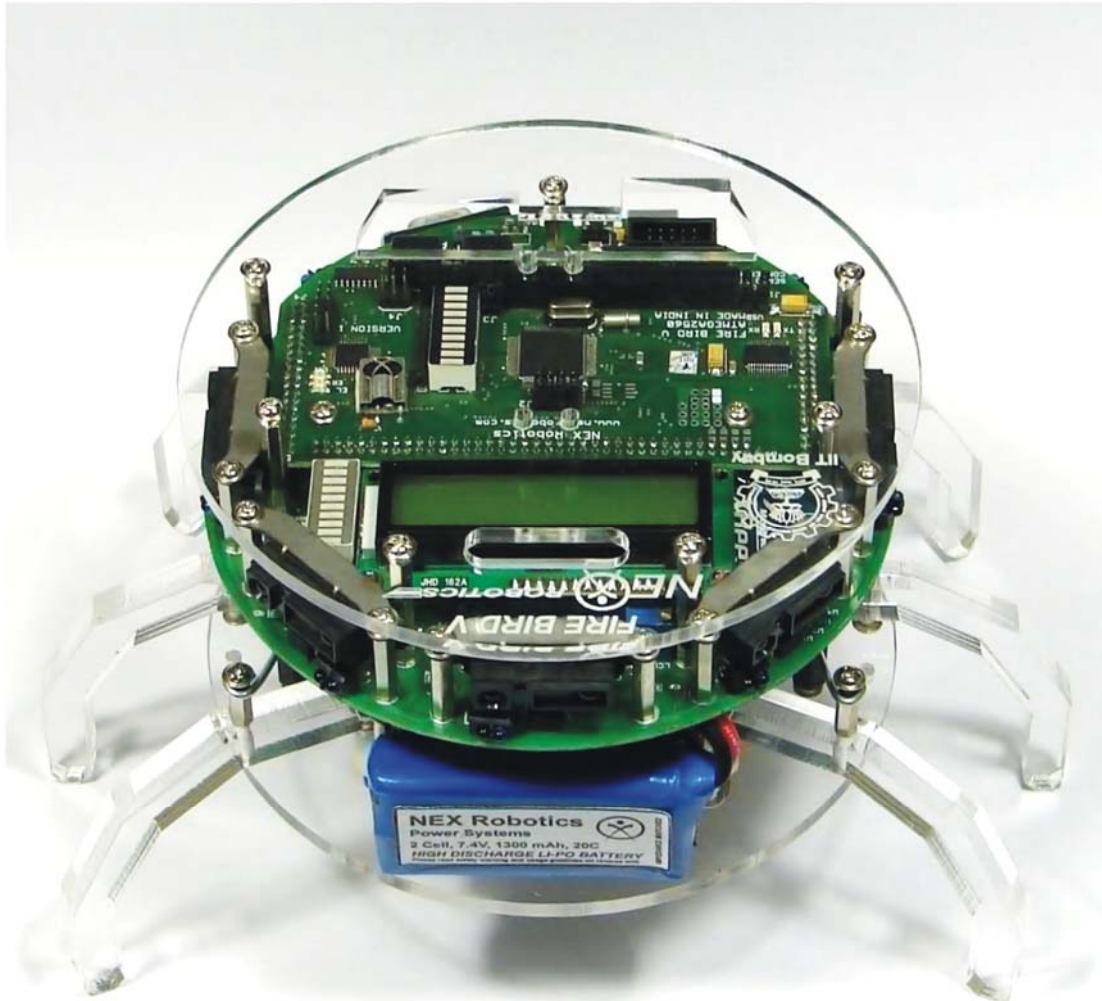


FIRE BIRD V

ATMEGA2560 INSECT ROBOTIC RESEARCH PLATFORM USER GUIDE

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Designed By:



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FIRE BIRD V



INSECT ROBOT USER GUIDE

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Notice

The contents of this manual are subject to change without notice. All efforts have been made to ensure the accuracy of contents in this manual. However, should any errors be detected, NEX Robotics welcomes your corrections. You can send us your queries / suggestions at info@nex-robotics.com



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Warning

Fire Bird V Insect Robot uses Lithium Polymer Battery. Refer to this user guide for the battery handling and charging instructions.

If robot is used even when battery low indicator buzzer is on, it will cause the battery to deep discharge. In this case, the battery charger will not charge batteries for safety reasons.



-  **Robot's electronics is static sensitive. Use robot in static free environment.**
-  **Read the hardware and software manual completely before start using this robot**



Recycling:

Almost all of the robot parts are recyclable. Please send the robot parts to the recycling plant after its operational life. By recycling we can contribute to cleaner and healthier environment for the future generations.

