

ADDITIONAL USE CASES FOR RFID TAGS by implementing 3D printed pushbutton functionalities

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Abstract — Passive ultra-high frequency (UHF) radio frequency identification (RFID) tags can be embedded to objects and to the surrounding environment for identification and sensing. The potential of the technology can be further increased by designing new features, such as push-button functionalities, to the tags. In this study, the additional features were created in a unique way through 3D printing. In this paper two prototype RFID push-buttons were created. Both prototype devices were found to be fully functional. Care professionals were gathered to ideate versatile future use cases for the developed push-button prototypes as assistive technology. New possibilities for using the buttons were identified especially for persons with limited cognitive and physical capabilities.

I. INTRODUCTION

The battery usually constitutes the limiting factor for the operating life of a battery-powered system and poses concerns over the safety, human health, and environmental pollution, alongside the risk associated with its disposal, as the potential severity of incidents during storage and recycling of waste batteries can be higher than in end-use applications [1]-[2].

In contrast, a passive ultra-high frequency (UHF) radio frequency identification (RFID) tag-based push-button would get its operating power by harvesting energy from the signal received from the RFID reader which, combined with its other features, such as light weight and low cost, make it a sustainable technology. Passive UHF RFID tags can be activated/deactivated, i.e., made readable/non-readable to an RFID reader by a human influence [3]. These properties also make the technology an attractive solution to be implemented to human-technology interfaces and games [3]-[5].



Fig. 1. Ready-made passive UHF RFID-based pushbutton prototypes, the first prototype with case open (right) and the second prototype (left).

II. PROTOTYPES

The prototypes were made with commercial Avery Dennison Smartrac series passive UHF RFID tags. One millimetre gap was cut to the antenna close to the chip. For the first prototype, a commercial TE Connectivity tactile push-button was soldered to connect both sides of the cut gap in the antenna. A 3D printed 6.5 x 100.8 x 19.2 mm (h x w x d) package was manufactured as a protective case for the push-button and the RFID tag (Fig. 1.) For the second prototype, we wanted to omit the commercial tactile button and use 3D printed parts as much as possible. This would enable us to design an enclosure with a wider range of possibilities in the future. The case was 3D printed in the following way: over the cut gap on the antenna trace, there is a flexible plastic overhang with about 2 mm clearance to the tag. Under that overhang is attached a 1 mm thick and soft two-sided tape. The thin copper tape was stuck to the two-sided tape's side that is facing the antenna. According to the initial tests the prototypes seemed to work well. Both ready-made prototypes are presented in Fig. 1.

III. CO-DESIGNING USE CASES FOR PUSHBUTTON PROTOTYPES

Co-design approach was used to identify possibilities and problems in real use environment in which the buttons would add value. In co-design, users are typically involved in the early phase of the design process, and they are considered as experts of their own needs and experiences. In this study we involved various care professionals (n=6) from different care environments (psychiatric nurse, home care nurse, speech therapist, physiotherapists (2) and occupational therapist.). The prototypes were used as technology demonstrations to help to understand the potential of the technology. After presentation of the prototypes, care professionals ideas of the potential use cases were collected.

The same pushbutton was ideated to be used as a trigger of nurse call or alarm but also for producing speech (asking for certain food, saying yes/no when the button is pushed) or counting symptoms, exercises, medication take, toilet use and other events. Combined with a speaker, the button could voice instructions for relaxation, exercise, task performance and correct order of tasks, but also identify items and provide time orientation for the visually or memory impaired. For time orientation, a button could be placed near a calendar. A user with memory problems can see the button and upon pressing it, it would say the date (and time of the day) out loud. Other information, relevant for individuals with memory problems which is frequently repeated by healthcare professionals can be programmed in the button. Buttons are intuitive and thus easy to use even for people with declined memory or cognitive abilities. Versatile user groups that could benefit from this technology were mentioned. The number of buttons was also discussed and several colour-coded buttons with different meanings attached to them were seen having a potential.

There were many ideas to integrate the pushbuttons in various places such as in assistive aids, clothing, or furniture/environment (see Fig. 2 and Fig 3). Also, the reader equipment was discussed and there were ideas to integrate the reader as part of the environment (see Fig. 3) or it could be a portable device near the user (see Fig. 2). An idea was also to have the button pushed by other body parts than fingers, such as elbow or foot. The reason behind this is to promote better hygiene, especially when the same button is used by multiple users, but also to include users with disabilities that may prevent the use of fingers. Readers embedded into environment were seen as a good solution in case the push button would be used for environmental controlling. Pushbuttons were also seen to have potential in protective clothing or shoes to call for equipment or help, for example. In these use scenarios use of computers or other controlling devices could be impossible or risky (surgery, helping/supporting patient or other activities which require both hands). The pushbuttons could also be used as unnoticeable alarm buttons in environments in which there are clients with challenging behaviour. As presence sensors, the push-buttons could be used to monitor when and how long a person has been, for example sitting in an office chair or armchair, or lying in a bed in a ward or at home. As there could be timestamps, this might help in monitoring the circadian rhythm and lifestyle of a person without measuring physiological signals.

IV. CONCLUSIONS

This study presented the design and 3D manufacturing of two prototypes using passive UHF RFID tags in integrating the functionality of a pushbutton to 3D printed objects. Based on the results of the study, it is possible to 3D print wirelessly working buttons with individual features without the need for electrical connections. Based on the viewpoints of social and healthcare experts, there is vast number of applications in which 3D printed passive RFID pushbuttons could add value. The next steps are the design and manufacturing of special-purpose push-button objects, in which the RFID tag is embedded into the object during the printing process and thus the push-button is printed embedding the whole the object.



Fig. 2. Visualisation of a potential use scenario for passive RFID push buttons. Wearable nurse call and mobile reader equipment.



Fig. 3. Visualisation of a potential use scenario for passive RFID pushbuttons. Reader equipment integrated into the environment, in this case toilet in which the push-button is used to call for help.

The work was funded by the Academy of Finland (decisions 337863, 337861, 294534, 332168) and by the Marie Skłodowska-Curie Research and Innovation Staff Exchange Programme of the European Union, H2020-MSCA-RISE-2019 (under grant agreement No. 871183).

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