

Video Camera

Technical Guide



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1. General

1.1. General and safety information

- In this section, the term "Wasp mote" encompasses both the Wasp mote device itself and its modules and sensor boards.
- Read through the document "General Conditions of Libelium Sale and Use".
- Do not allow contact of metallic objects with the electronic part to avoid injuries and burns.
- NEVER submerge the device in any liquid.
- Keep the device in a dry place and away from any liquid which may spill.
- Wasp mote consists of highly sensitive electronics which is accessible to the exterior, handle with great care and avoid bangs or hard brushing against surfaces.
- Check the product specifications section for the maximum allowed power voltage and amperage range and consequently always use a current transformer and a battery which works within that range. Libelium is only responsible for the correct operation of the device with the batteries, power supplies and chargers which it supplies.
- Keep the device within the specified range of temperatures in the specifications section.
- Do not connect or power the device with damaged cables or batteries.
- Place the device in a place only accessible to maintenance personnel (a restricted area).
- Keep children away from the device in all circumstances.
- If there is an electrical failure, disconnect the main switch immediately and disconnect that battery or any other power supply that is being used.
- If using a car lighter as a power supply, be sure to respect the voltage and current data specified in the "Power Supplies" section.
- If using a battery in combination or not with a solar panel as a power supply, be sure to use the voltage and current data specified in the "Power supplies" section.
- If a software or hardware failure occurs, consult the Libelium Web [Development section](#).
- Check that the frequency and power of the communication radio modules together with the integrated antennas are allowed in the area where you want to use the device.
- Wasp mote is a device to be integrated in a casing so that it is protected from environmental conditions such as light, dust, humidity or sudden changes in temperature. The board supplied "as is" is not recommended for a final installation as the electronic components are open to the air and may be damaged.

1.2. Conditions of use

- Read the "General and Safety Information" section carefully and keep the manual for future consultation.
- Use Wasp mote in accordance with the electrical specifications and the environment described in the "Electrical Data" section of this manual.
- Wasp mote and its components and modules are supplied as electronic boards to be integrated within a final product. This product must contain an enclosure to protect it from dust, humidity and other environmental interactions. In the event of outside use, this enclosure must be rated at least IP-65.
- Do not place Wasp mote in contact with metallic surfaces; they could cause short-circuits which will permanently damage it.

Further information you may need can be found at: <http://www.libelium.com/development/wasp mote>

The "General Conditions of Libelium Sale and Use" document can be found at:
http://www.libelium.com/development/wasp mote/technical_service

2. Hardware

2.1. Introduction

The new Video Camera Sensor board in conjunction with the 3G module for Wasp mote allows to take photos (VGA - 640x480) and record videos (QVGA - 320x240) and send them to the Cloud by using high speed WCDMA and HSPA cellular networks in the same way as Smartphones do. This makes possible sensor nodes send not only discrete sensor information such as temperature or humidity (which can be encoded using just a single number) but also complex streams of information such as photos and videos. This new feature allows developers the creation of new **Smart Security** applications.

The 3G module offers speed rates of 7.2Mbps in download mode and 5.5Mbps when uploading to the Cloud photos and videos taken by the Video Camera Sensor board, which makes possible to create a distributed photo/video network where hundreds of small sensor nodes send at the same time the information captured.

The new Video Camera Sensor board includes 22 high power infrared (IR) LED's to implement the night vision mode - allowing Wasp mote take pictures and record videos in total darkness-. This mode is activated automatically changing the IR filter under the lens by using the luminosity information given by two sensors integrated on the board, a LDR sensor to capture the visible light (400-600nm) and an infrared sensor to measure the IR levels (600-1000nm).

Each Wasp mote sensor node may integrate at the same time a medium/long range radio such as 802.15.4 / ZigBee / 868MHz / 900MHz / Sigfox/ Bluetooth / WiFi / LoRa/ and one long range 3G radio. This way we can minimize costs by using the mobile network just when really needed.

The 3G module comes with an internal SD Card of 2GB (extended up to 32GB) which is used to store the photos and videos taken by the Video Camera Sensor Board without the need of being handled by the node MCU. This ensures we get real speed ranges (7.2Mbps download and 5.5Mbps upload) as the communication is direct between the SD and the 3G module.

The 3G module counts also with an internal GPS that enables the location of the device outdoors and indoors combining standard NMEA frames with mobile cell ID triangulation using both assisted-mobile (A-GPS) and mobile-based (S-GPS) modes. By using the information given by the GPS we can add meta information to the multimedia files setting the geolocation of where the pictures and videos are taken.

2.2. General Description

The Video Camera Sensor Board allows to Wasp mote to take pictures and record video along with the Wasp mote 3G/GPRS board. The board includes 22 IR LEDs, divided in two blocks controlled each one by transistors, to give extra illumination and record with few light or in the night. To eliminate the IR distortion when the board is used with natural light, the board has a filter exchanger with a IR light filter.

The board has two sockets for a LDR and a IR photodiode. With the information of these sensors the users can select the proper filter and, if is necessary, to use the IR LEDs.

The Video Camera Sensor Board also includes a presence sensor (PIR), to generate an interruption on Wasp mote and take a picture or record a video when a person passes by, this feature is specially designed for security and surveillance applications.

2.3. Specifications

Weight (with sensors): 43gr

Dimensions: 73 x 53 x 1.3 mm

Dimensions WaspMote + 3G module + Videocamera: 73 x 62 x 48 mm

Temperature Range: [-25°C, 70°C]



Figure : Video Camera Sensor Board

2.4. Electrical Characteristics

IR LED power voltages:

3,6V – 4,2V (from battery)

IR cut filter exchanger power voltages:

3,6V - 4,2V (from battery)

Image Sensor Analog Voltage:

3,3V

Image Sensor Digital I/O Voltage:

2,8V (from WaspMote 3G/GPRS board)

LDR and IR photodiode Sensor Voltage:

3,3V

PIR Sensor Voltage:

3,3V

Maximum admitted current (continuous) for sensors:

200mA

IR LED maximum current (continuous) for block 1:

1A

IR LED maximum current (continuous) for block 2:

1A

2.5. Assembling

The board needs to be assembled along with the 3G/GPRS board as the photos and video are handled and stored by it. Once they are stored in the internal SD of the 3G module, they can be sent using the 3G radio or passed to the Wasp mote MCU and then sent by other radios such as the WiFi. Read more about this in the section “Sending photos and videos”.

Follow the next steps to assemble correctly the boards:

- Connect the battery to Wasp mote.
- Insert the microSD card and the SIM card (if necessary).

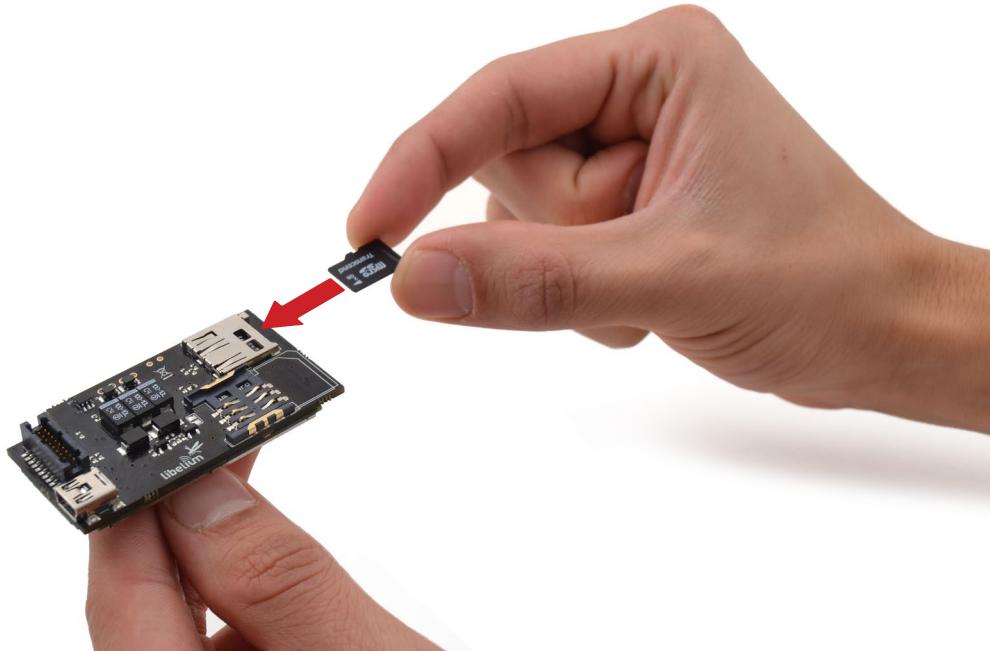


Figure : Inserts microSD card

- Connect the FPC to the Wasp mote Video Camera Sensor board. To do this, first pull carefully out the sides of the connector, inserts the FPC with metallic contacts facing up and, at the final step, push in the laterals of the connector to close it.

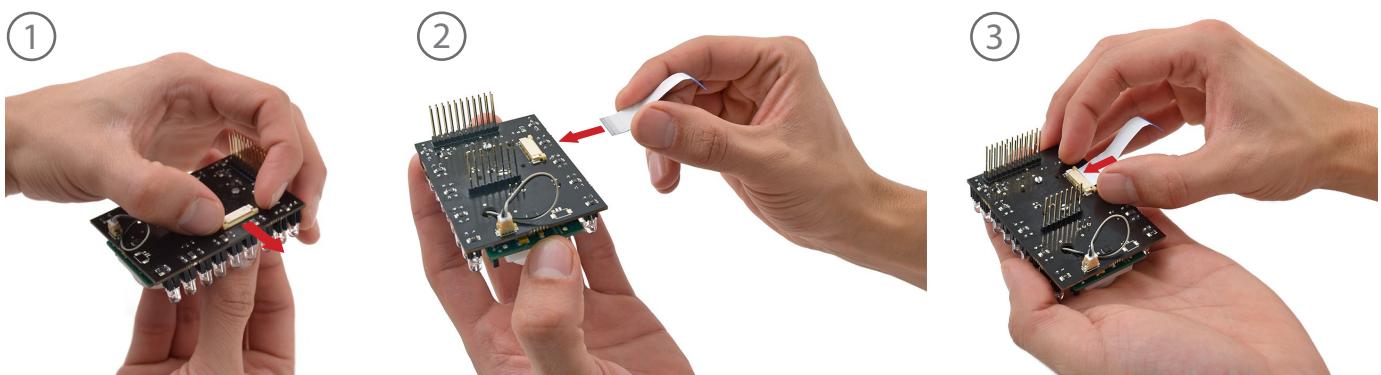


Figure : Connecting FPC bus to Video Camera Sensor Board

- Follow the same steps to connect the FPC to the WaspMote 3G/GPRS board.
- Connect the WaspMote 3G/GPRS board in the socket 1 on WaspMote.

