Agri-Snap: Designing Portable IoT Weather Monitoring System to Improve Farmer's Acceptance Towards Using IoT Technology on The Farm

S.A.B Anas[1*], R.S.S Singh[1], K.F.Samat[2], A.F.T Ibrahim[1]

[1]Faculty of Electronic and Computer Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[2]Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding author's email: aisyah@utem.edu.my

ABSTRACT: This paper presents Agri-Snap, a portable Internet-of-Thing (IoT) weather monitoring system with four dedicated sensor circuit blocks that integrates magnetic snaps into the blocks for easier assembly with the controller block. Agri-Snaps separates a typical IoT weather monitoring circuit connection into several electronic blocks. Each block can be magnetically snapped together to allows the farmers to understand how to assemble, self-troubleshoot and maintain the IoT weather monitoring system without requiring extensive understanding of IoT technology and electronic concepts. These features enable the farmers to improve their acceptance towards implementing IoT technology on their farm field. A user-experience experiment is conducted with ten participants to validate Agri-Snap's viability. The results showed that those participants positively rated Agri-Snap as attractive, easy to understand and assemble, exciting and innovative.

Keywords: *Agriculture; Human-Computer Interaction; Interaction Design*

1. INTRODUCTION

Smart farming based on IoT weather monitoring technology enables farmers to reduce waste and optimize productivity. Nevertheless, unfortunately, farmers in Malaysia are far from optimal and still use traditional farming practices, resulting in low crop yield [3]. Moreover, the lack of IoT weather monitoring technology exposure makes the farmers vulnerable to crop failure [2]. Hence, to improve the problem mentioned above, an easy-to-assemble and easy-to-maintain IoT weather monitoring system is required to increase the farmer chances of accepting, implementing and adopting the IoT technology in their farm field.

2. DESIGN AND IMPLEMENTATION

A typical IoT weather monitoring system for agriculture were seldom designed to ease assembly and maintenance but rather complex wiring design and difficult to understand. In contrast, Agri-snaps is a portable, 3D printed farmer-friendly IoT weather monitoring system consisting of two main component blocks; the controller block (Figure 1a) and sensor blocks (Figure1b). Each colour-coded sensor block is uniquely designed with an engraved sensor icon on top of each block and can be easily snapped together with the controller block using small magnets embedded in the block, as shown in Figure 1c. Without a basic understanding of IoT and electronics concepts, the design of Agri-snap (Figure 1d) can allow the farmers to understand how to integrate, self-troubleshoot and maintain the system in their farm field without requiring expertise on the farm site.

2.1 Magnetic snap and pogo pins

One key design decision was to allow the farmers to clearly understand how to assemble and easily set up the IoT weather monitoring system on their own. The electronic connection of Agri-Snap was inspired by the work of Bdeir on littleBits[1]. Like littleBits, Agri-Snap can be assembled by snapping small magnets of the controller block and the sensor block together, as shown in Figure 2. In addition, pogo pins were used and embed into the designed block to allow the current/signal to flow from the controller block to the sensor block and vice versa. The combination of magnetic snaps and pogo pins enabled solid contacts between the controller block and the sensor block, and therefore the current/signal can flow smoothly throughout the system.

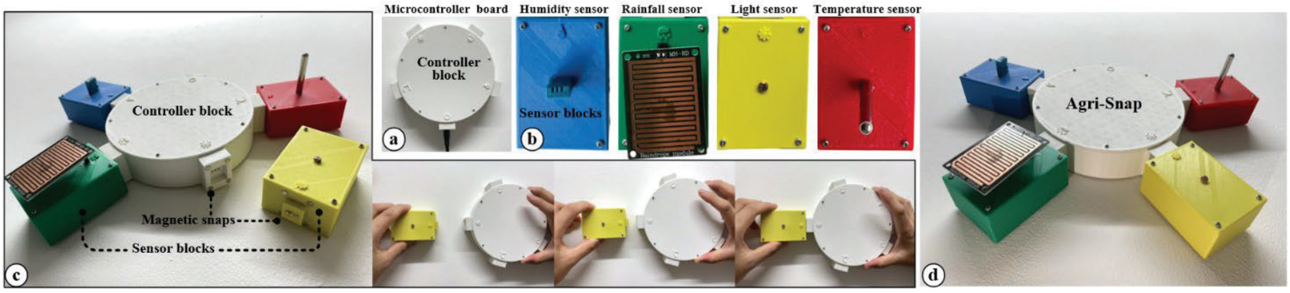

Figure 1 The design of Agri-Snap: a. The controller block b. Sensor blocks (from left: humidity sensor, rainfall sensor, light intensity sensor and temperature sensor) c. Magnetic snaps were embedded into Agri-Snap for ease-of-assembly and maintenance d. Fully assembled Agri-Snap.

