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Sports Game Station

Exercise, entertainment and seizure detection

Introduction

Today, more and more people are participating in sports, pedaling a stationary bicycle or running on a treadmill to remain fit. However, at the same time more children are forgoing physical exercise and spending more time playing video games. Not only can the lack of exercise lead to weight gain, but the visual nature of high-speed video games can lead to pediatric seizures in children with photosensitive seizure disorder.

The seizures can be induced by photic stimulation (flicker) or by spatially periodic patterns^[1]. These stimuli are found in multiplayer online role-playing games, small handheld games, video or television games and special game consoles^[2]. Recognizing the risk, international organizations, including the International Telecommunication Union (ITU) and the International Organization for Standardization (ISO), have begun to consider international guidelines for photic and pattern stimulation in public media to help protect such individuals^{[1], [2], [3], [4]}.

Freescale has built a wireless game controller demonstrator that combines a stationary exercise bicycle with video game technology to help people stay fit while playing their games. What's more, by integrating a ZigBee® transceiver and a three-axis low-g microelectromechanical system (MEMS) accelerometer, the Freescale Sports Game Station (SGS) is designed to detect evidence of conditions such as a pediatric seizure and wirelessly transmit an alert signal to parents or other caretakers. The concept is designed to help make video game playing healthier and safer.

Pediatric seizures epidemiology

For some time, viewing television and video games has been linked to photosensitive epileptic seizures. In Japan in December 1997, a televised Pokemon animated program reportedly induced seizures in a number of children. The investigation was narrowed down to a section of the show that included a 15 Hz alternating red and blue flashing light. This tended to confirm previous reports that children with photosensitive seizure disorder are particularly affected by flashes of very-long-wavelength monochromatic lights. In the 1999 study, "Photosensitive Epilepsy and Image Safety," the authors concluded that video game display flicker, intermittent photic stimulation (IPS) at 50 Hz, may underlie the seizures suffered by game players with photosensitive seizure disorder^{[3], [5]}.

Reducing the risk of pediatric seizures

Programmers can help reduce the risk of video game-induced seizures by eliminating such IPS instances as opposing changes in luminance between pairs of flashing lights and transition to or from saturated red, and by limiting flashing sequences to no more than three per second.

To help players lessen the risk of seizure, the Epilepsy Foundation recommends:

- Sitting at least two feet from the screen in a well-lit room.
- Reducing the brightness of the screen.
- Not allowing children to play video games if they are tired.
- Taking frequent breaks from the games and looking away from the screen every once in a while. Do not close and open eyes while looking at the screen as blinking may facilitate seizures in sensitive individuals.
- Covering one eye while playing, alternating the covered eye at regular intervals.
- Turning the game off if strange or unusual feelings or body jerks develop.

Freescal Sports Game Station: combining exercise, entertainment and seizure detection

Station Diagram

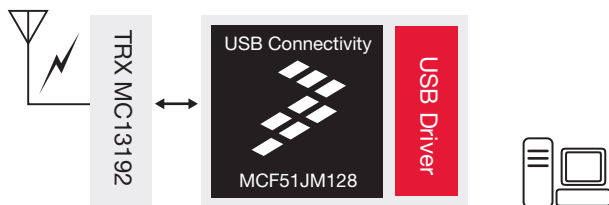


Figure 1

SGS has two parts, one is a station and the other is an endpoint. On the station board (Figure 1), there is a 32-bit MCF51JM128 microcontroller (MCU) based on the V1 ColdFire® core with integrated USB On-The-Go and an MC13192 short-range, low-power 2.4 GHz industrial, scientific and medical (ISM) band transceiver.

Endpoint Diagram

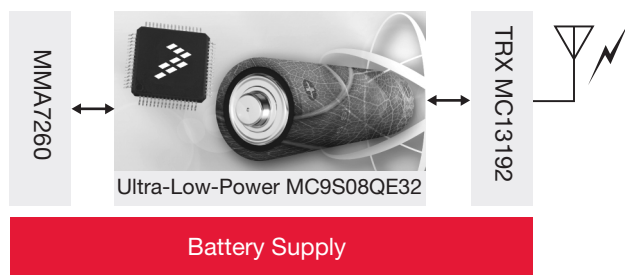


Figure 2

The endpoint board (Figure 2) includes an ultra-low-power 8-bit MC9S08QE32 (S08QE32) main control chip, an MC13192 low-power 2.4 GHz wireless transceiver and the MMA7260QT 3-axis, low-g MEMS accelerometer.

As part of the complete system (Figure 3), the endpoint is attached to the player's body or activity equipment to record movement. The accelerometer senses motion (specific human action) and converts the action to an analog electronic signal. The MCU (S08QE32) reads the analog signal and converts it to a suitable keyboard key value. After that, the MCU sends the key value to the wireless transceiver through the SPI port and directs the wireless transceiver to transmit the data to the station. When the transceiver on the station board receives a key value data packet, it alerts the MCU (MCF51JM128), which reads the data through the SPI port and sends the key value to a PC via a USB cable. Thus, the PC can recognize human actions as a keyboard value.