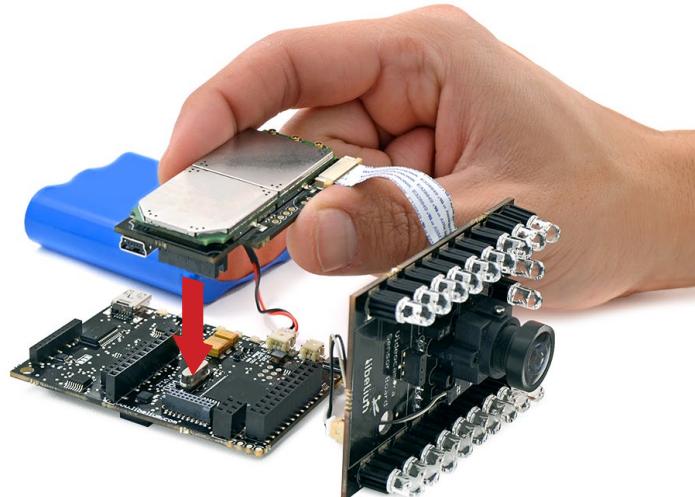


Figure : Mounting 3G/GPRS board in Waspmote

- Insert the Video Camera Sensor board on WaspMote. Beware, the last two pins of the 2x12 connector (the nearest of the corner) must be empty.



Figure : Mounting Video Camera Sensor Board in Waspmote

- Insert the PIR sensor, the luminosity sensor and the IR sensor. The IR sensor has polarity. Please, refer to chapter "IR sensor" for more information.

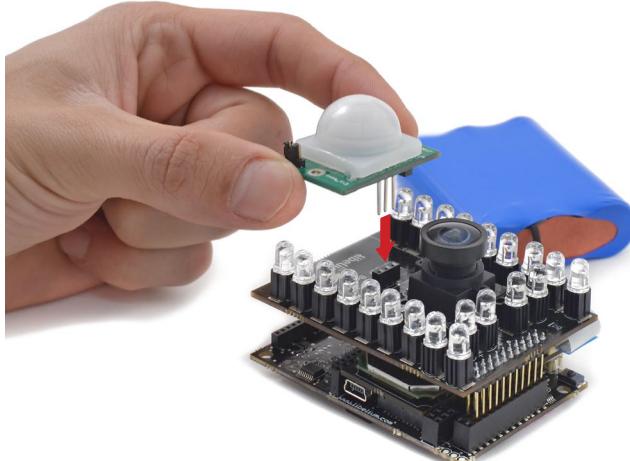


Figure : Connecting sensors

3. Sensors

3.1. Camera Sensor

3.1.1. Specifications

Width(min.): 24mm

Height: 24mm

Length: 17mm

Max resolution: 640x480 for pictures, 320x240 for video

Image Sensor Analog Voltage: 3,3V

Image Sensor Digital I/O Voltage: 2,8V (from Wasmote 3G/GPRS board)

Temperature range:

operating: -30°C to 70°C junction temperature

stable image: 0°C to 50°C junction temperature

Consumption (active): 48 mA

Angle of view: 70°

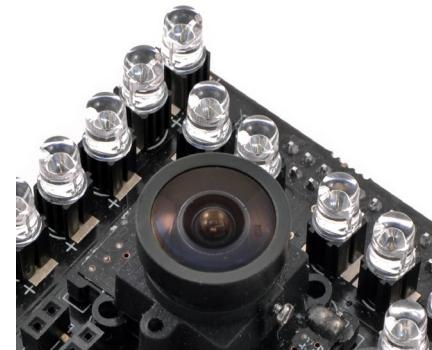


Figure : Camera sensor with IR cut filter and lens

3.1.2. Measurement Process

The image sensor is fully managed by Wasmote 3G/GPRS board. Please, refer to API chapter for more information.

3.2. Luminosity sensor

3.2.1. Specifications

Resistance in darkness: 20MΩ

Resistance in light (10lux): 5 ~ 20kΩ

Spectral range: 400 ~ 700nm

Operating Temperature: -30°C ~ +75°C

Minimum consumption: 0uA approximately



Figure : Light sensor LDR

3.2.2. Usage

With this sensor we can know the level of visible light and we can decide if switch on or switch off the blocks of IR LED.

3.2.3. Measurement process

This is a resistive sensor whose conductivity varies depending on the intensity of light received on its photosensitive part. The measurement of the sensor is carried out through the analog-to-digital converter of the microcontroller, reading the resulting voltage out of a voltage divider formed by the sensor itself and the load resistor of 10kΩ.

The measurable spectral range (400nm – 700nm) coincides with the human visible spectrum so it can be used to detect light/darkness in the same way that a human eye would detect it.

The sensor value can be read with the next function:

```
{
    LDR_value = readAnalog(SENS_LDR);
}
```

3.2.4. Socket

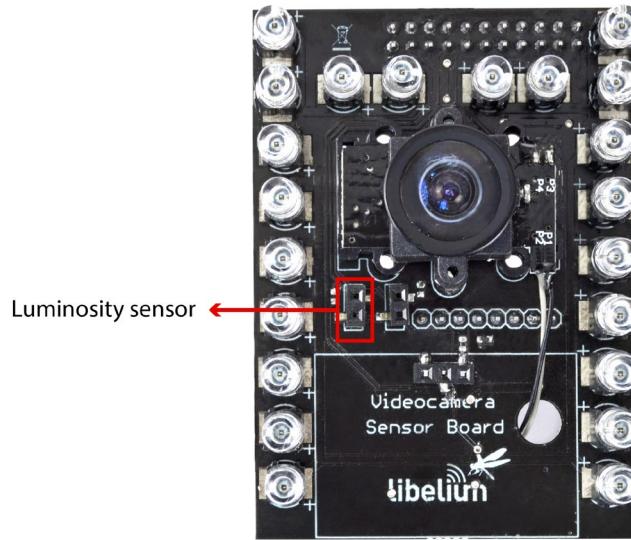


Figure : Socket for luminosity sensor

3.3. IR sensor

3.3.1. Specifications

Peak sensitivity wavelength: 860nm

Collector dark current (Ee=1mW/cm²): 100nA

Operating Temperature: -25°C ~ +85°C



Figure : IR sensor

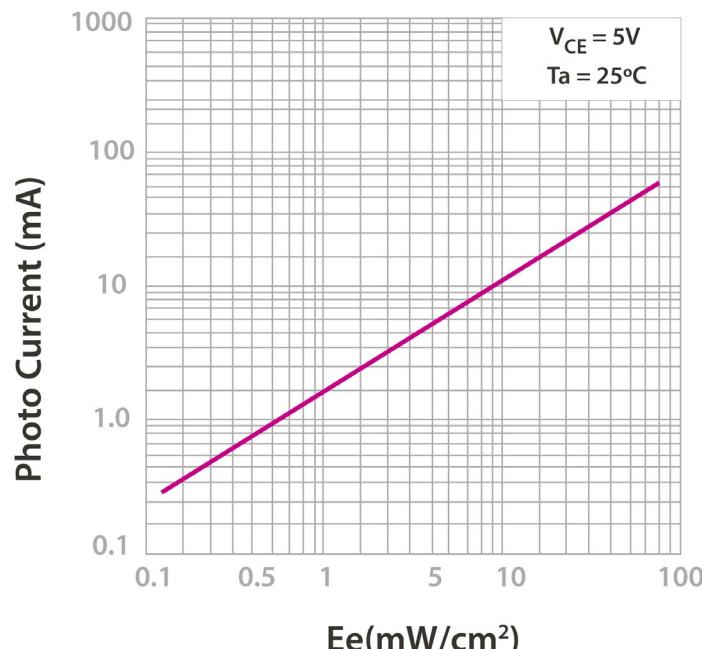


Figure : Photo Current vs. Irradiance taken from the Premier Farnell Group sensor data sheet

3.3.2. Usage

With this sensor we can know the level of IR light and we can decide if enable the IR cut filter filtering the IR light or disable the IR cut filter allowing the pass to all light.

3.3.3. Measurement process

This is a transistor in which the current of this base varies depending on the intensity of the light received on its photoelectric part. The current generated in base allows the conduction of current through collector-emitter. The current produces a voltage in a resistance connected between the emitter of the phototransistor and ground. The voltage of the resistance can be read through the analog-to-digital converter of the microcontroller.

The sensor value can be read with the next function:

```
{
    IR_value = readAnalog(SENS_IR);
}
```

3.3.4. Socket

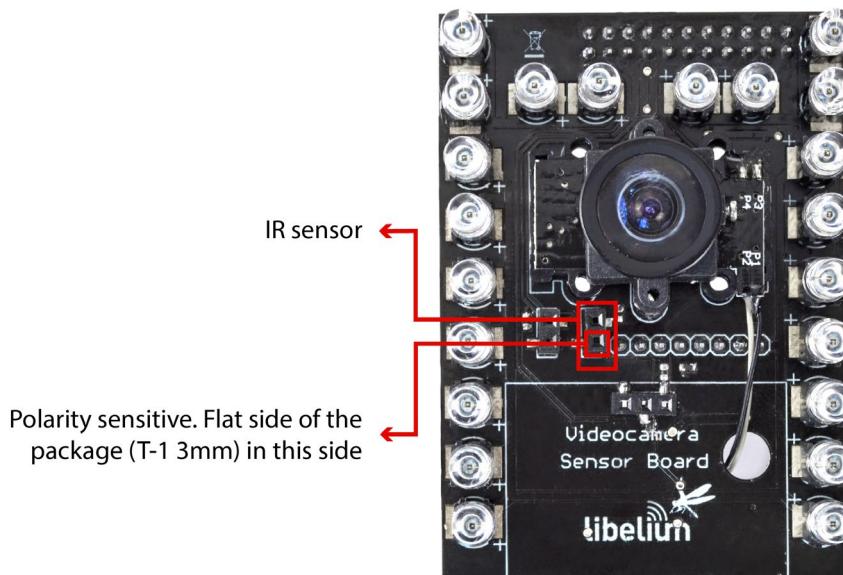


Figure : Socket for IR sensor

3.4. Presence sensor (PIR)

3.4.1. Specifications

Height: 25.4mm
Width: 24.3mm
Length: 28.0mm
Consumption: 100 μ A
Range of detection: 6 ~ 7m
Spectral range: ~ 10 μ m



Figure : PIR presence sensor

3.4.2. Usage

This sensor allows the Video Camera Sensor Board to generate an interrupt in WaspMote when the presence sensor detects, for example, a person or an animal.