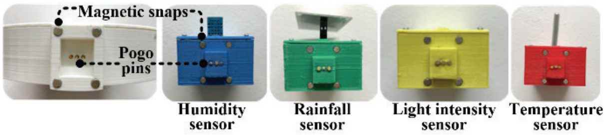

Figure 2 Magnetic snaps and pogo pins were embedded into the design of Agri-Snap to secure the connection between the controller block with the sensor blocks.

2.2 Weather icon and colour-coded

Another key design decision was to allow the farmers to recognize the functionality of each sensor easily and to which slot the sensor blocks should be snapped together with the controller block. As shown in Figure 3, each sensor block and each sensor slot at the controller block is engraved with weather icons. To snap the sensor block with the sensor slot at the controller block, the engraved icon at the sensor slot must match with the engraved icon at the sensor block.

Apart from that, each sensor block has different colour-coded to represent the sensors, such as blue block to represent humidity sensor, green block to represent rainfall sensor, yellow block to represent light intensity sensor and red block to represent temperature sensor. Hence, the prototype design allows the farmers to assemble, self-troubleshoot easily and maintain the IoT weather monitoring system on their own even without a basic understanding of electronic components.

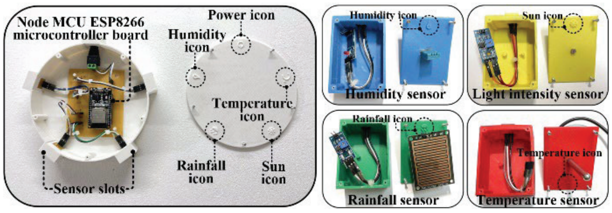

Figure 3 The physical design of Agri-Snap with engraved weather icon and dedicated colour-coded.

3. EVALUATION AND RESULTS

A user experience experiment was conducted with ten participants (age range: 23 to 25). All participants had no prior experience with IoT weather monitoring system, and they were required to assemble Agri-Snap independently. Afterwards, the participants were required to fill out a User Experience Questionnaire (UEQ) [4] to measure the participant's experiences with the Agri-Snap. The UEQ questionnaire allows a quick assessment of the user experience interacting with a product. It provides six subscales: 1) Attractiveness (refer to the physicality of the product), 2) Perspicuity (refer to which the product is easy to understand), 3) Efficiency (refer to how fast the product can be assembled), 4) Dependability (refer to the predictability when interacting with the product), 5) Stimulation (refer to which the product triggers excitement) and 6) Novelty (refer to whether the product is innovative and creatively designed). Each item of the UEQ can be rated on a 7-point Likert scale where −3 means the participants negatively evaluated the product, whereas +3 means the participants have a positive impression of the product. A neutral impression will fall in between −0.8 and +0.8.

Overall, the user experience towards Agri-Snap was positive, with all subscales of the UEQ exceed +0.8, as shown in Figure 4. The results proved that the participants experienced Agri-Snap as attractive, feasible, easy to assemble, interesting, exciting and innovative.

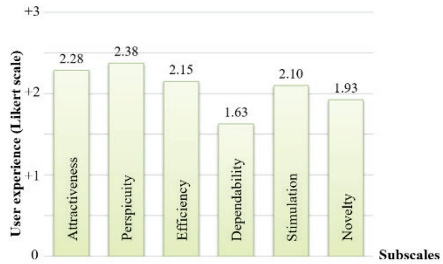

Figure 4 Overall results for UEQ items, per scale.

4. DISCUSSION AND CONCLUSION

As shown in Figure 4, Dependability was the least positive evaluated subscale. Some participants might have a problem predicting where the sensor blocks should be snapped together with the controller block. It can be speculated that perhaps it is difficult to distinguish the engraved weather icons at the controller block due to the white colour of the controller block. Therefore, to improve Agri-Snap's design, instead of referring to the weather icon, the colour of the sensor slots can also be changed following the colour code of the sensor blocks, respectively. This design solution will instantly allow the user to depend on the colour code when assembling the Agri-Snap. Nonetheless, the design of Agri-Snap has been positively accepted by the participants.

ACKNOWLEDGEMENT

The authors are grateful to Universiti Teknikal Malaysia Melaka for the financial support through PJP/2020/FKEKK/PP/S01759.

REFERENCES

[1] Bdeir, A. Electronics as material: littleBits. Proc. TEI 2009, ACM Press (2009), 397-400.

[2] D. Glaroudis, A. Iossifides, and P. Chatzimisios, "Survey, comparison and research challenges of IoT application protocols for smart farming," Comput. netw., vol. 168, 2020, p. 107037.

[3] J. R. Sa'ari, J. Jabar, M. N. H. Tahir, F. R. Azmi, N. A. Razak, M. Wee, N. H. Marmaya, and F. Mashahadi, "Farmer's acceptance towards sustainable farming technology," Turkish Online Journal Of Design Art And Communication, vol. 8, 2018, pp. 824–831.

[4] Laugwitz, B.; Schrepp; M. & Held, T. (2008), "Construction and evaluation of a user experience questionnaire", in Holzinger, A. (Ed.): USAB, 2008, pp. 63–76.