Important:

1. Use this Application note with the Fire Bird V Hardware and Software Manual.
2. User must go through the Fire Bird V's Hardware and Software manuals before using the robot.
3. Crystal of the ATMEGA2560 microcontroller is upgraded to 14.7456MHz from 11.0592Mhz in all the Fire Bird V ATMEGA2560 robots delivered on or after 1st December 2010. This documentation is made considering crystal frequency as 14.7456MHz.

1. Introduction


Thanks for choosing the Fire Bird V mobile robot platform. Fire Bird V will give you good exposure to the world of robotics and embedded systems. Thanks to its innovative architecture and adoption of the ‘Open Source Philosophy’ in its software and hardware design, you will be able to create and contribute to complex applications that run on this platform, helping you acquire expertise as you spend more time with them.

Safety precautions:

- Robot’s electronics is static sensitive. Use robot in static free environment.
- Read the assembling and operating instructions before working with the robot.
- If robot’s battery low buzzer starts beeping, immediately charge the batteries.
- To prevent fire hazard, do not expose the equipment to rain or moisture.
- Refrain from dismantling the unit or any of its accessories once robot is assembled.
- Charge the Lithium Polymer battery only with the charger provided with the robot.
- Never allow Lithium Polymer battery to deep discharge. Charger will not charge deep discharged battery.
- Mount all the components with correct polarity.
- Keep wheels away from long hair or fur.
- Keep the robot away from the wet areas. Contact with water will damage the robot.
- To avoid risks of fall, keep your robot in a stable position.
- Do not attach any connectors while robot is powered ON.
- Never leave the robot powered ON when it is not in use.
- Disconnect the battery charger after charging the robot.

Inappropriate Operation:

Inappropriate operation can damage your robot. Inappropriate operation includes, but is not limited to:

- Dropping the robot, running it off an edge, or otherwise operating it in an irresponsible manner.
- Interfacing new hardware without considering compatibility
- Overloading the robot above its payload capacity.
- Exposing the robot to wet environments.
- Continuing to run the robot after hair, yarn, string, or any other item has become entangled in the robot’s axles or wheels.
- All other forms of inappropriate operation.
- Using robot in areas prone to static electricity.
- Read carefully paragraphs marked with  caution symbol.

Warning

Fire Bird V Insect Robot uses Lithium Polymer Battery. Refer to this user guide for the battery handling and charging instructions.

If robot is used even when battery low indicator buzzer is on, it will cause the battery to deep discharge. In this case, the battery charger will not charge batteries for safety reasons.

2. Fire Bird V ATMEGA2560 Insect Robot

Important: Use Fire Bird V ATMEGA2560 Hardware and Software manual along with this application note.

The Fire Bird V robot is the 5th in the Fire Bird series of robots. First two versions of the robots were designed for the Embedded Real-Time Systems Lab, Department of Computer Science and Engineering, IIT Bombay. These platforms were made commercially available from the version 3 onwards. All the Fire Bird V series robots share the same main board and other accessories. Different family of microcontrollers can be added by simply changing top microcontroller adaptor board. Fire Bird V supports ATMEGA2560 (AVR), P89V51RD2 (8051) and LPC2148 (ARM7) microcontroller adaptor boards. This modularity in changing the microcontroller adaptor boards makes Fire Bird V robots very versatile. User can also add his own custom designed microcontroller adaptor board.

