

Wireless Gaming platform based on Motion MEMS and ZigBee ®

Manoj Kumar, Prashant Pandey

This article describes the operation of a wireless gaming platform. The platform consists of handheld battery operated units and a USB-ZigBee dongle. The handheld units are mounted with an accelerometer, magnetometer, pressure sensor, and temperature sensor. The parameters like temperature, altitude, and magnetic north can be displayed on the local display, and when needed, transferred wirelessly to a PC desktop application where analysis of these parameters could be done or presented in a manner for easier visualization.

The handheld units (also called gadgets) are able to send the data to USB-ZigBee dongle with minimal delay. The accelerometer data thus can be transferred to a PC application in about 100 milliseconds. Such a delay characteristic allows it to be used as a wireless game controller with a near real-time feedback to the game player.

In order to validate this concept the existing keyboard based games have been used. The left, right, forward and backward keys as used in the existing PC games are mapped to correspond to the motion MEMS actions. This provides instantaneous access to several existing games for experiments using this concept.

The solution is designed in a manner that the gaming controller or the USB-ZigBee dongle can act as a master depending on the usage scenario. In the gaming mode, the USB-ZigBee dongle acts as the master so that multiple game controllers can be connected to it. In this mode the solution can support readily available games that are typically single player and up to two player keyboard games.

The motion MEMS is captured and converted into equivalent keystrokes in the PC driver. This concept allows the hardware to be used any available game that designed to take keystrokes as input.

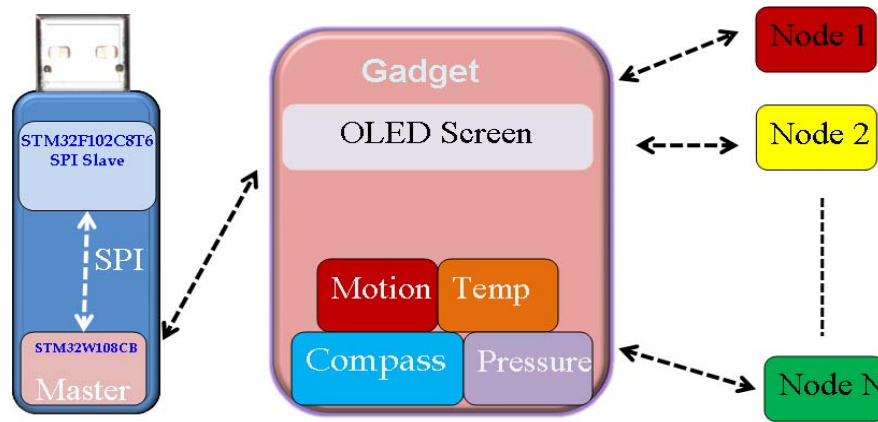


Figure 1 System Block Diagram

The key features of the solution are the following:

- USB-ZigBee Presentation Pointer
- MEMS based Gaming Control
- OLED display user interface for sensor data display and menu navigation
- On-Board MEMS Sensors: Accelerometer ,Magnetometer
- Barometric Pressure & Altitude Measurements
- Temperature Sensor Measurements
- Easy USB-ZigBee interface
- Ability to read data from other sensor nodes
- USB-ZigBee dongle can be used as a USB storage device.

1 The solution is comprised of following components

The solution is comprised of a Handheld Gadget / Gaming controller, a USB-ZigBee dongle, some sensor nodes, and PC software application

1.1 Gadget / Gaming Controller

The gadget is the battery powered handheld portable unit with all the sensors. The unit has a digital temperature sensor (STLM75), MEMS pressure sensor (LPS331AP), a composite inertial module with accelerometer and magnetometer (LSM303DLHC), and the board is capable of wireless ZigBee communication with another USB-ZigBee DONGLE. This gadget will have an onboard display to show the sensor data/information and a MENU for control and setting facilities. To save on size and costs it is preferable to use a microcontroller with an integrated radio module e.g. STM32W108CB from STMicroelectronics.