3.4.3. Measurement process

The PIR sensor (Passive Infra-Red) is a pyroelectric sensor mainly consisting of an infra-red receiver and a focusing lens that bases its operation on the monitoring of the variations in the levels of reception of detected infra-reds, reflecting this movement by setting its output signal high.

The $10\mu\text{m}$ spectrum corresponds to the radiation of heat from the majority of mammals as they emit temperatures around 36°C .

The maximum detection direction goes perpendicular to the Video Camera Sensor Board.

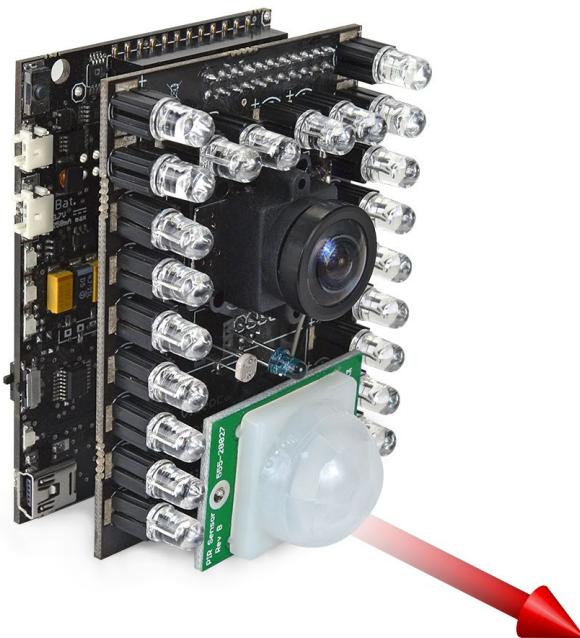


Figure : PIR maximum detection range

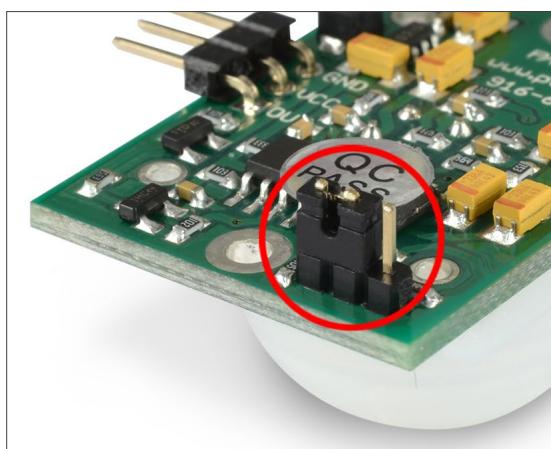


Figure : Maximum range jumper configuration

The connection between WaspMote and the PIR sensor has been designed to generate an interruption. When the PIR detects a change of state, it changes his output from '0' to '1'. This change generates an interruption in WaspMote by UART1. Before to use the UART1, the monitoring pin ([PIR_3G_PIN_MON](#)) must be forced to '0' to allow the connection with the WaspMote 3G/GPRS board. This can be done with the function `disablePIRInterrupt()`. Please, refer to API chapter for more information.

3.4.4. Socket

The sensor must situated in the PIR socket (see figure below):

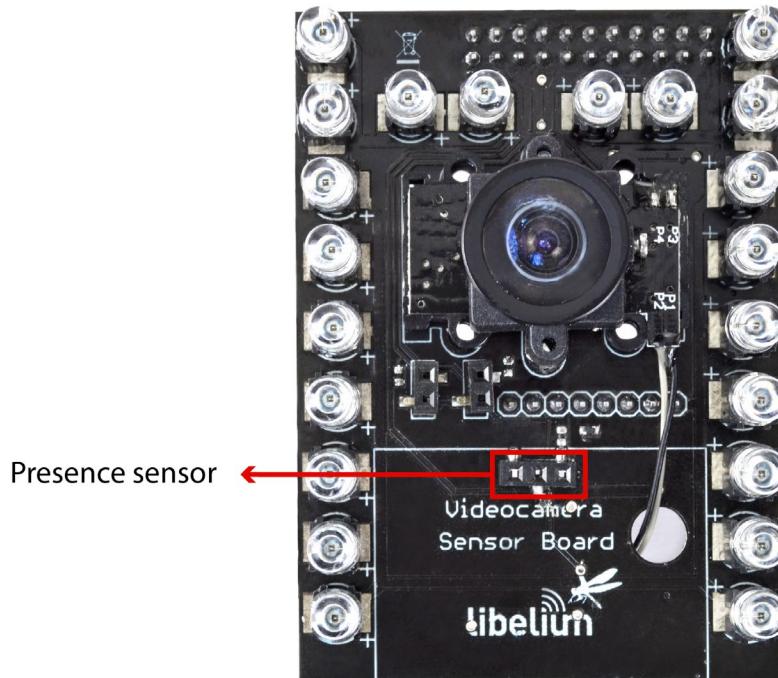


Figure : Socket for presence sensor

4. Night Vision

The Video Camera Sensor Board has been developed to allow WaspMote to take pictures and record video with few light or in total darkness. To use this feature the Video Camera Sensor Board has integrated 22 IR LEDs to illuminate the focused zone. Also, to combine this feature with the use of the camera with daylight, the Video Camera Sensor Board includes a IR cut filter to eliminate a pink distortion on the image.

Daylight photos



Figure : Photo daylight1



Figure : Photo daylight2

Indoor low light level comparative



Figure : Photo without night vision



Figure : Photo with night vision activated

Corridor

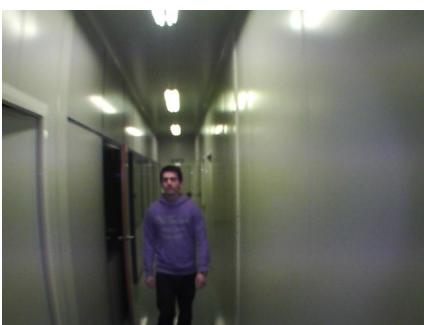


Figure : Photo with light



Figure : Photo without light and with night vision deactivated



Figure : Photo without light and with night vision activated

4.1. IR lighting

4.1.1. Description

The Video Camera Sensor Board have 22 IR LEDs divided in two blocks controlled each one by transistors, to give extra illumination and record with few light or in the night. Block 1 can be controlled by pin [DIGITAL6 \(POWER_LED\)](#) and the block 2 by pin [DIGITAL8 \(POWER_LED2\)](#) or using the function [powerIRLED\(\)](#). Please, refer to API chapter for more information.

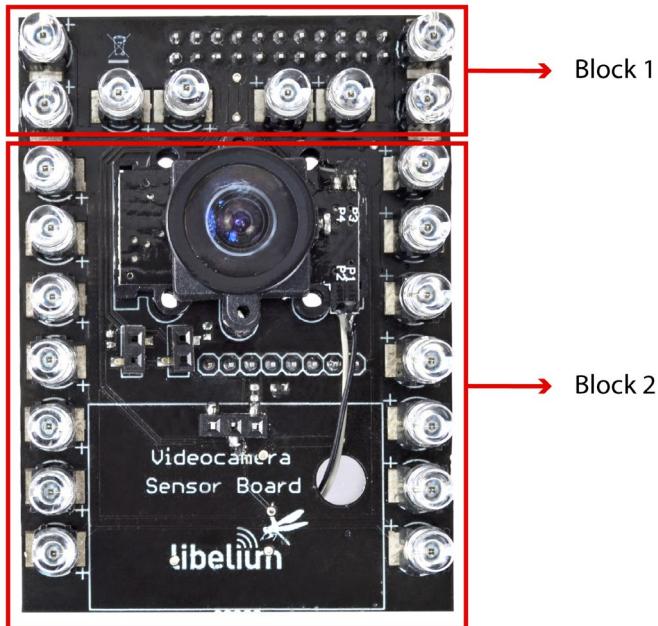


Figure : IR LED blocks



Figure : IR LEDs activated

4.1.2. Specifications

Block 1

Number of LEDs: 8

Total current consumption: 200mA at 3,7V; 270mA at 4,2V

Current for each LED: 50mA at 3,7V; 67,5mA at 4,2V

Block 2

Number of LEDs: 14

Total current consumption: 390mA at 3,7V; 490mA at 4,2V

Current for each LED: 48,75mA at 3,7V; 61,25mA at 4,2V

LED description

Model: HIR7393C

Peak wavelength: $\lambda_p=850\text{nm}$

View Angle: 50°

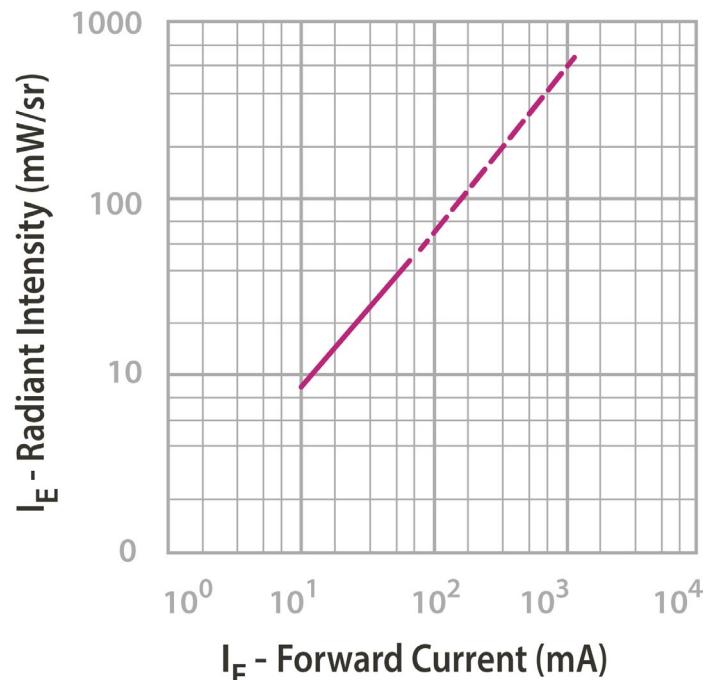


Figure : Relative Intensity vs. Forward Current taken from the Everlight Electronics Co., Ltd.