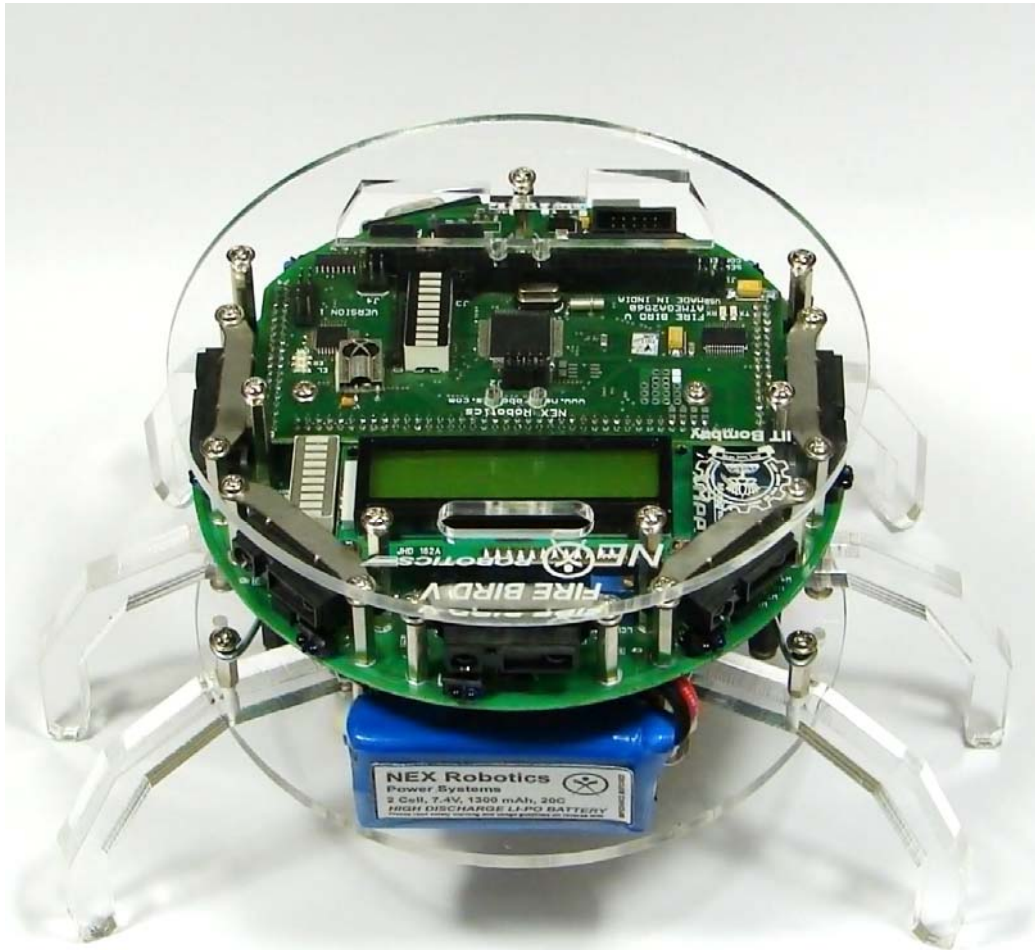


Figure 2.1: Fire Bird V Insect Robot

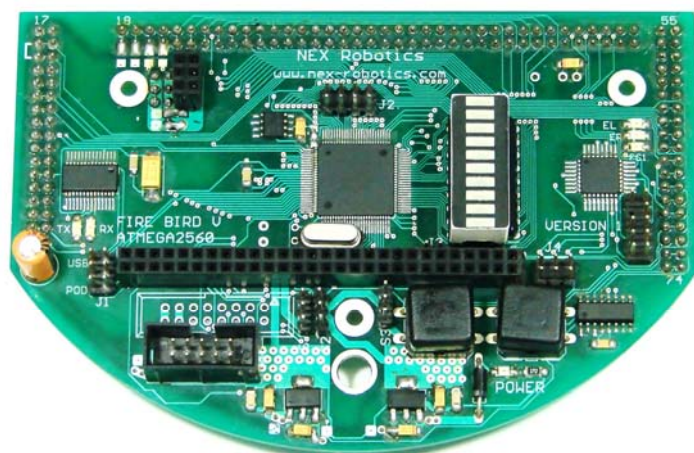


Figure 2.2: ATMEGA2560 (AVR) microcontroller adaptor board on Fire Bird V Insect Robot