Figure 2 Handheld Unit / Game Controller

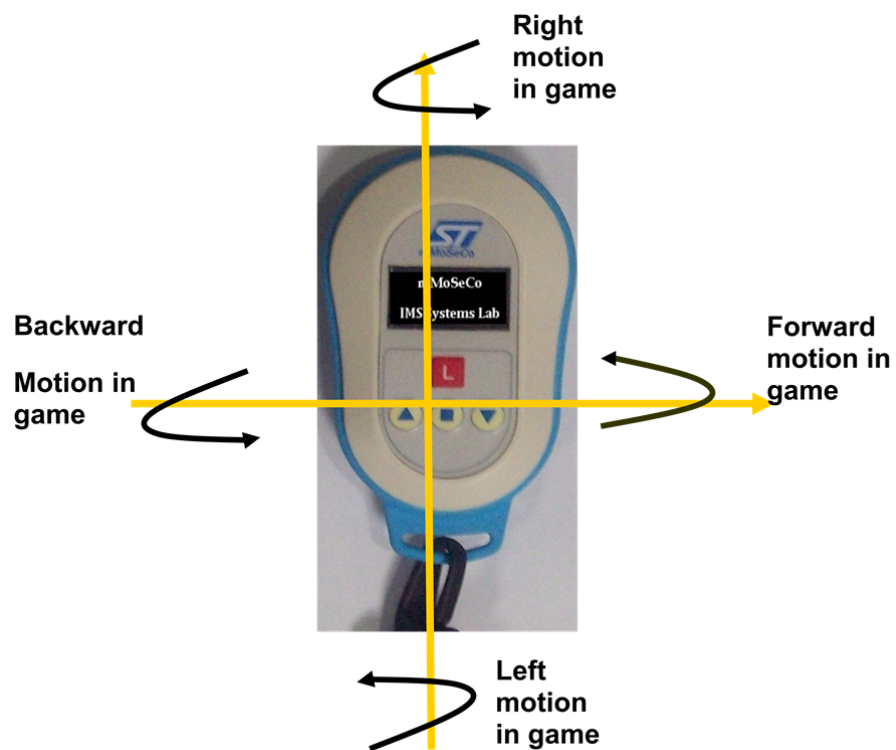


Figure 3 Game Control Using Accelerometer

The gadget board is 3.3V battery powered. An ON/OFF switch is provided. The gadget has a Li-Ion rechargeable battery that can be charged from the 5V USB from a computer or a standalone 5V USB power supply. It has a standalone linear Li-Ion Battery charger with thermal regulation (STC4054GR). A low dropout regulator (STC4054GR) is

used for voltage regulation. The game controller unit has an OLED display for better visibility; an OLED voltage booster like STOD1812PUR is required to drive the OLED display.

The gadget board offers two modes of operation:

- PC Mode
- Standalone Mode

1.1.1 PC Mode

The PC mode signifies the PC connected mode of operation. In this mode, the handheld unit is connected to the USB-ZigBee dongle via ZigBee. The following functionality features are available in this mode:

- Sensor data display on gadget : Default Auto-scroll Gadget Mode
- Wireless Game Play : Gadget game Mode
- Wireless Presentation Pointer for Microsoft® Office PowerPoint: Gadget Presentation Mode
- Sensor Data upload to PC GUI: Gadget Sensor Mode
- Stopwatch

In case the dongle is switched on after the gadget, the ZigBee connectivity is indicated by a connection icon on the right corner of board. In case the dongle is not connected, there will be no icon.

1.1.2 Standalone Mode

The standalone mode signifies the gadget operation in which it's not connected to the PC and typically displays data from onboard sensors. ZigBee may be switched off in this mode, if the external wireless sensor need not be connected. The following functionality features are available in this mode:

- Sensor data display on gadget
- Stopwatch
- Sensor Data Display : Default Auto-Scroll Mode
- Sensor data display from external wireless sensor nodes

1.2 Dongle

The dongle is USB powered USB-ZigBee bridge between Computer and Gadget unit and transfers data/command from WE_GADGET to computer and vice versa. The major components of board are STM32W108CB (ZigBee communication) and STM32F102C8T6 (USB access line) as major components. The dongle is implemented as a composite USB device exposing USB Mass Storage, USB Keyboard and a USB custom HID interface.

