Guest Editorial
Special Issue on IEEE RFID 2020 Conference

PERHAPS more than anything, our *digital connectedness* was made evident during these recent years. In what became a historic first ever all-virtual meeting for the annual IEEE RFID conference, in October of 2020 researchers and practitioners from across the globe met in a virtual space to discuss how to bridge the physical and the digital. As RFID technology continues to mature and evolve, we are beginning to see how RFID systems can integrate with IoT infrastructure and meet the growing demand for crossing the physical/digital divide.

RFID technology itself, broadly encompasses many fields. As this technology marches onwards towards its theoretical limits, there remains need for antenna designs, chip designs, microwave techniques, communications systems, protocols, embedded controllers, systems integrators and much more. In recognition of this broad scope, the IEEE Council on RFID (CRFID) works with its fifteen IEEE member societies to support ongoing research efforts for RFID and RFID-related systems. With the Journal of Radio Frequency Identification (JRFID) serving as a premiere publication venue, and the ongoing formation of Technical Communities and working groups, there remains a bright future for RFID systems.

Since the launch of the IEEE JRFID in 2017, each year the journal features a special issue that presents extended versions of articles that were featured in that year's RFID conference. The eight papers in this issue are extended versions of those featured in the IEEE RFID 2020 conference that took place virtually October 5–9, 2020. While originally scheduled for May 2020, many authors took advantage of a second round of submissions that opened that summer. The papers in this issue are written by researchers from six countries: Austria, Brazil, Japan, New Zealand, the United Kingdom and the USA. The topics range from antenna design, mobile robotic platforms, NFC testbeds, energy harvesting circuits, and localization estimation.

In [A1], Wan *et al.* present a testbed for retail stores where many items may be tagged. When many tags are present, traditional algorithms begin to fail due to the congestion. The paper describes a motion detection algorithm, based on phase and RSSI, to separate the moving tags—and their associated items—from the stationary tags. The results are certainly of interest to anyone looking to integrate RFID tags and technology into a densely populated retail environment.

In [A2], Erb *et al.* tackle the issue of near-field RFID technology interoperability. Their solution lowers the barrier for interoperability testing and provides richer results beyond a binary pass/fail. With this system it is possible to debug entire communication exchanges and examine how various variables affect performance. Their modular framework will certainly aid NFC developers in their efforts and encourage others to take a closer look at this area and continue expanding interoperability testing.

In [A3], Mitsugi and Kawakita use commodity hardware in the form of softare defined radios (SDRs) to perform simultaneous inventory of UHF RFID tags as well as angle of arrival (AoA) estimation. While typical AoA systems require a large amount of hardware and synchronization, the authors are able to instead switch combinations of receiving antennas within the SDR systems in order to calibrate and perform phase cancellation. Using their SDRs, Gen2 inventory rounds are performed while achieving less than three degree phase offset error.

In [A4], Parthiban designs a UHF antenna intended to operate in doorway portal applications. The antenna can operate from the corners of the doorway and is beem-steerable through phase-delay of the array elements. This antenna is designed to be small and unobtrusive and works within the constraints of the European bands in the 865–868 MHz spectrum.

In [A5], Cantalice *et al.* revisit the power harvesting circuit for a near-field RFID transponder. Using feedback loops and a PWM circuit, their work shows an increase in available power to device as well as read range. Not only was this simulated, but also experimentally verified with a fabricated chip in a 180 nm CMOS process. For magnetically coupled transponders, this is an important improvement.

In [A6], Qi *et al.* continue their work showing new uses for a seemingly forgotten technology: tunnel diodes. Not only can tunneling tags yield a higher operating range compared to traditional RFID tags, this paper shows that even in non-line of sight scenarios tunneling tags still outperform their counterparts while simultaneously offering an improved location estimation accuracy using phase-based positioning.

In [A7], Liu *et al.* present a localization method for a mobile robotic platform. This system exploits reference tags with known locations to enable the robot to estimate its position. This is achieved by an inverse synthetic aperture radar method in which the robot uses the phase from the reference tags to update its trajectory. Using their technique, the authors show their robotic platform can navigate with an improved localization accuracy over the state of the art.

In [A8], Sun looks at the issue of security for an RFID tag. Instead of focusing on cryptography and data encryption, this work makes it possible to completely block a tag from being read at a reader. This is achieved by using a relay that is capable of analyzing the signals it receives, and then

Digital Object Identifier 10.1109/JRFID.2021.3125390

transmits its own signal to the reader that effectively cancels the tag's responses. However, the system could instead choose to boost the signal (via constructive interference) at the reader, increasing the tag's effective read range.

These papers represent a sample of the variety of papers presented at the RFID conference: from near-field systems, to UHF antenna design, to security measures, and localization. We have seen how important the digital side of our lives has become, and RFID will continue to grow, evolve and work to bridge the physical and the digital. The new ideas and challenges this growth brings is welcome by those who research and explore the technology surrounding RFID systems.

APPENDIX: RELATED ARTICLES

[A1] C.-Y. Wan, C. Tanriover, and R. C. Shah, "Utilizing RFID tag motion detection in high tag density environments for customer browsing insights," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 345–356, Dec. 2021.

[A2] M. Erb, C. Steger, M. Troyer, and J. Preishuber-Pflugl, "A framework for automated NFC interoperability test systems," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 357–367, Dec. 2021.

[A3] J. Mitsugi and Y. Kawakita, "Simultaneous Gen2 inventory and angle of arrival measurement of backscatter signals with multiple commodity SDRs," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 368–377, Dec. 2021.

[A4] P. Parthiban, "Right-angled V-shaped conformal dual-patch antenna array for RAIN RFID doorway portals," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 378–386, Dec. 2021.

[A5] R. Cantalice, F. P. A. Cortes, E. Fabris, S. B. Ferreira, and H. Klimach, "Two-feedback loop shunt regulator based on PWM RF power detector aiming RFID applications," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 387–396, Dec. 2021.

[A6] C. Qi, F. Amato, B. Kihei, and G. D. Durgin, "Fine-scale phase-based ranging through walls and obstructions using tunneling RFID tags," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 397–406, Dec. 2021.

[A7] Z. Liu, Z. Fu, T. Li, I. H. White, R. V. Penty, and M. Crisp, "An ISAR-SAR based method for indoor localization using passive UHF RFID system with mobile robotic platform," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 407–416, Dec. 2021.

[A8] W. Sun, "Destructive and constructive full duplex relaying for commodity RFID system," *IEEE J. Radio Freq. Identif.*, vol. 5, no. 4, pp. 417–426, Dec. 2021.

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