2.1 Fire Bird V Specifications:

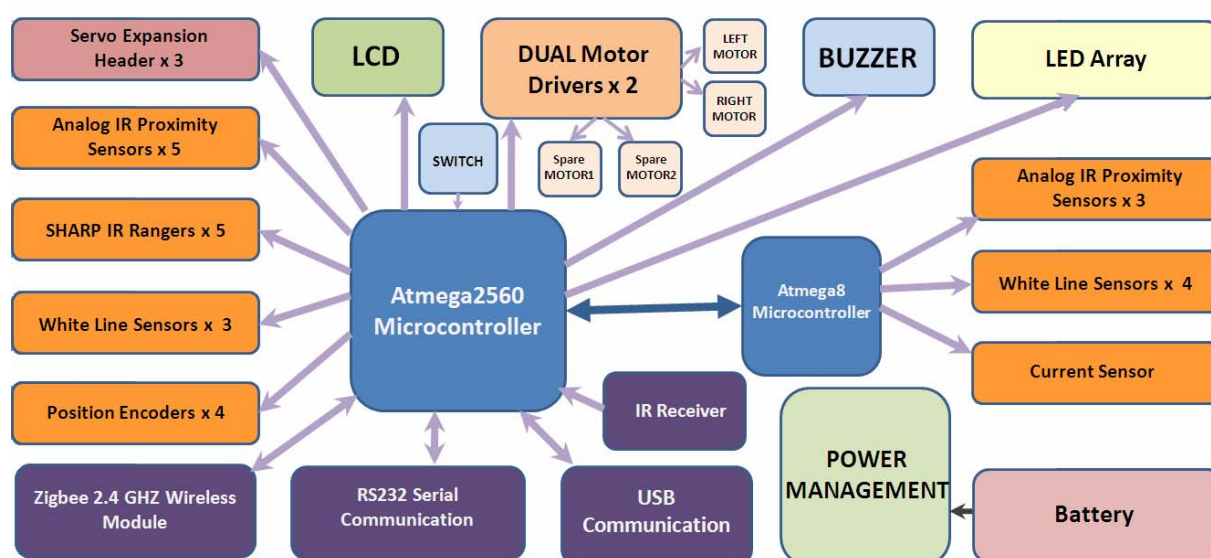


Figure 2.3: Fire Bird V ATMEGA2560 robot block diagram

Note:

All the features of the Fire Bird ATMEGA2560 Insect Robot except the Battery, Battery charging and the locomotion are exactly same as of Fire Bird V standard model. Use this user guide along with the robot's hardware and software manual.

Fire Bird V ATMEGA2560 technical specification

Microcontroller:

Atmel ATMEGA2560 as Master microcontroller (AVR architecture based Microcontroller)

Atmel ATMEGA8 as Slave microcontroller (AVR architecture based Microcontroller)

Sensors:

Five Sharp GP2D12 IR range sensor (One in default configuration)

Eight analog IR proximity sensors

Eight analog directional light intensity sensors

Battery voltage sensing

Current Sensing (Optional)

Indicators:

2 x 16 Characters LCD

Indicator LEDs

Buzzer

Control:

Autonomous Control

PC as Master and Robot as Slave in wired or wireless mode

Communication:

Wireless ZigBee Communication (2.4GHZ) (if ZigBee wireless module is installed)

USB Communication

Wired RS232 (serial) communication

Simplex infrared communication (From infrared remote to robot)

Dimensions:

Height: 13cm

Length: 16cm

Width: 24.5cm

Weight: 1500gms

Power:

7.4V, 1300mAh Lithium Polymer battery (NR-BLiPo-2-1300) with smart battery charger NR-BLIC-03

Battery Life:

30 minutes while motors are operational at 75% of time

Locomotion:

Three high torque, metal gear Servo motors (NRS-995) driving six legs in the pairs of two

Important

For the safety during transportation, robot's battery is disconnected. Before connecting battery to the robot, make sure that power switch is moved towards back direction of the robot (AP). You need to charge the battery before first use. Refer to section 2.2 for battery charging.

2.2 Battery Charging

Fire Bird V Insect robot requires higher current than standard configuration robot. In order to fulfill this additional current requirement while keeping weight low, 7.4V, 1300mAh lithium polymer battery (Product code: NR-BLiPo-2-1300) is used. It can supply discharge current up to 26 Amps.

Never allow battery to go below 6.6V. Robot's battery low indication threshold is set at 6.6V. When battery voltage drops below 6.6V, Battery buzzer will start beeping.

In multi-celled Lithium Polymer battery pack, it is possible for the individual cells to develop differences in their charge levels. Since Lithium Polymer batteries are very sensitive to overcharging, it is important that cells inside the battery pack should be kept at the equal levels when charging.

Fire Bird V Insect robot comes with its own NR-BLIC-02 or NR-BLIC-03 balance charger from the NEX Robotics. While charging the batteries it monitors individual cell voltages of the battery pack and it adjusts the rate of charge to the individual battery to do balance charging. NR-BLIC-02 operates on 12 to 15V DC while NR-BLIC-03 operates on 110 to 240V AC. Use only NR-BLIC-02 or NR-BLIC-03 battery charger for battery charging.



Figure 2.4: NR-BLIC-02 and NR-BLIC-03 battery charger from NEX Robotics



Figure 2.5: Lithium Polymer battery NR-BLiPo-2-1300



Figure 2.6: Connecting battery charger NR-BLIC-03 to the robot

Warning

In case of Fire Bird V Tank Drive robot Never ever charge the battery while the robot is on. It will damage battery or charger or both.

If robot is used even when battery low indicator buzzer is on, it will cause the battery to deep discharge. In this case, the battery charger will not charge batteries for safety reasons.

Instructions for the battery charging:

For battery charging instructions refer to “Lithium Polymer Balance Charger NR-BLIC-02, NEX Robotics.pdf” or “Lithium Polymer Balance Charger NR-BLIC-03, NEX Robotics.pdf” which is located in the “Manuals and Application notes” folder in the documentation CD.