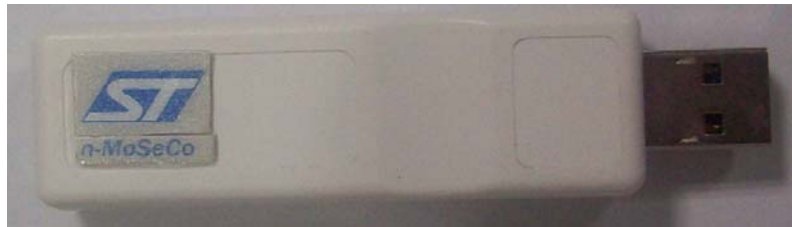


Figure 4 USB-ZigBee Dongle

The USB mass storage mode is used to give access to the micro SD card mounted in the onboard slot used as a USB storage device. Thus when using it as a presentation pointer, user can store the presentation content on the device itself.

The Removable Disk drive is shown in the “My Computer” indicating successful board boot-up. The USB keyboard interface is used for game and multimedia controls. The custom HID interface is used for interaction with GUI application. The dongle board is USB powered connected directly to the computer using USB ‘A’ connector. The use of HID protocol ensures that no driver installation is required; the board makes use of Microsoft Windows in-built HID drivers.

1.3 Wireless sensor nodes

The handheld unit may optionally be connected to external wireless sensor nodes. It may forward the sensor data to the PC when in PC mode; in this case the handheld unit acts as a ZigBee router. It may also display on local display when in standalone mode. In the PC mode, when connected to external sensors, the handheld device creates a ZigBee mesh network. The sensor nodes are self-contained compact and low power sensor devices typically containing a single sensor and a microcontroller with ZigBee transceiver. Each of

these nodes can be realized with low power ZigBee microcontrollers like the STM32W108CB.

2 Menu Navigation

The menu navigation for entering the different functionalities is based on center key press. The key functionality is as follows:

- Center Key: For entering the menu options
- Up/Down Keys: For menu navigation in default display mode and slide control in presentation mode

3 PC Software

The system has a dedicated PC application suite called the n-MoSeCo Control center to configure and manage the system. The software application package can be distributed on the Micro-SD card bundled with the USB-ZigBee dongle itself. Typical system requirement for such an application are as follows.

A minimum of 1GB RAM, 500MB HDD space, 2GHz Processor is needed for good operation. The preferred configuration is 2GB RAM, 500MB HDD Space, 2 GHz multi-core processor, DX10 Graphics Card. The n-MoSeCo control center is very intuitive software to demonstrate the capabilities of the n-MoSeCo device.

