MicroData: live visualisation & recording of micro:bit sensor data

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ABSTRACT

MicroData is an application that makes it easy to interactively visualise and record live sensor data in support of data literacy in the classroom. It leverages a BBC micro:bit coupled with an Arcade shield accessory, and needs no other hardware. It makes data discovery and collection easier for school children and teachers. We describe some of MicroData's key features and anticipate how it could be used in the classroom and beyond.

KEYWORDS

data science, physical computing, science education, micro:bit, data literacy, interactive learning

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1 INTRODUCTION

Sensors are common in our daily lives: home security systems use motion, light and audio sensing to detect unusual conditions and alert us, cars are outfitted with distance sensors to assist with parking or to apply emergency braking when needed, and airbags contain accelerometers to detect and deploy in response to a crash. As these sensors and the computers they are wired to become less expensive, we can expect to find them in more of the systems we encounter in our lives. An understanding of these sensors, and the data they generate, is therefore increasingly important.

In schools, these same sensors—and more—can also be useful for taking measurements during practical experiments in subjects such as physics, biology, chemistry and environmental studies. Research shows that getting students engaged with hands-on activities, such as running experiments themselves, improves learning outcomes [1]. However, digital sensing and data collection systems are often not practical for classroom use. One challenge is simply cost; each student or pair of students will need their own sensing system, assuming that they need to work independently. A second challenge is the availability of a reliable and easy-to-use solution for sensing and collecting data from a variety of sensors, that secondary school students can use without significant training. Finally, in many cases it may be desirable to perform sensing and data collection outdoors, necessitating a solution that's portable and battery-powered.

The *BBC micro:bit* [1] has a lot of potential in the scenarios we are discussing. It is a small, self-contained and battery-powered computing device which is prominent in classrooms around the world. It has a variety of built-in sensors which can detect acceleration, temperature, light level, sound level and magnetic fields. It has an edge connector that allows external analog voltages to be applied and measured, and other sensors to be added. Finally, it has a data recording facility that allows the storage of data in non-volatile flash memory. We therefore believe the micro:bit provides a solid foundation for sensing and data collection.

The micro:bit V2 also is powerful enough to drive a small display. The advent of *Arcade shields* for the micro:bit, which have a small color display and extra inputs, has enabled two new scenarios: (1) MakeCode Arcade [4] allows the programming of retro arcade games in the web browser and deployment to the micro:bit, plugged into the display shield; (2) MicroCode [3] is a MakeCode Arcade application that allows students to program the micro:bit directly, without the need for an internet-connected computer with web browser. In addition, the micro:bit V2's support for the Jacdac platform [2] enables the use of additional sensors, such as ones for humidity and soil moisture, in the same easy-to-use manner of a built-in micro:bit sensor.

We believe the above factors demonstrate the potential for the micro:bit and Arcade shield to be used as a platform to build interactive learning experiences that enhance data collection for science experiments in secondary schools.

2 MICRODATA

MicroData is an application that enables students to use a micro:bit to record and visualise data from a selection of 19 sensors, including built-in sensors on the micro:bit and external Jacdac sensors. Students can visualise the readings from up to 5 sensors at once in real-time, or can choose to record the readings from these sensors to flash storage. These recordings can then be uploaded to an external computer or they can be viewed in a tabular or graph format on the Arcade shield. Additionally, students can choose to record

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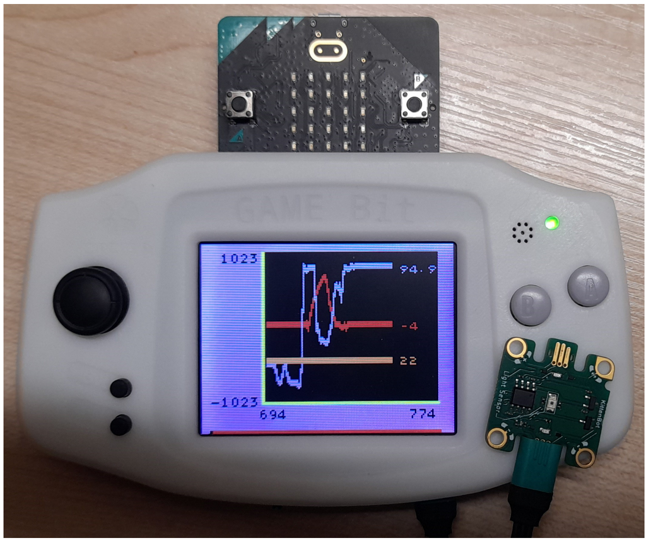

Figure 1: Visualising live data with MicroData.

