

Case Study

Intelligent cough monitor improves respiratory care

Goal

Design a cough monitor that is compact and lightweight enough for small children to wear, with a long battery life. Develop powerful machine learning algorithms for the device to analyze cough frequency, and listen only for coughs, ignoring background noise.

Solution

Quvium developed the Sonasure cough monitor based on an Arm Cortex-M processor for its low-power processing and machine learning capabilities. The team also used the Arm Keil MDK Pro software development solution to accelerate product development.

Benefits

Cortex-M:

- High performance for complex machine learning workloads
- Energy efficient for long battery life
- Small-form factor for small bodies

Arm Keil MDK Pro:

- Fully integrated development environment including royalty-free optimized middleware
- High performance and efficient C/C++ code compilation
- Instruction-accurate platform for debugging and testing algorithms

Peace of mind with personalized cough analysis

When chemist and computer scientist Steve Schmidt and product development specialist Karen Travers, both parents of asthmatic children, came together to form Quvium, their goal was to change the lives of people with chronic respiratory disorders. Hundreds of millions of people worldwide live with asthma, Chronic Obstructive Pulmonary Disorder (COPD) and Cystic Fibrosis, according to the World Health Organization.

Quvium set out to develop an intelligent, durable, wearable cough monitor that tracks early symptoms, informs treatment plans, and sends alerts if emergency action is needed. The goal was a button-sized device that analyzes cough sound waves and uses machine learning algorithms to detect significant changes in cough

frequency, which are often an early indicator of potential health issues. The device also had to be smart enough to block out background noise and only collect cough data.

Tough enough for small kids

Usability in the real world was a major challenge for the development team. While they had early success with signal detection in quiet rooms, coughs became harder to detect in the presence of background noise such as radios and traffic. As well as small and lightweight, the Sonasure device also had to be tough, easy to wear, and childproof. At night it should be recharged beside the patient, but still able to detect coughs.



To bring the concept to reality, Quvium turned to Arm processor technology and software for its scalability and machine learning processing power. The small, low-power Cortex-M processor offers the durability and scalability needed for embedded applications, and provides the high-performance and power-efficiency the Sonasure required. Arm machine learning capabilities allowed Quvium to develop a unique feature for the device—the ability to quickly analyse a cough and identify a normal baseline for each individual wearer.

“We knew that if we wanted to do a reasonable compute without draining the battery or wearing a device the size

and weight of a brick, that Arm had what we needed,” says Schmidt. “We had to make a device that is power efficient and processor intensive enough to do pre-processing on sound capture and filter out words so no verbalisation travelled over the airways. It also had to have pre-processing capability to identify likely coughs and when it detects one, it sends it over to a base station for further analysis. All this was accomplished with the Arm Cortex-M4 processor. It had the right combination of cost, size, power management and compute power.”

Accelerated software development

Quvium used Arm’s flagship software development solution for Cortex-based microcontrollers, Arm Keil MDK Pro. The comprehensive solution includes all the components Quvium needed to create, build, and debug embedded applications. And as the Pro version includes access to Cortex-M4 simulation models, Quvium could develop their software alongside the hardware, dramatically reducing development time.

Optimizing the C/C++ code efficiently for size and performance was important too, especially considering the complexity of the code for the machine learning algorithms. The pre-developed CMSIS packs eliminated the need to create all the machine learning code from scratch – developers simply implemented the relevant kernels to maximize performance and minimize memory footprint.

“Arm Keil MDK brings together the most efficient compiler, CMSIS software packs, and the most instructionally accurate platform for the purpose of testing the algorithm in one solution,” explains Ragu Bharadwaj, developer for Quvium Sonasure. “It’s a great all-round solution. In fact, choosing the world’s most efficient compiler was one of the major influences on our decision to choose this combination of Arm hardware and software.”

Life-saving power in the size of a button

Quvium has achieved its goals for the Sonasure cough monitor thanks to Arm, Schmidt adds. The device is intelligent, wearable and powerful – three meters away Sonasure still works well enough to block out background noise and just listen to coughs.

Acting as an early detection system for respiratory distress, the device analyzes cough frequency and duration at the edge, interpreting the data to expose crucial patterns that may affect treatment actions and plans. When deviations are detected, the server sends a text message to the user or carer alerting them to take action.



With such powerful capabilities in such a small footprint, Sonasure lets clinicians and carers improve the control and management of chronic respiratory diseases during daily life activities, enabling early intervention that has the potential to save thousands of lives each year.

“It works if the wind is blowing, if the user is running through fields, if you put it beneath a coat. It can be placed on the recharge station at night and it still works,” Schmidt says. “A cough contains a lot of information but until now nobody has been able to capture it in a sustained, high-quality way. Thanks to Arm, we’re enabling people to use that signal in their efforts to stay well and become better.”