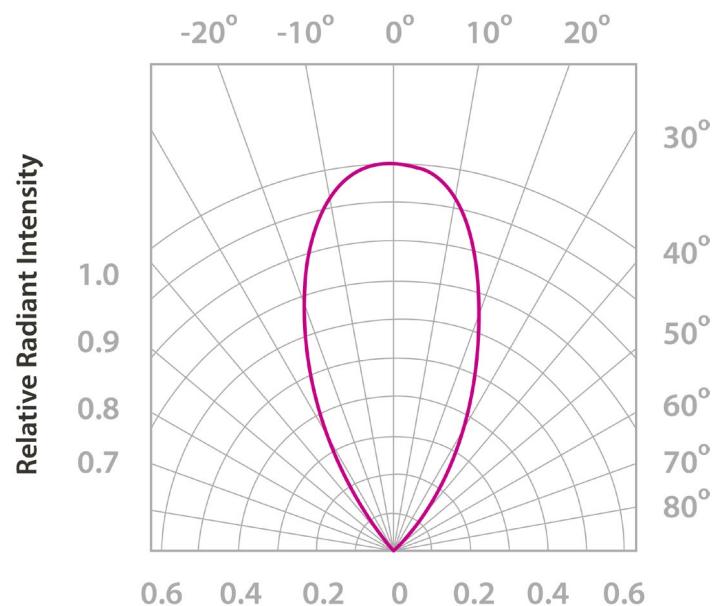


Figure : Relative Radiant Intensity vs. Angular Displacement taken from the Everlight Electronics Co., Ltd. data sheet

4.2. IR cut filter

4.2.1. Description

The Video Camera Sensor Board has got installed a IR cut filter. This light filter has two glasses inside. One glass allows take images with day light without a pink hue in the image, it eliminates the light over 625nm. The other one allows to pass the light spectrum between 400nm and 1100nm. This IR cut filter can work with WaspMote in all positions.

The filter are activated when the WaspMote uses the camera. The user can select the filter with the function `selectFilter()`. Please, refer to API chapter for more information.

4.2.2. Specifications

Height: 25.6 mm

Width: 5.5mm

Length: 30.5mm

Current consumption: 65mA

AR Glass Specification:

- Glass shape: 8.4*7.6mm(t=0.40mm)
- Wave Length(nm): 400~1100nm

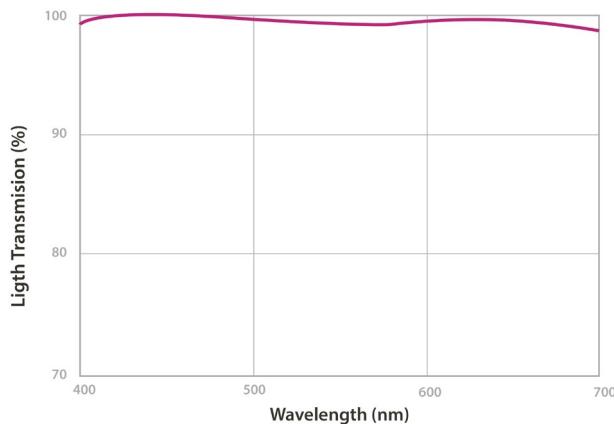


Figure : Light transmission vs. Wavelength for AR Glass taken from IR cut filter data sheet

Blue Glass Specification:

- Glass shape: 8.4*7.6mm(t=0.55mm)
- IR filter cut wave length(nm): 625 ± 10 nm

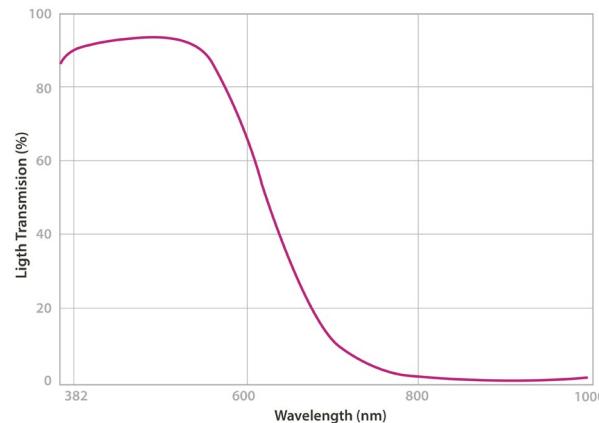


Figure : Light transmission vs. Wavelength for Blue Glass taken from IR cut filter data sheet

5. Board configuration and programming

5.1. Focusing the lens with microSD card

- 1º Load the code "Focusing the lens with microSD" in WaspMote. The code is in the examples section.
- 2º Open the serial monitor and wait for the picture
- 3º Check the picture in the microSD card and if it is necessary, loosen the fixing screw of the lens and rotate the lens in little steps.

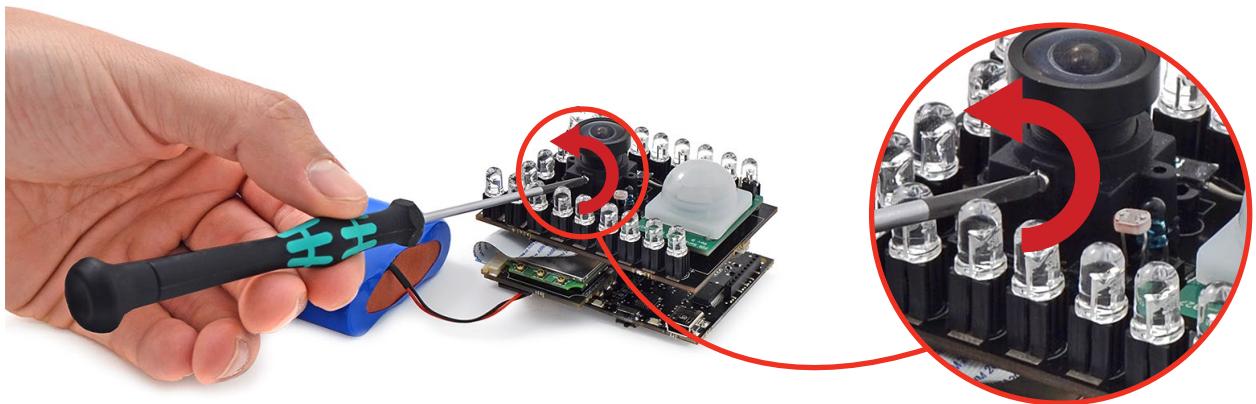


Figure : Loosing the fixing screw

- 4º Insert the microSD in WaspMote 3G/GPRS board and repeat the step 3 until focus the lens.
- 5º Tighten the fixing screw of the lens and power off WaspMote.

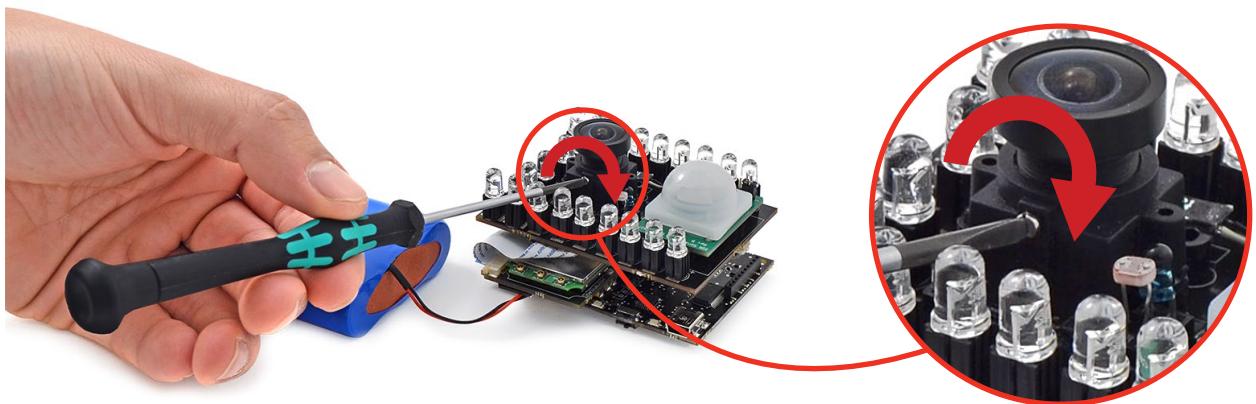


Figure : Tighten the fixing screw

5.2. Focusing the lens via videocall

A fast method to calibrate the lens is to make a videocall with WaspMote assembled and in the installation place.

1º Open the code "Focusing the lens via videocall", put your phone number in 'phone_number' variable and load the code in WaspMote. The code is in the 3G examples section of WaspMote IDE

2º Wait the videocall in your phone.

3º Loosen the fixing screw of the lens and rotate the lens until you can focus correctly.

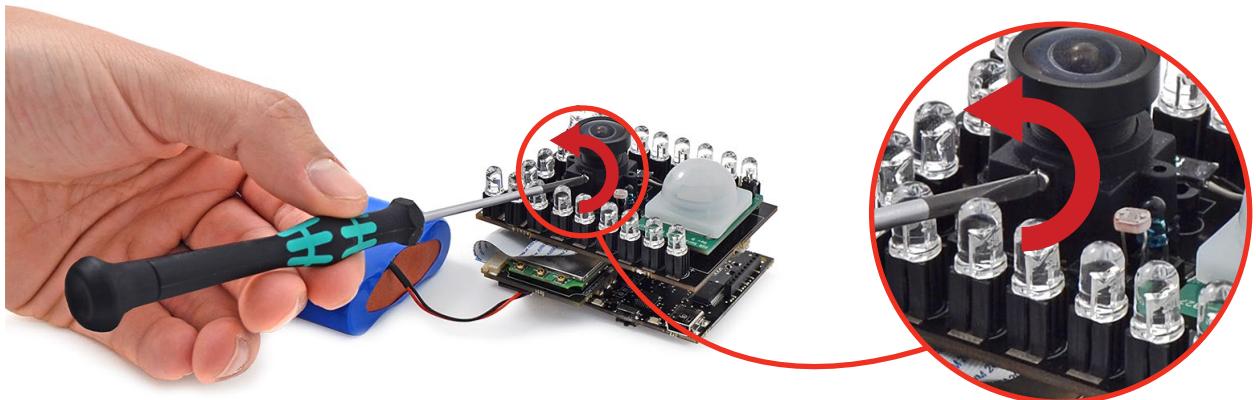


Figure : Loosing the fixing screw

4º Tighten the fixing screw of the lens and hang the videocall in the phone.