Figure 2: Accelerometer data logging in progress.

events, by specifying that a sensor is recorded only under certain conditions. Below are two figures that demonstrate MicroData in action. Figure 2 shows readings from three sensors in real-time, the second shows the recording from three sensor at once. Both are running on a battery-powered Arcade shield.

Figure 1 shows a real-time graph of three sensors: temperature (orange), accelerometer (red) and light data (pink) from a connected Jacdac sensor (pictured bottom-right).

Figure 2 shows accelerometer readings for the X, Y, Z dimensions being logged independently of one another into flash storage. The student can use the up and down keys on the Arcade shield to view information about the logging—such as the period, number of measurements and for how much longer recording will continue.

3 EXAMPLE EXPERIMENTS

The following examples present some of the ways in which MicroData could be used inside and outside of the classroom to enhance learning experiences. These user stories may be costly or infeasible to accomplish with a more conventional computer and sensor(s) setup.

Biology: A student wishes to observe the relationship between the growth of a plant and its temperature and the amount of light or water it receives. The student can take daily measurements of the height of the plant and setup MicroData to take a continuous and reliable log of the temperature and light level around the plant and the moisture of its soil all at once. The student can then view this data on the device.

Physics: A student is measuring the voltage at two points in a circuit to understand how voltage changes in response to changes in resistance. They can use the real-time graph and the three analog pins to check the current that flows to the their components. This enables them to fix the issue and continue their project.

4 STATUS

MicroData has undergone continual evaluation and refinement by the authors during its development. We also asked an independent human-computer interaction expert and an education expert for external feedback, leading to further iteration.

We acknowledge that what we have is just the start. Although MicroData's features mean it can be used to collect data from a variety of sources, there is still room for refinement in order to maximise the experience inside and outside of the classrooms. While the work thus far is promising, only by studying how MicroData is used in the classroom can we learn what its strengths and weaknesses are. We would be delighted to identify collaborators from across the community in support of this.

REFERENCES

[1] Jonny Austin, Howard Baker, Thomas Ball, James Devine, Joe Finney, Peli De Halleux, Steve Hodges, Michał Moskal, and Gareth Stockdale. 2020. The BBC micro:bit—from the UK to the world. *Commun. ACM* 63, 3 (2020), 62–69. https://doi.org/10.1145/3368856

[2] James Devine, Michal Michał, Peli de Halleux, Thomas Ball, Steve Hodges, Gabriele D'Amone, David Gakure, Joe Finney, Lorraine Underwood, Kobi Hartley, Paul Kos, and Matt Oppenheim. 2022. Plug-and-play Physical Computing with Jacdac. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 6, 3 (2022), 110:1–110:30. https://doi.org/10.1145/3550317

[3] Kobi Hartley, Elisa Rubegni, Lorraine Underwood, Joe Finney, Thomas Ball, Steve Hodges, Eric Anderson, Peli de Halleux, James Devine, and Michal Moskal. 2024. Meet MicroCode: a Live and Portable Programming Tool for the BBC micro:bit. In *23rd annual ACM Interaction Design and Children (IDC) Conference*. ACM, ACM.

[4] Michal Moskal, Thomas Ball, Abhijith Chatra, James Devine, Peli de Halleux, Steve Hodges, Shannon Kao, Richard Knoll, Galen Nickel, Jacqueline Russell, Joey Wunderlich, and Daryl Zuniga. 2021. Web-based Programming for Low-cost Gaming Handhelds. *The 16th International Conference on the Foundations of Digital Games (FDG) 2021*, 1–12. https://doi.org/10.1145/3472538.3472572