













touch detection, received signal processing, MCU system, the processing software related to event detection and the server-side coupling environment, which decodes and shares the touch event environment, are described. Functionality of acoustic-sensing-based touch detection is built into each thing; the individualized touch reaction degree according to the user and feature of a medium is analyzed; programmable interfaces for providing user reactions and services corresponding to specific touch event are introduced; the structure of dynamic coupling control for Matlab/Simulink is realized and the possibility of the proposed structure that makes the touch of things individualized at the user/supervisor level is presented.

### CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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### REFERENCES AND NOTES

- [1] Y. Makino, A. Kamigori, and T. Maeno, "Wireless wearable vibration sensor for touch-based life log system," in *Networked Sensing Systems (INSS), 2012 Ninth International Conference on*, June 2012, pp. 1–4.
- [2] T. Collins, "Active acoustic touch interface," *Electronics Letters*, vol. 45, no. 20, pp. 1055–1056, September 2009.
- [3] P. Lopes, R. Jota, and J. A. Jorge, "Augmenting touch interaction through acoustic sensing," in *Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces*, ser. ITS '11. New York, NY, USA: ACM, 2011, pp. 53–56. [Online]. Available: <http://doi.acm.org/10.1145/2076354.2076364>
- [4] D. Park, J. Youn, and J. Cho, "A low-power microcontroller with accuracy-controlled event-driven signal processing unit for rare-event activity-sensing iot devices," *Journal of Sensors*, vol. 2015, 2015.
- [5] K. Yatani and K. N. Truong, "Bodyscope: a wearable acoustic sensor for activity recognition," in *Proceedings of the 2012 ACM Conference on Ubiquitous Computing*, ser. UbiComp '12. New York, NY, USA: ACM, 2012, pp. 341–350. [Online]. Available: <http://doi.acm.org/10.1145/2370216.2370269>
- [6] P. Khanna and M. Sasikumar, "Article: Recognising emotions from keyboard stroke pattern," *International Journal of Computer Applications*, vol. 11, no. 9, pp. 1–5, December 2010, published By Foundation of Computer Science.
- [7] B. R. Jones, R. Sodhi, R. H. Campbell, G. Garnett, and B. P. Bailey, "Build your world and play in it: Interacting with surface particles on complex objects," in *Mixed and Augmented Reality (ISMAR), 2010 9th IEEE International Symposium on*, Oct 2010, pp. 165–174.
- [8] R. W. Picard, "Toward computers that recognize and respond to user emotion," *IBM Syst. J.*, vol. 39, no. 3-4, pp. 705–719, Jul. 2000. [Online]. Available: <http://dx.doi.org/10.1147/sj.393.0705>
- [9] S. Lee, J. Cho, T. G. Kim, and D. Park, "Things-touch system and matlab/simulink interoperation environment based on acoustic event sensing for individualized things-human interaction," *Journal of IEMEK*, vol. 10, no. 4, pp. 189–198, Aug 2015.
- [10] K. T. Son, H. hung Huang, and C. C. Lee, "Generation of surface acoustic waves for general sensing applications," in *2008 58th Electronic Components and Technology Conference*, May 2008, pp. 1690–1694.
- [11] X. Li, M. Ding, M. Wang, C. Yang, and C. Wang, "Hardware-in-the-loop simulation system of vis based on matlab and adams," in *2015 IEEE International Conference on Mechatronics and Automation (ICMA)*, Aug 2015, pp. 1391–1396.
- [12] R. Isermann, J. Schaffnit, and S. Sinsel, "Hardware-in-the-loop simulation for the design and testing of engine-control systems," *Control Engineering Practice*, vol. 7, no. 5, pp. 643 – 653, 1999. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0967066198002056>
- [13] B. A. Guvenc, B. Sencer, M. Giray, and L. Guvenc, "Use of a simulink engine blockset in real time hardware in the loop simulations," in *Mechatronics, 2004. ICM '04. Proceedings of the IEEE International Conference on*, June 2004, pp. 410–414.
- [14] H. Wang, M. M. U. Rehman, M. Evzelman, and R. Zane, "Simulink based hardware-in-the-loop rapid prototyping of an electric vehicle battery balancing controller," in *2015 IEEE 16th Workshop on Control and Modeling for Power Electronics (COMPEL)*, July 2015, pp. 1–6.
- [15] J. Liu, J. Wu, and Z. Lou, "Noise-controlled technique to improve vibration touch in humans," in *Sixth International Conference on Intelligent Systems Design and Applications*, vol. 1, Oct 2006, pp. 999–1002.