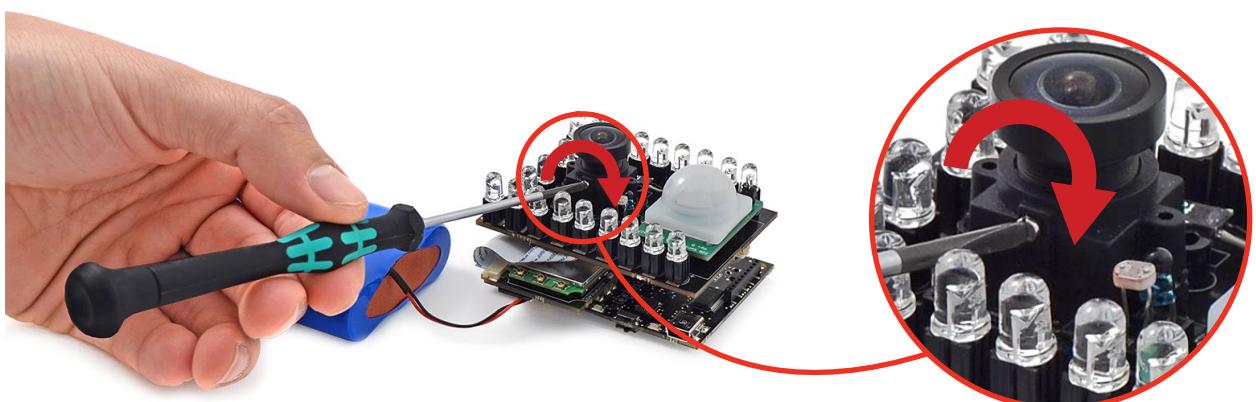


Figure : Tighten the fixing screw

5.3. Focusing the lens with calibration program (only for Windows)

- 1º Load the code "Focusing the lens with calibration program" in WaspMote from 3G examples of WaspMote IDE
- 2º Connect the WaspMote 3G/GPRS board to your computer with the miniUSB connector. Then power on WaspMote.

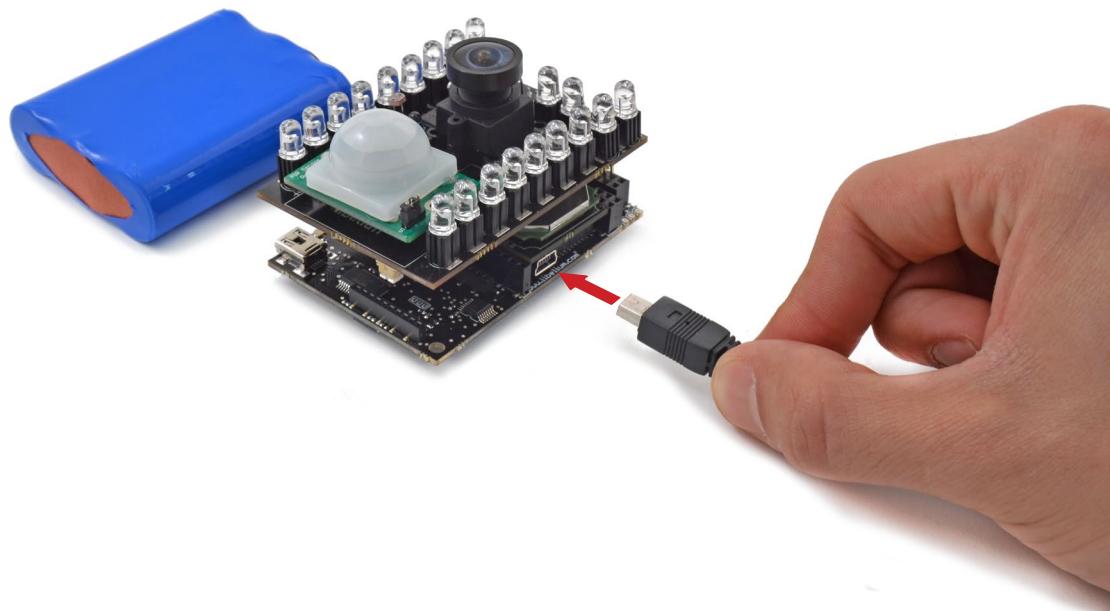


Figure : USB connector on WaspMote 3G/GPRS board

- 3º Open the CameraDemo.exe and select SIM5218

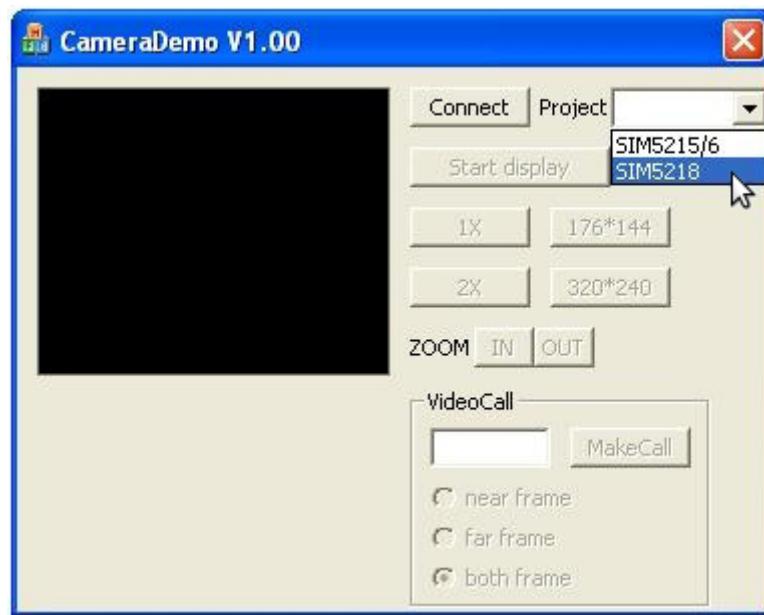


Figure : Select SIM5218 in CameraDemo program

4º Loosen the fixing screw of the lens and rotate the lens until you can focus correctly.

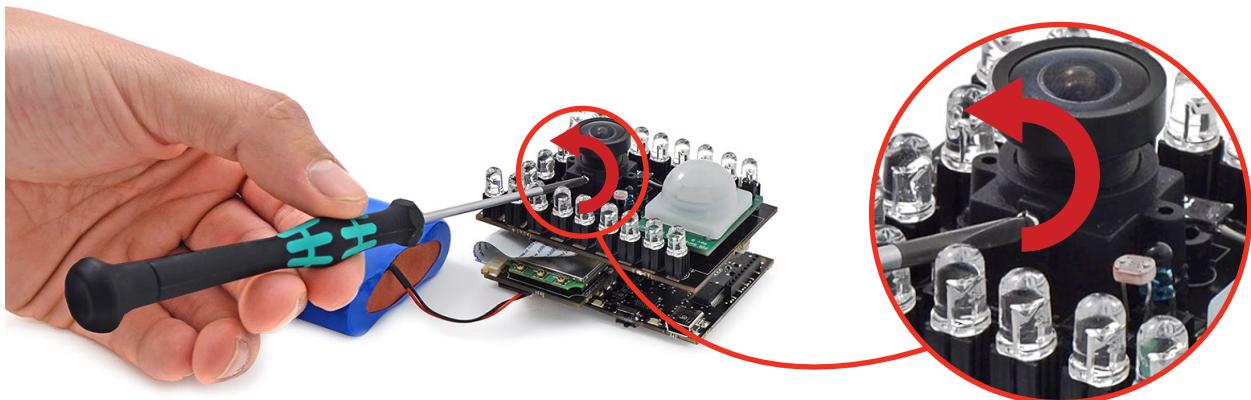


Figure : Loosing the fixing screw

5º Tighten the fixing screw of the lens and press disconnect button in CameraDemo. Close CameraDemo and unplug the USB from WaspMote 3G/GPRS board.

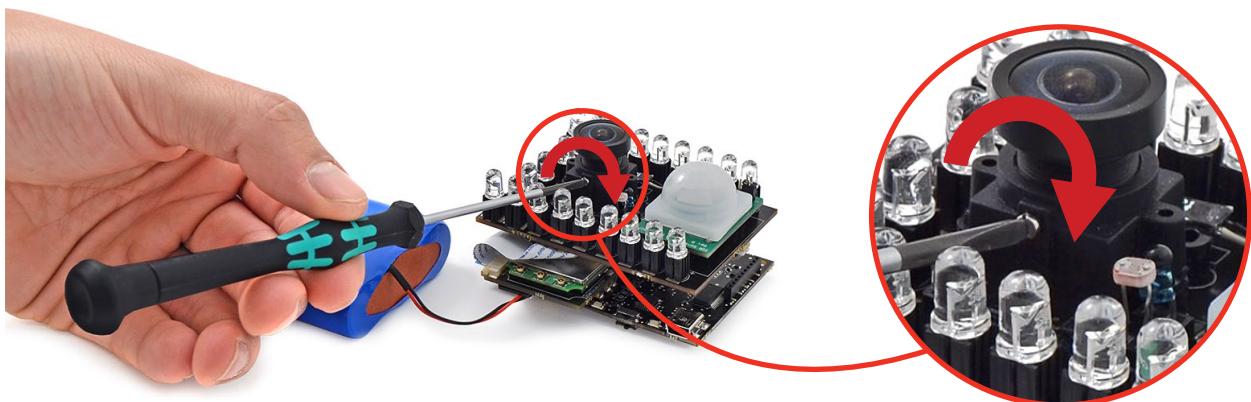


Figure : Tighten the fixing screw

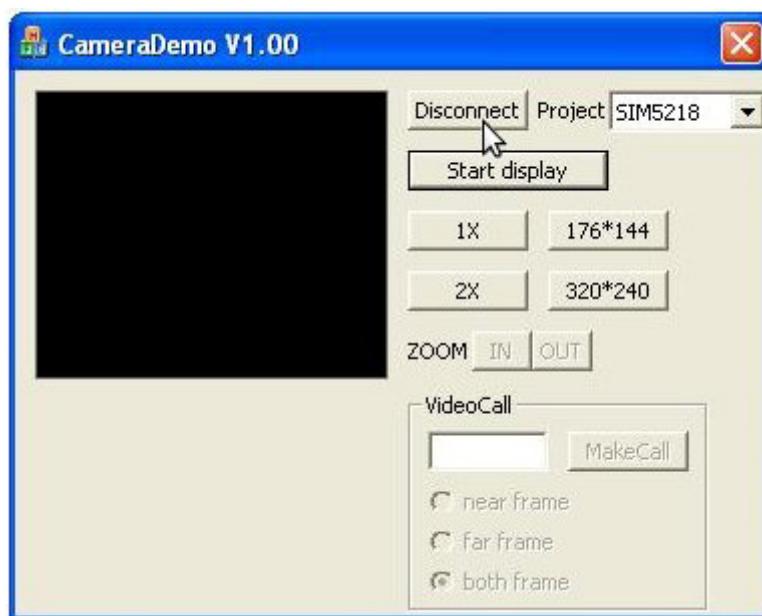


Figure : Disconnect the module and close CameraDemo

Now, the Video Camera Sensor Board has the lens calibrated. You can load your code on WaspMote.

