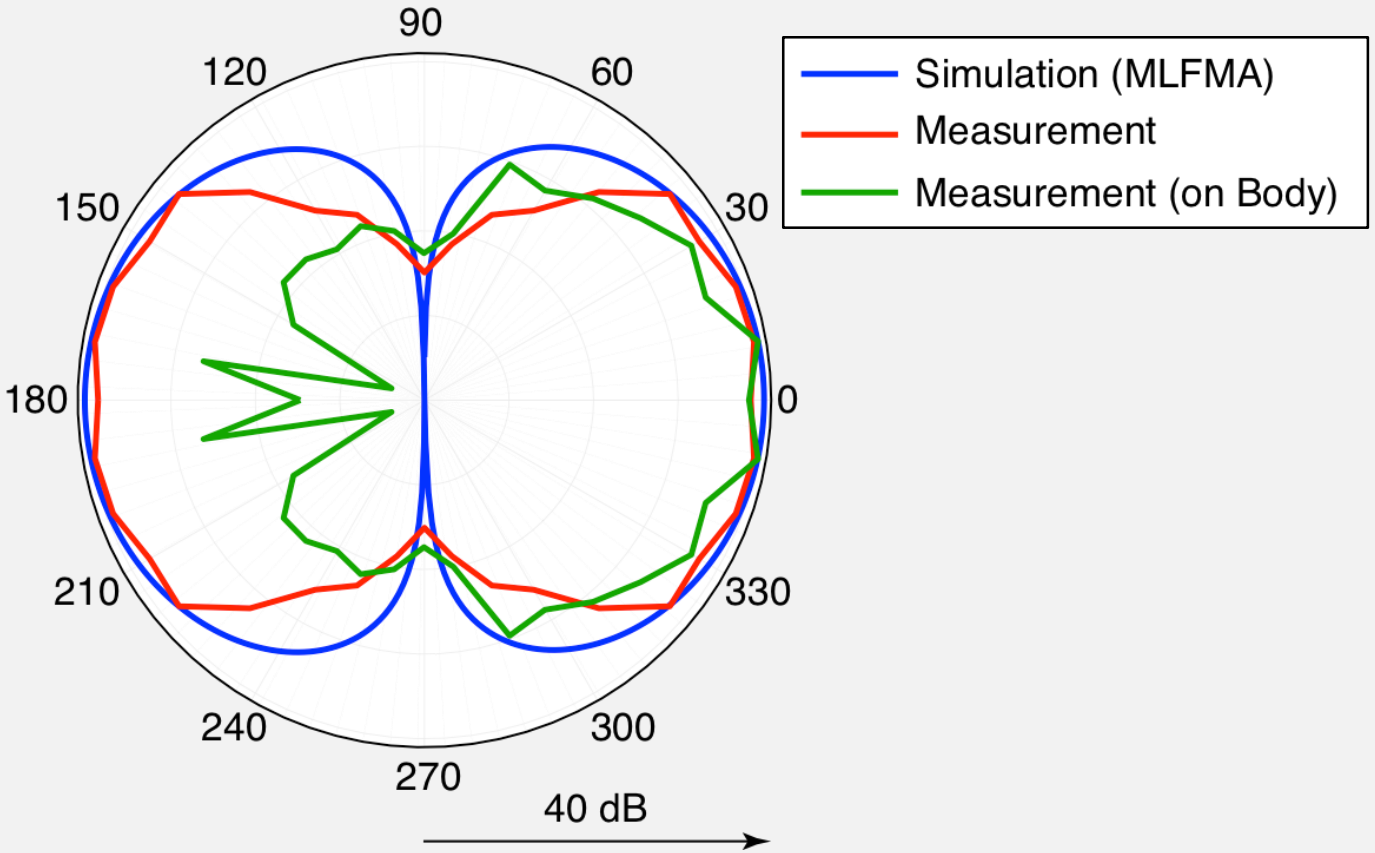
MEASUREMENT OF DIPOLE AND BOWTIE ANTENNAS



REFLECTION COEFFICIENT OF DIPOLE AND BOWTIE ANTENNAS



GAIN OF BOWTIE ANTENNA



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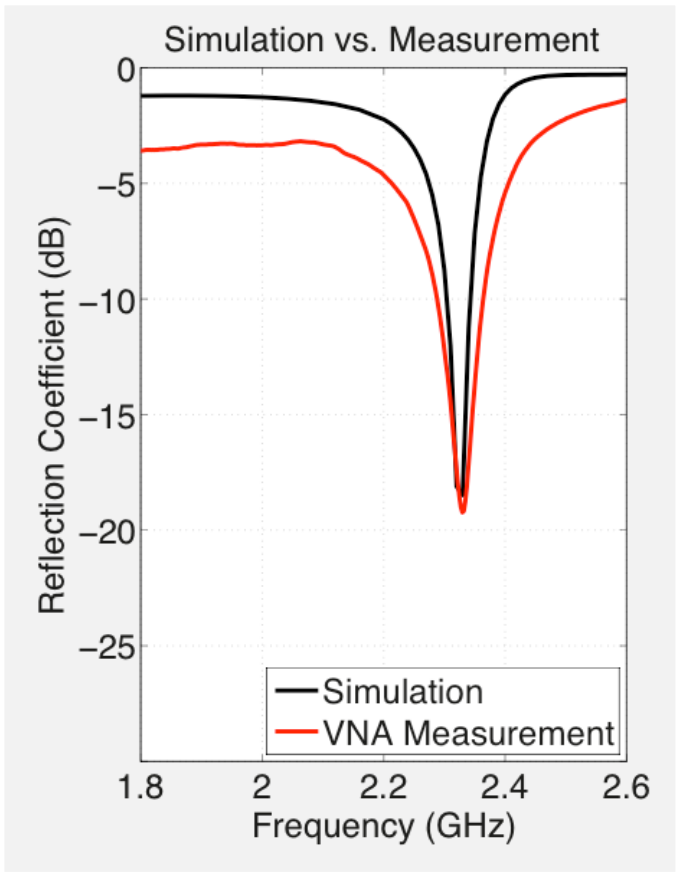
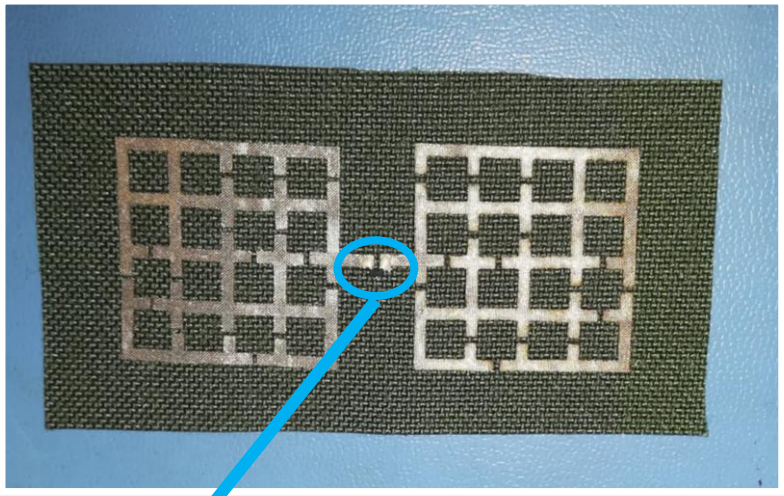
CAGE-DIPOLE ANTENNA WITH SMA CONNECTOR

- Reflection coefficient of the antenna minimized for 50Ω port impedance aproximately at $2.4GHz$.
- SMA connector is glued to fabricated cage-dipole.
- Measurement and simulation results demonstrate very well agreement.



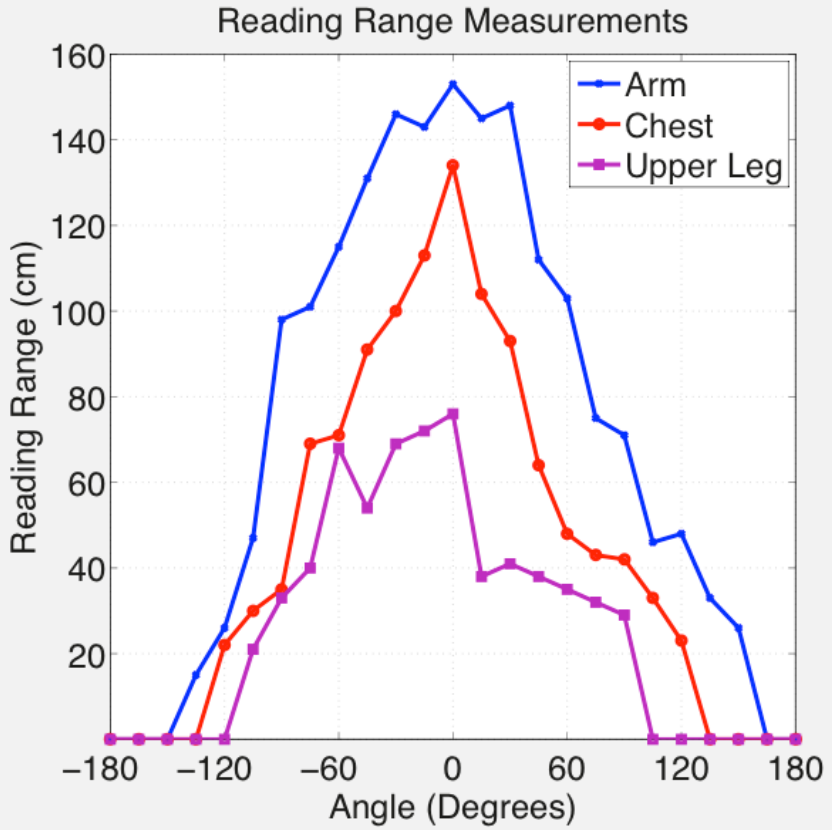


CAGE-DIPOLE ANTENNA WITH RFID IC

- Alien Higgs-3 UHF RFID IC is used.
- Input impedance of IC is $20.55 - j191.2\Omega$ @$865MHz$.
- Designing a good antenna for this IC without an optimization tool is very hard.
- GA-MLFMA combination results with an antenna matched to IC.
- Simulation result of reflection coefficient is less than $-20dB$.

ON-BODY MEASUREMENT RESULTS OF CAGE-DIPOLE RFID ANTENNA

$$Free\ Space\ Measurement\ Range \cong 370cm$$



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CONCLUSION

- In this study, new materials are used succesfully to fabricate antennas to meet the requirements of novel technologies.
- Antenna design process is shortened thanks to the abilities of the simulation environment which is a combination of MLFMA and GA.
- Obtained results and continuing studies make further studies' future bright.

FURTHER WORK

- Find new materials to build antennas from EE literature, and by cooperating with material scientists and textile experts,
- Characterize the target materials, and test whether those materials are appropriate or not to build antennas,
- Compare the new materials with the older ones like copper wires, silver ink and woven fabric,
- Build basic antennas with new materials in free space and on human body,
- Build more complex antennas and add RFID IC's,
- Try to improve the simulation and measurement environment by comparing the simulation and measurement results with each other.

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Mediterranean Microwave Symposium

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(QR provided)

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THANKS FOR YOUR ATTENTION!