Radio Frequency Identification

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Radio frequency identification (RFID) is widely used in several contexts, such as logistics, supply chains, asset tracking, and health, among others, therefore drawing the attention of many researchers.

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1. Introduction

It is expected that technology will work for us in more transparent and ubiquitous ways. RFID is implemented in many contexts, such as logistics [1][2], supply chains [3][4], asset tracking [5][6][7], healthcare [8][9], industrial enterprise environments [5][6], and many others, making our lives easier and generating vast quantities of information on many levels.

2. RFID Applications

RFID technology is making its way into various fields, sometimes keeping a low profile. However, it is becoming more relevant in people's lives, creating paths to new applications and complementing known ones. In some cases, these applications do not directly interact with people, but RFID supports different processes for realizing products and services used daily. Accordingly, with reason, RFID is sometimes seen as a requirement or core technology for the Internet of things (IoT). This is affirmed by the total documents published on this topic, positioning IoT well above other applications. RFID supports many applications of the Internet of Things due to characteristics such as high volume, non-contact reading, tag features and, more importantly, low price. The situation is clearly reflected in the graphs (a) and (b) in Figure 1, with the more prominent indicators in Table 1.

In second place, we have supply chain management, in which RFID is essential for identification and information capture for real-time management, using different methods such as frameworks and protocols. This allows high versatility due to the variety of tags available; all these processes are continually studied to solve security issues and possible vulnerabilities. RFID is also used in localization applications, extending the primary function of the technology, representing the second-largest activity in terms of the percentage of documents in last years (PDLY), as shown in Table 1. For traceability and logistics, RFID supports a variety of applications in supply chains and shop floor deployment. RFID is opening paths to new applications in an ever more ubiquitous fashion, blending into our lives much more, such as in healthcare spaces for ensuring data security and allowing more robust

management of patients, equipment, and personnel. Similarly, it is applied to support the control of access to physical spaces and systems or enforcing the control of access to information captured by different sensors along with RFID. All these findings are presented in detail in the following sections and represented graphically in Figure 1. This chapter presents the top research applications identified through the scientometric analysis.

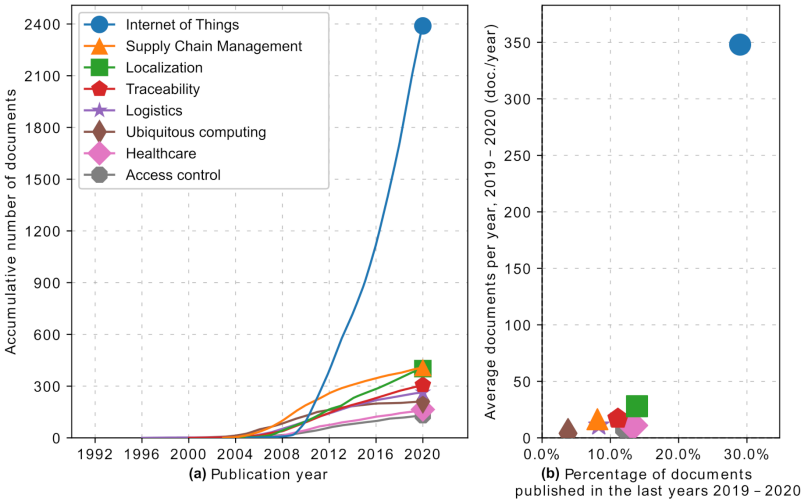

Figure 1. (**a**) Top applications, and number of publications by year. (**b**) Average number of publications per year and percentage of documents published between 2019 and 2020.

Table 1. Top author keywords for RFID applications.

Pos	Author Keywords	Total	AGR	ADY	PDLY	h-Index
1	Internet of Things	2399	8.0	348.0	29.0	73
2	Supply Chain Management	408	1.0	16.5	8.1	49
3	Localization	402	−4.5	28.0	13.9	32
4	Traceability	307	−1.5	17.0	11.1	29
5	Logistics	264	−1.5	11.0	8.3	20
6	Ubiquitous Computing	210	0.5	4.0	3.8	25
7	Healthcare	165	1.0	11.0	13.3	23
8	Access Control	131	2.0	8.0	12.2	14

3. Facts about RFID

Applications of RFID technologies were found in many contexts, from asset identification to tracking for industrial [5][6] and general [7] public environment applications, for instance, indoor applications [10][11], robot navigation [12][13][14][15], and the positioning of objects, even those not visible [16][17][18]. Ultra-wideband has been used to overcome

some of the current problems with narrowband frequencies [19][20]. Additionally, it helps organizations with management and safety for construction [21][22] and pushes the limits of transmission signals' ability to enhance the quality [23][24][25][26] in different frequencies [6][20].

We found privacy and authenticity to be of utmost concern [27][28][29]. Herein, we focused on the most active RFID applications based on scientometric variables, resulting in eleven groups. The applications characterized for this technology especially concern the IoT, which supports the idea that RFID is a key requirement for the Internet of Things [30][31][32]. We also found RFID to be applied in supply chains [33][34], providing ways to detect counterfeiting [35][36] and keep track of any asset [37][38][39][40][41]. The most active security topics appear to be testing the existing protocols to search for flaws, ways to solve them [42][43][44][45][46][47][48], and balancing privacy and performance for different scenarios [49][50][47][48][51]. It was found that privacy and security are of general concern, almost in all applications. In addition, it was noted that healthcare is a topic that shows a positive AGR in the results, and it includes RFID in different related operations [8][9][52][53][54][55][56][57][58][59][60][61][62][63]. RFID is also used in access control, such as for managing access to spaces and systems [44][64][65][66][45][46], and its use in the human body has also been explored from different perspectives [67][68][69].

RFID is used in diverse scenarios and continues to grow in its applications and functionalities, such as working with wireless sensors and IPv6, the new addressing system for the IoT, expanding its frequencies wherein technological advances are permitted (currently to ultra-wideband). Thus, this technology can find emerging utility in RF, electronics, and security, and it is not an exaggeration to state that RFID will be the technology that will allow reaching the point, through the IoT, where every existing object will be able to be connected to the Internet.

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