5.4. Battery

We recommend the use of the 6600mAh rechargeable battery model and have an external power source to recharge it in case WaspMote + Video Camera Sensor Board has to be long time running.

5.5. API

The Video Camera Sensor Board is fully managed by WaspMote 3G/GPRS board. In consequence, WaspMote 3G/GPRS API must be used. For more information, please refer to the chapter "Camera related functions" in the WaspMote 3G/GPRS Networking Guide.

5.5.1. Starting the camera

The camera must be started before the use. To start the camera, use the function `startCamera()`.

Example of use:

```
{  
    // Starts the camera:  
    _3G.startCamera();  
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not detected
- '-3' if camera is already started

5.5.2. Stopping the camera

When do not use the camera, the function `stopCamera()` stops and turns off the camera reducing the power consumption.

Example of use:

```
{  
    // Stops the camera:  
    _3G.stopCamera();  
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started

5.5.3. Configuring the resolution

The camera can be configured with 6 different resolutions. The next table shows the resolution, the number of horizontal and vertical pixels and the library parameter to use with the function.

Resolution	HxV(pixels)	library parameter
STAMP	80x48	0
QQVGA	160x120	1
QCIF	176x144	2
QVGA	320x240	3
CIF	352x288	4
VGA	640x480	5

The highest resolution for pictures are VGA (5) and for videos are QVGA (3).

Example of use:

```
{
    // Sets QVGA resolution
    _3G.cameraResolution(3);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not detected
- '-3' if camera not started

5.5.4. Configuring the brightness

The camera has seven levels of brightness, from 0 to 6 (0 is the lowest, 6 is the highest).

Example of use:

```
{
    // Sets highest brightness
    _3G.cameraBrightness(6);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

5.5.5. Configuring the rotation

The image of the camera can be rotated in steps of 90 degrees: 0, 90, 180 and 270.

Example of use:

```
{
    // Rotates the camera 90 degrees
    _3G.cameraRotation("90");
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

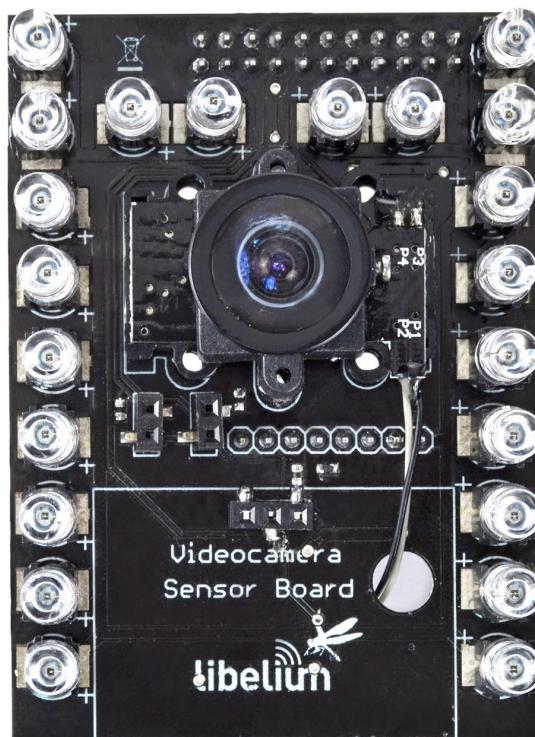


Figure : Camera with 0° rotation

5.5.6. Configuring the FPS

For record a video 3 different FPS can be selected. The parameters are '0' for 7.5 FPS, '1' for 10 FPS and '2' for 15 FPS

Example of use:

```
{
    // Selects 15 fps
    _3G.cameraFPS(2);
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

5.5.7. Configuring the picture name

The name of the pictures can be customized by the user. The name can have up to 20 characters. The name is only a part of the whole name; the whole name is namexxx.jpg where xxxx is an index of the picture after user defined name.

Example of use:

```
{  
    // Sets the name of the pictures  
    // The final name is → Test_name_xxxx.jpg  
    _3G.pictureName("Test_name_");  
}
```

This function returns:

- '1' on success
- '0' if error

5.5.8. Adding time stamp on pictures

The function `pictureTimeStamp()` allows to add a time stamp with the date and time of the 3G module.

Example of use:

```
{  
    // Adds time stamp  
    _3G.pictureTimeStamp(1);  
  
    // Don't add time stamp  
    _3G.pictureTimeStamp(0);  
}
```

This function returns:

- '1' on success
- '0' if error

5.5.9. Taking pictures

The function `takePicture()` takes a picture and stores it in the folder "Picture". To select if store in the module memory or the external microSD card use the function `selectStorage()`.

Example of use:

```
{  
    // Takes a picture:  
    _3G.takePicture();  
}
```

This function returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state
- '-4' if there isn't memory enough

5.5.10. Recording videos

There are 4 functions related with recording a video:

- `startVideo()`. Starts the recording of the video
- `pauseVideo()`. Pauses the recording of the video
- `resumeVideo()`. Resumes the recording of the video
- `stopVideo()`. Stops the recording of the video

Example of use:

```
{
    // Starts the recording:
    _3G.startVideo();

    // Records 15 seconds and pauses:
    delay(15000);
    _3G.pauseVideo();

    // Waits 5 seconds and resumes the record:
    delay(5000);
    _3G.resumeVideo();

    // Records 15 seconds and stops:
    delay(15000);
    _3G.stopVideo();

}
```

The function `startVideo()` returns:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state
- '-4' if there isn't memory enough

The functions `pauseVideo()`, `resumeVideo()` and `stopVideo()` return:

- '1' on success
- '0' if error
- '-2' if camera not started
- '-3' if camera is in invalid state

5.5.11. Making videocalls

It makes a videocall to the given telephone number. To do this you can use the function `makeVideoCall(phone_number, record)`. The input parameter 'record' allows to record the videocall. '0' not record video, '1' only record far-end video, '2' only record near-end video and '3' record both far-end and near-end, The video files have been saved in the folder VideoCall/

Example of use :

```
{
    // Makes a videocall and record both far-end and near-end:
    _3G.makeVideoCall("*****", 3);
}
```

This function returns:

- '1' if success
- '0' if error
- '-1' if error connecting to the other party,
- '-2' if error with setup or the other party hangs the call
- '-3' if error connecting the videocall
- '-4' if error recording the call (videocall is active)

To hang a videocall use the function `hangVideoCall()`.

Example of use:

```
{  
    // Hangs the active videocall:  
    _3G.hangVideoCall();  
}
```

This function returns:

- '1' if success
- '0' if error

5.5.12. Setting the video quality

The video quality can be selected with the function `VideoCallQuality(VideoQuality)`. The parameter `VideoQuality` can be between 5 for 5 for high quality image or 15 for high motion profile.

Note: This function can be used only when videocall is in idle state, and the setting is available until power off.

Example of use:

```
{  
    // Sets high quality image:  
    _3G.VideoCallQuality(5);  
}
```

This function returns:

- '1' if success
- '0' if error

5.5.13. Sending DMTF tones

DMTF tones can be sent during a videocall. Allowed tones are 0–9, * and #.

Example of use:

```
{  
    // Sends an example string:  
    _3G.VideoCallDMTF("0123456789*#");  
}
```

This function returns:

- '1' if success
- '0' if error

5.5.14. Managing IR LEDs

The IR LED blocks of the Video Camera Sensor Board can be managed with the function `powerIRLED(IR_block)`. The input parameter `IR_block` selects the illumination level: '0' powers off all LEDs, '1' powers on block 1, '2' powers on block 2 and '3' powers all LEDs.

Example of use:

```
{  
    // Power on IR LED block 1  
    _3G.powerIRLED(1);  
}
```

This function returns nothing.

5.5.15. Managing IR cut filter

The IR cut filter is managed with the function `selectFilter(filter_state)`. The input parameter `filter_state` selects the state of the filer: '0' enables the IR cut filter and '1' disables the filter.

Example of use:

```
{  
    // Power on IR LED block 1  
    _3G.powerIRLED(1);  
}
```

This function returns nothing.

5.5.16. Managing interrupts

Presence sensor allows to generate interrupts in WaspMote. The function `enablePIRInterrupt()` sets the 3G/GPRS Board in sleep mode, it activates the presence sensor and it waits until the sensor be ready.

The function `disablePIRInterrupt(PIR_state)` must be used when an interrupt occurs. The parameter `PIR_state` selects if the presence sensor it's power off (`PIR_state` is '0') and still active (`PIR_state` is '1'). The function blocks presence sensor to generate interrupts and wake up the 3G/GPRS from sleep mode. When a new interrupt is required use the function `enableInterrupt()`.

These functions return nothing.

The example code showed below use the interrupts functions to take the picture.