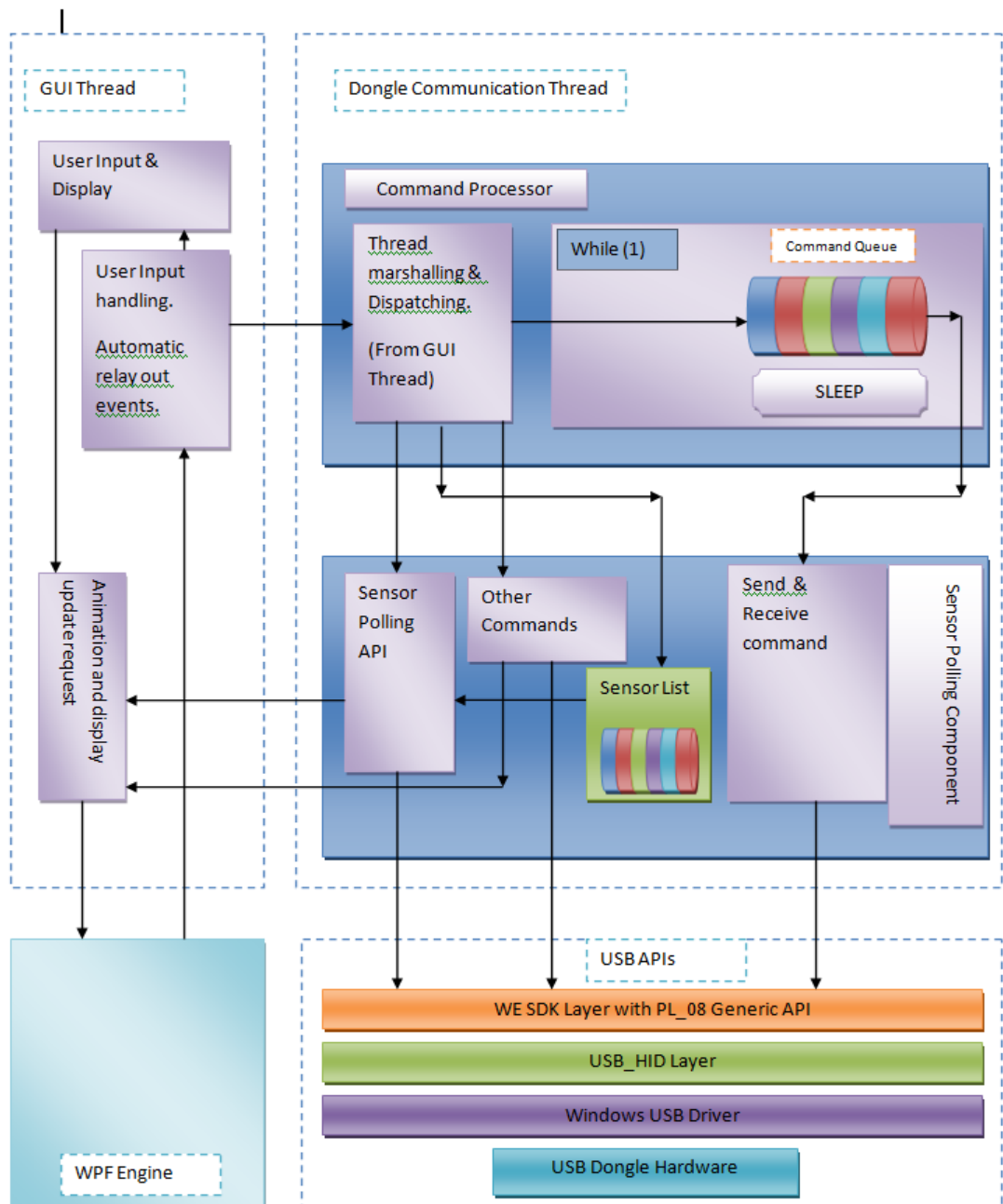


Figure 5 Architecture for the PC Software



Figure 6 The PC Graphical User Interface

Different Modes of operation of the software application

While running in PC mode, when the user changes the operation mode on the handheld unit, it sends a command to the software application running on the PC to change its mode also. Following modes are supported by the application

3.1 Presentation Mode

The presentation mode is the wireless slide navigation control for Microsoft Office PowerPoint. In this mode the button commands received from handheld controller gadget are used to navigate through the slides. In presentation mode the user makes use of up and down navigation keys on the handheld controller to move backward or forward in the presentation.

This mode is customizable and a different set of keys may be remapped to control a media player application.

3.2 Game Mode

The game mode is the wireless game control for computer based game using gadget board 3-Axis accelerometer. The wireless gadget/game controller should be put in PC mode, and then in game mode. One more game controller can be added to the configuration for multiplier gaming. The n-MoSeCo device generates Up, Down, Left and Right arrow

keystrokes to control your game and Play game using MEMS tilt orientation. If the arrow keys are remapped for game control for player 1, the player 2 may make use of different set of keys e.g. 'W', 'S', 'A', 'D' alphanumeric keys.

3.3 Sensor Mode

The sensor mode is the wireless data upload mode for all sensors mounted on gadget board. All the sensor data for the temperature sensor, pressure sensor, accelerometer, and magnetometer is shown on the PC application. Additionally, the user may save this data to a file for later reference. If additional sensor nodes are connected to the handheld device, it routes their data also to the PC application for display.

4 Conclusions

This platform shows that ZigBee, despite being a power and data rate protocol, can be used to control a fast paced computer game. All this is possible while increasing the utility of the device by adding additional features while being compatible with all major operating systems due to the use of standard HID based communication. In this platform, the concept of controlling java based games by ZigBee and Motion MEMS is extended to all available commercial games that can be controlled by a computer keyboard. Such games are available in good numbers due to the historic evolution of computer based games industry.

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