In this example, the endpoint acts as a sensor that transmits activities and motions to the station while the station acts as a USB human interface device class (USB HID) keyboard device. When connected to a PC, it is recognized as a simple

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SGS System Overview

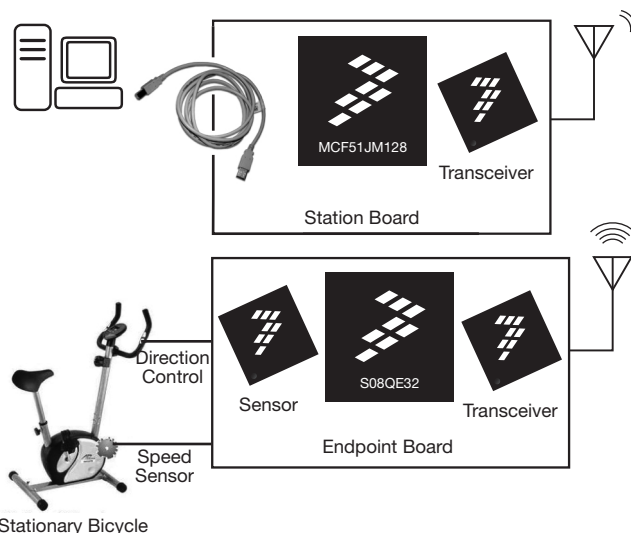


Figure 3

USB keyboard, enabling many popular keyboard or joystick controlled video games to use this system as its controller. For different game controllers, this platform is able to use different movement sensors, simple buttons or joysticks. For instance, Freescale's 3-axis low-g MMA726x accelerometers are already used for tilt detection in some well-known PC games. For stationary bicycles, the speed sensor and direction control keys can be adopted. For a wrestling game, a joystick can be used as a direction controller and the accelerometers sense the punching and kicking motions.

Using the endpoint sensor to detect seizures

Adding significant value to the Freescale's SGS, the endpoint can be used to provide some peace-of-mind for players with photosensitive seizure disorder. The same endpoint hardware can be used, requiring only a different software implementation that can recognize a seizure event. A seizure may occur when a brief, strong surge of electrical activity affects part or all of the brain. Seizures can last from a few seconds to a few minutes and can exhibit many symptoms, from blank staring, lip smacking or jerking movements to more dangerous convulsions and loss of consciousness.

To detect evidence of conditions such as a seizure, a reliable algorithm is necessary. This special algorithm must be designed using enough samples of seizure waveforms (caused by jerking body movements) gathered by the accelerometer to ensure exceptional accuracy. Once the seizure information is transmitted to the station and, in turn, sent to a computer, a software program running on the PC can alert parents through an automatic text message to their cell phones or a buzzer alarm in the game console that an unexpected seizure has occurred. This data could also be submitted to a neurologist to verify the waves and confirm any abnormal activity.

Long battery life

Because the SGS endpoint is a wireless game controller, power consumption is an important design consideration. All three of the primary components exhibit exceptional low-power performance: the ultra-low-power S08QE32 MCU (about 0.4 μ A in STOP mode), MC13192 wireless transceiver and the MMA7260 low-g accelerometer (about 3 μ A in sleep mode). In addition, if there is no signal detected by the sensor within several minutes, the endpoint itself will enter sleep mode to conserve battery life.

Software Overview Diagram

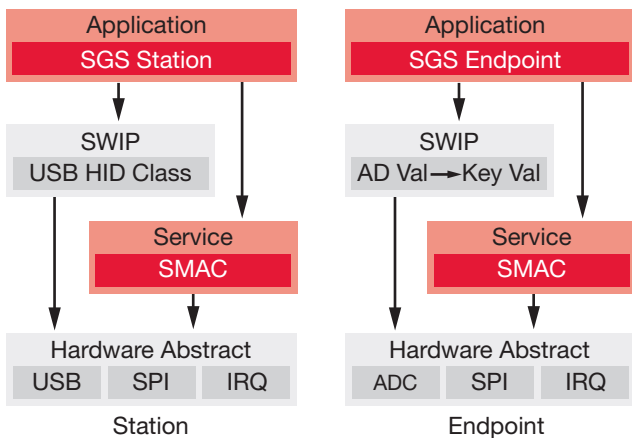


Figure 4

SGS firmware

It is easy to program the firmware for both the station and endpoint (Figure 4). The station includes a USB driver, USB-HID keyboard protocol and simple multimedia access controller (SMAC) protocol. (For more details on the USB driver and USB-HID class for ColdFire MCUs, please refer to the CMX_USB-LITE stack, available at www.freescale.com).

For the endpoint, a SMAC and a simple algorithm translates tilt, movement, direction and speed signals into a keyboard or joystick where values are needed. The endpoint's MMA7260QT accelerometer outputs variable voltage levels to X, Y and Z output pins when it detects a tilt, movement or acceleration. The ADC module in the S08QE32 MCU reads the voltage level outputs and converts them to digital values that can be recognized as movement activity. And with the SMAC protocol, any simple data packet can be easily sent or received effectively.

SMAC

SMAC is an uncomplicated software protocol based on the IEEE® 802.15.4 protocol that works with Freescale's transceivers with 8-bit MCU control. It is free of charge from Freescale and is intended to be used for fast product development and system evaluation. SMAC is simple and easy to use because it implements neither the full ZigBee stack nor the complete 802.15.4 layer. SMAC is ideal for low-cost applications that require basic primitives, such as transmit, receive and power and channel selection. For more details on SMAC, please refer to the stack reference manual (search for SMACRM) at www.freescale.com.

Conclusion

Freescale has the necessary technology to develop a sophisticated gaming system to provide entertainment, promote fitness and detect photosensitive seizures. Wireless transceivers (MC1319x/1320x family) and free stacks (SMAC), accelerometers (MMA726x family), low-power 8-bit MCUs (S08QE family) and high-performance, connectivity-enabled ColdFire MCUs (MCF51JM family) are the key elements used to build the SGS system. Technical support is also available, and Freescale designers regularly consult with customers and medical doctors to develop more new products that can improve the quality of life.

References

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