5.6. Example code

We provide below with a code suitable for take a picture and send via FTP server. Take into account that to work with this example you need an FTP account.

```

/*
 * This example shows how use the presence sensor interrupt taking a
 * picture and uploading it when the interrupt occurs. To use this example,
 * a Video Camera Sensor Board with presence sensor is required.
 *
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 *
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 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program. If not, see <http://www.gnu.org/licenses/>.
 *
 * Version:          1.0
 * Design:          David Gascón
 * Implementation:  Alejandro Gállego
 */

#include "Wasp3G.h"

int count=0;
int answer=0;

char picture_name[30];

void setup(){

    USB.ON();
    USB.println(F("Starting"));

    // Activates the 3G module:
    while (_3G.ON() != 1){
        USB.println(F("Waiting..."));
    }
    USB.println(F("3G module ready..."));

    _3G.setTime();

    _3G.setMode(_3G_RF_OFF);
    USB.println(F("RF circuits disabled"));

    // if there isn't a name the 3G module use the date and time for the picture's name
    _3G.pictureName("");

    // waits for SD and then selects as storage
    USB.println("Waiting for SD...");
    while (_3G.isSD() == 0);
    _3G.selectStorage(1);

    intArray[PIR_3G_POS] = 0;
}

```

```

void loop(){
    USB.print(F("Enabling PIR interrupt..."));
    _3G.enablePIRInterrupt();
    USB.println(F("ready"));

    // waits the interrupt
    do{
        PWR.sleep(0);
    }while ( intFlag & PIR_3G_INT == 0 );
    USB.println(F("PIR interrupt detected"));

    // disables the interrupt and start communications with the 3G module
    _3G.disablePIRInterrupt(1);

    USB.println(F("Changes power mode to full"));
    _3G.setMode(_3G_FULL);

    // starts the camera and configures it
    count = 3;
    do{
        answer[0] = _3G.startCamera();
    // if the camera is started (before startCamera function), stops it
        if(answer[0]==-3)
        {
            _3G.stopCamera();
        }
        count--;
    }while((answer[0] != 1) && (count > 0));

    if (answer == 1)
    {
        // configures the camera
        _3G.cameraResolution(5);
        _3G.cameraBrightness(3);

        count = 3;
        do{
            // power on the LED light if its necesary
            _3G.autoLight();
            answer = _3G.takePicture();

            // power off the LEDs
            _3G.powerIRLED(0);
            count--;
        }while ((answer != 1) && (count > 0));

        // saves the name of the picture
        strcpy(picture_name, _3G.buffer_3G);

        // stops the camera
        _3G.stopCamera();

        if (answer == 1){
            USB.println(F("Picture captured!"));
            USB.print(F("Connecting to the network..."));
            while (_3G.check() == 0);
            USB.println(F("connected"));

            // configures 3G connection for FTP
            answer = _3G.configureFTP("server_name", "server_port", "user_name", "password",
1, "I");
        }
    }
}

```

```
if (answer == 1)
{
    USB.print(F("Uploading the picture..."));
    USB.println(picture_name);

    // uploads file from SD card to the FTP server:
    answer = _3G.uploadFile(4, picture_name, 60);
    if (answer == 1)
    {
        USB.println(F("Upload done"));
    }
    else if(answer == -2)
    {
        USB.print(F("Upload failed. Error code: "));
        USB.println(answer, DEC);
        USB.print(F("CME error code: "));
        USB.println(_3G.CME_CMS_code, DEC);
    }
    else
    {
        USB.print(F("Upload failed. Error code: "));
        USB.println(answer, DEC);
    }
}
else
{
    USB.print(F("Configuration failed. Error code:"));
    USB.println(answer, DEC);
}
else
{
    USB.print(F("Error taking the picture. Error code:"));
    USB.println(answer, DEC);
}
else
{
    USB.print("Error starting the camera. Error code: ");
    USB.println(answer, DEC);
}

_3G.setMode(_3G_RF_OFF);
USB.println(F("RF circuits disabled"));
}
```

6. Sending the photos and videos

WaspMote can take pictures from two states. When WaspMote and the 3G/GPRS are in sleep mode it can wake up and take a photo or start recording a video in 1,3 or 1,7 seconds according to the configuration of the camera. If the module 3G/GPRS starts from the OFF state, the time required increases to 11-15 seconds due to the initialization time required. The table below contains the time required to take a picture or to start recording a video in the different configurations.

Initial state	Configuration	Time (s)
WaspMote and 3G/GPRS board are in sleep mode (consumption: 1-1,5mA)	Minimum	1,3
	Complete	1,7
WaspMote is in sleep mode and 3G/GPRS board is off (consumption: 60µA)	Minimum	13-17
	Complete	14-18

Figure : Time required to take a photo or start a video record

The minimum configuration do the next actions:

- 1st Disables the interruption from the presence sensor (PIR).
- 2nd Start the camera
- 3rd Check the ambient light and selects the IR cut filter
- 4th Sets the resolution
- 5th Takes the photo or starts to record
- 6th Power off the IR LEDs

The complete configuration do the next actions:

- 1st Disables the interruption from the presence sensor (PIR).
- 2nd Start the camera
- 3rd Check the ambient light and selects the IR cut filter
- 4th Sets the resolution
- 5th Brightness Setup
- 6th Rotates the image
- 7th Takes the photo or starts to record
- 8th Power off the IR LEDs

Once the photo has been taken or the video has been recorded, the file can be:

- sent to an FTP server
- sent as an attachment in an email
- stored in a Meshlium

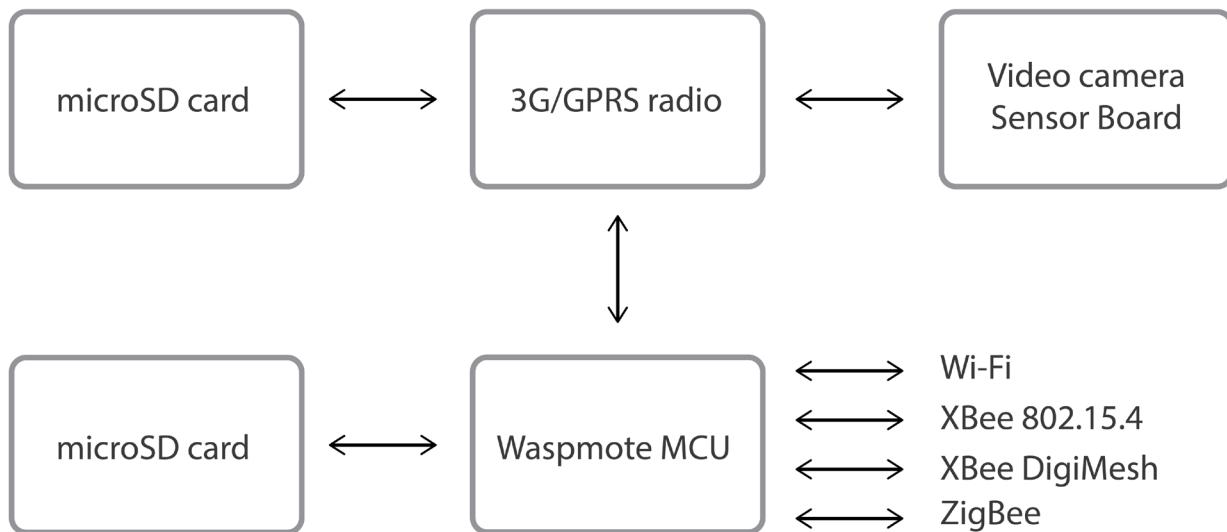


Figure : General flow diagram to send photos and videos

The fastest way to send the photos and the videos is by using the 3G connection. This transmission method has two advantages over WiFi. The first one is the data location, the files (photos or videos) are stored directly into the 3G/GPRS module or in the microSD card of the 3G/GPRS board. So, the transmission of data to send is not limited by the baudrate of the UART (limited to 115200 bps). The second one is the transmission speed of the 3G connection (HSUPA up to 5.76Mbps). This allows a fast upload of the file (20 seconds to configure the access to the FTP server and upload 100KB) and a reduction of the time WaspMote is powered ON.

The second transmission way is WiFi. The file must be stored first in the microSD card of WaspMote and then send to the WiFi module for send to the network. The advantages of this method are the high number of WiFi networks available and the high transmission speeds (the time required to upload a file it's around 90 seconds).

A short time of transmission is very important to increase the life of the battery.

Refer to table "Time required to send a photo" in section "Sending times"

6.1. Sending photos and videos by 3G/GPRS

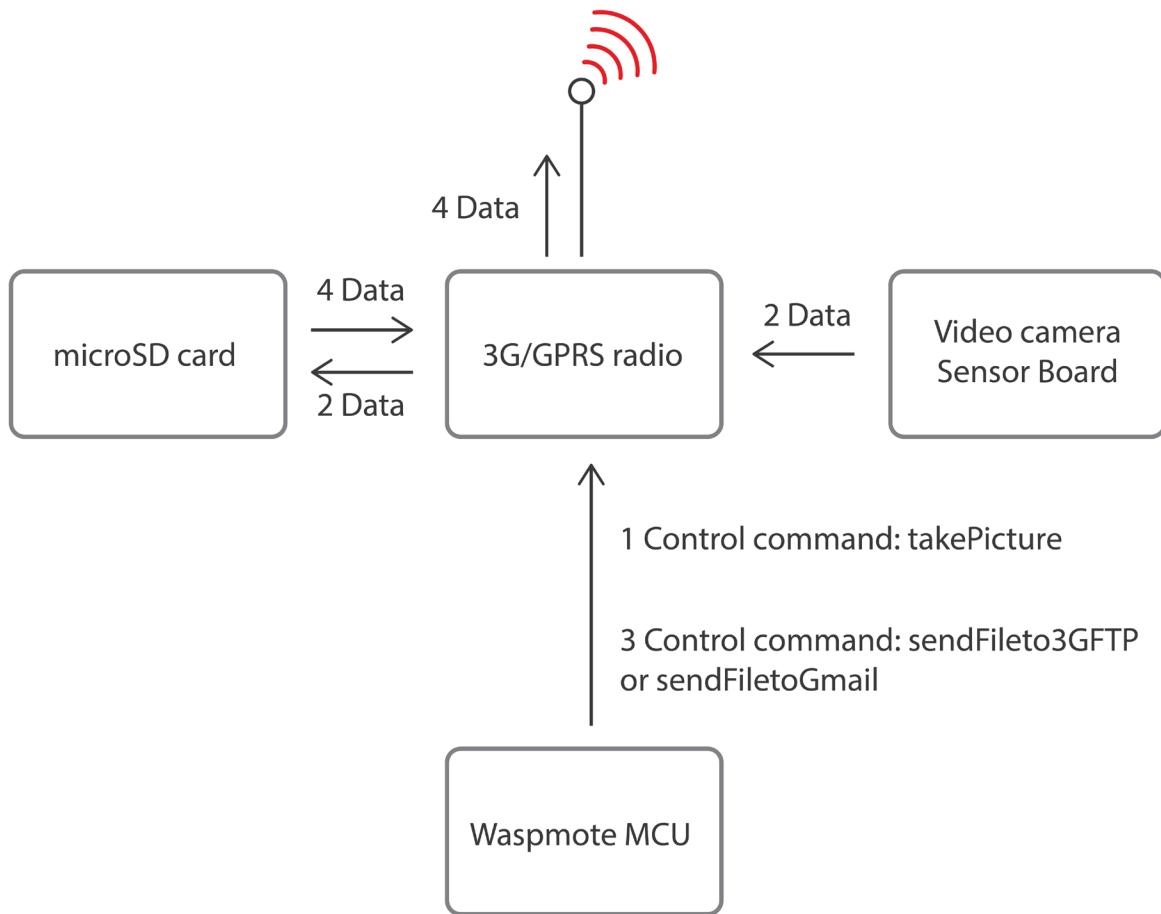


Figure : Flow diagram to send photos and videos via 3G/GPRS connection

3G/GPRS radio is the fast way to upload the multimedia content obtained from the Video Camera Sensor Board. With this method, WaspMote only manages the commands to work with the 3G/GPRS and the Video Camera Sensor Board (steps 1 and 3). The data flows from the camera to the microSD card of the 3G/GPRS module (step 2) and, then, from the microSD card to the network (step 4).

These are the steps:

- Step 1: WaspMote manages the commands to take the photo or the video.
- Step 2: 3G/GPRS Board takes photo or video data from the sensor and stores in its own microSD card.
- Step 3: WaspMote manages the connection of the 3G/GPRS Board to the network.
- Step 4: The 3G/GPRS Board sends the file as attachment in an email or to FTP server.

The API has got developed two functions to send the photos via SMTP or upload photos and videos to an FTP server. Refer to the “API” subsection in this chapter for more information about these commands.

Note for USA users: We have tested the new 3G shield with the AT&T network which supports natively the GSM and 3G protocols. With other carriers may also work although we haven't tried and thus we can not ensure it. For this reason we recommend to use AT&T SIM cards.

6.2. Sending photos and videos by WiFi

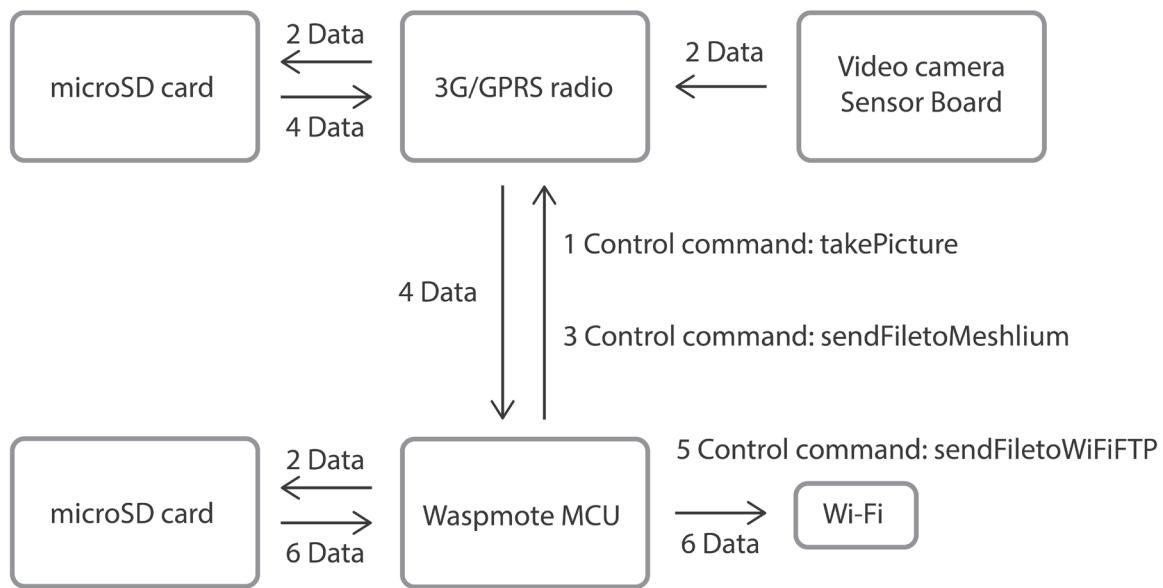


Figure : Flow diagram to send photos and videos to FTP server via WiFi

You can send the photo or video captured to the network using WiFi radio.

These are the steps:

- Step 1: Waspmote manages the commands to take the photo or the video.
- Step 2: 3G/GPRS Board takes photo or video data from the sensor and stores in its own microSD card.
- Step 3: Waspmote manages the commands to extract the file and store it in the microSD card.
- Step 4: 3G/GPRS Board sends the file to Waspmote.
- Step 5: Waspmote join to the WLAN and connects to the FTP server.
- Step 6: Waspmote sends the file to the FTP via WiFi.

The function `sendFiletoWiFiFTP()` have been developed to manage the transfer from Waspmote to the network (steps 3 to 6). Refer to the “API” subsection in this chapter for more information.

6.3. Sending times

Radio	Destiny	Time (s)
3G/GPRS	Upload to FTP	16
	Attach in an email	18
WiFi	Upload to FTP	90

Figure : Time required to send a photo (100KB)

These times correspond to the transmission of an image of max resolution 640x480 (100KB). Lower image resolutions decrease dramatically the transmission time.

6.4. API

6.4.1. Sending pictures or videos to an FTP server with WiFi

This function uses the WiFi module to send the pictures or the videos captures by the Video Camera Sensor Board. You must include the Wi-Fi libraries before the 3G libraries. The function, `sendFiletoWiFiFTP`, needs the next input parameters:

- Name of the file to send in WaspMote 3G/GPRS Board. The file must be in the current directory
- Name of the file to save in the FTP server
- FTP address
- FTP port
- FTP mode: 0 for passive mode and 1 for proactive mode
- FTP username
- FTP password
- WiFi encryption: WEP, WPA1, WPAMIX and WPA2
- WiFi password
- SSID

Example of use:

```
{  
    // First, goes to the folder with the videos  
    _3G.goRoot(1);  
    _3G.cd("Video");  
    // Then, sends VIDEO01.mp4 to FTP  
    _3G._3G.sendFiletoWiFiFTP("VIDEO01.mp4", ""VIDEO01.mp4", "ftp.server.com",  
        21, 0, "FTP_username", "FTP_password", WPA2, "wifi_pass", "SSID");  
}
```

The function returns:

- '1' if success
- '-2' if error setting the connection options
- '-3' if error setting the DHCP options
- '-4' if error setting FTP parameters
- '-5' if error setting authentication key
- '-6' if error setting the join mode
- '-7' if error joining to the WiFi network
- '-8' if error opening the FTP session
- '-9' if error uploading the file

6.4.2. Sending pictures or videos to an FTP server with 3G/GPRS Board

The function `sendFileto3GFTP` configures the 3G/GPRS Board to send an image to an FTP server using the 3G or GPRS connection. The parameters needed in order are the next:

- Location of the file: 0 for current directory, 1 for "C:/Picture" directory, 2 for "C:/Video" directory, 4 for "D:/Picture" directory and 5 for "D:/Video" directory
- Name of the file
- FTP address
- FTP port
- FTP mode: 0 for proactive mode and 1 for passive mode
- FTP username
- FTP password

Example of use:

```
{  
    // Sends PIC_0003.jpg from C:/Picture to an FTP server  
    _3G.sendFileto3GFTP(1, "PIC_0003.jpg", "ftp.server.com", "FTP_port", 1,  
        "FTP_username", "FTP_password");  
}
```

The function returns:

- '1' on success
- '-2' if error setting the connection parameters (APN)
- '-3' if error setting the FTP server ('-13' if CME error available)
- '-4' if error setting the FTP port ('-14' if CME error available)
- '-5' if error setting the FTP mode ('-15' if CME error available)
- '-6' if error setting the FTP type ('-16' if CME error available)
- '-7' if error setting the user name ('-17' if CME error available)
- '-8' if error setting the FTP password ('-18' if CME error available)
- '-20' if error uploading the file
- '-22' if error with CME code (FTP error)
- '-23' if error getting the file of the size to upload

6.4.3. Sending a picture as attachment of an email with 3G/GPRS Board

The function `sendFileto3Gemail` sends an email with a picture or a video attached. The parameters needed in order are the next:

- SMTP server
- SMTP port
- STMP account
- STMP password
- Sender address
- Sender name
- Recipient address
- Recipient name
- Subject of the email
- Body of the email
- Picture name

Example of use:

```
{  
    // Sends PIC_0016.jpg from C:/Picture to an FTP server  
    _3G.sendFileto3Gemail("smtp.server.com", 995,  
        "smtp_user@mail.com", "smtp_password", "sender_addr@mail.com",  
        sender_name, "recipient_addr@mail.com", recipient_name,  
        "Email_subject", "Email_body", "PIC_0016.jpg");  
}
```

The function returns:

- '1' if success
- '0' if error setting username and password
- '-1' if error setting server and port
- '-2' if error setting sender address and name
- '-3' if error setting recipient address and name
- '-4' if error setting subject
- '-5' if error setting the body
- '-6' if error attaching the file
- '-7' if error sending the email

7. Consumption

This board uses four power supplies. The image sensor, luminosity sensor, IR sensor and logic of IR cut filter driver are powered through 3'3V sensor power. The image sensor also uses 2'8V power supply from WaspMote 3G/GPRS board (control isn't necessary). Presence sensor is powered by GPS power. The IR LEDs and the power driver for the IR cut filter are powered directly by battery pin.

Table of consumption

	Consumption
Board Off	0µA
Camera sensor	48mA
Luminosity sensor	<100uA
IR sensor	100µA max.
Presence sensor	100µA
LED block 1	200mA at 3,7V; 270mA at 4,2V
LED block 2	390mA at 3,7V; 490mA at 4,2V
IR cut filter	65mA

8. API changelog

Keep track of the software changes on this link:

www.libelium.com/development/wasp mote/documentation/changelog/#Videocamera

9. Documentation changelog

From v4.2 to v4.3

- References to the new Sigfox module

From v4.1 to v4.2

- Added notes about transmission times when the module sends a picture.
- Feature for transmission of files (photo/video) to Meshlium via XBee was discontinued
- References to the new LoRa module
- Created new chapter "API changelog"

From v4.0 to v4.1

- Added notes about carriers in US in section "Sending photos and videos by 3G/GPRS."

10. Maintenance

- In this section, the term "Waspmote" encompasses both the Waspmote device itself as well as its modules and sensor boards.
- Take care with the handling of Waspmote, do not drop it, bang it or move it sharply.
- Avoid putting the devices in areas of high temperatures since the electronic components may be damaged.
- The antennas are lightly threaded to the connector; do not force them as this could damage the connectors.
- Do not use any type of paint for the device, which may damage the functioning of the connections and closure mechanisms.

11. Disposal and recycling

- In this section, the term "Wasp mote" encompasses both the Wasp mote device itself as well as its modules and sensor boards.
- When Wasp mote reaches the end of its useful life, it must be taken to a recycling point for electronic equipment.
- The equipment has to be disposed on a selective waste collection system, different to that of urban solid waste. Please, dispose it properly.
- Your distributor will inform you about the most appropriate and environmentally friendly waste process for the used product and its packaging.