Two cell and three cell battery packs from the NEX Robotics has different types of connectors. These batteries will go only in the correct type of connector of the Battery Charger.

Warning:

- Do not charge 2 cell and 3 cell batteries at the same time.
- Charge batteries which can handle 650mA charging current.
- If battery is hot or slightly warm allow it to cool down completely before charging.
- Do not open battery packs and modify them. Modified packs will not have matched impedance, which can lead to dangerous situations.
- Always charge batteries in open space of at least 10feet x 10feet on the concrete floor.
- Do not charge battery near flammable liquids.
- While charging put batteries away from children.

Important:

Never ever allow battery to discharge below 3.3V per cell i.e. 6.6V for 2 cell battery packs or 9.9V for 3cell battery packs. After this critical value battery voltage falls very rapidly. Robot will start giving battery low warning after battery voltage reaches 6.8V. Battery charger will not charge any deep discharged battery pack and it will indicate fault condition. This is done for the safety reasons.

2.3 Battery Maintenance

In general Lithium Polymer battery does not require special maintenance. Charge battery at least once a month. Never allow battery voltage fall below 6.6V.

2.4 Locomotion using 3 Servo motors

Fire Bird V ATMEGA2560 Insect Robot uses three servo motors to control to move six legs in pairs for the locomotion. Left servo motor drives left front and back legs. Right servo motor drives right front and back legs. Center servo motor controls middle left and right legs.

Connect left servo motor to the S1 servo motor socket, right servo motor to the S2 servo motor socket and center servomotor to the S3 servo motor socket.

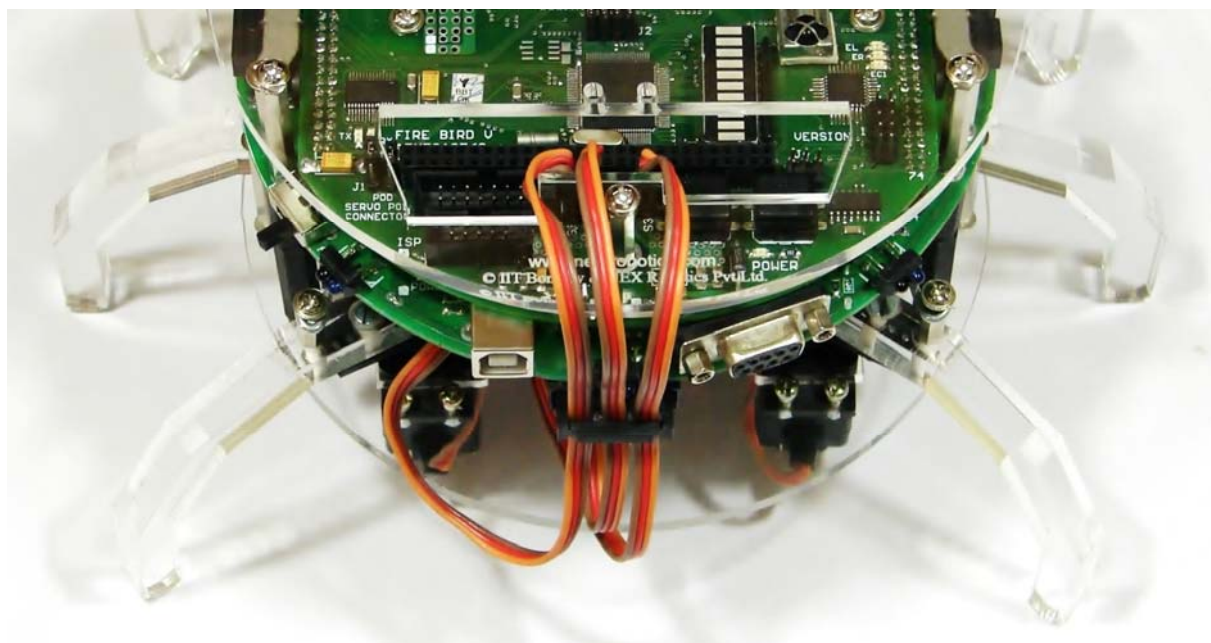


Figure 2.7: Servo motor connections

Servo motor is an essentially geared DC motor which rotates from 0° to 180° based upon input signal in the form of pulse train. Servo control is done by sending a PWM signal to the PWM input pin of the servo motor. The servo motor compares this signal to the actual position of the servo and adjusts the angle of the servo motor accordingly. Position of the servo motor is determined by the pulse width of waveform which has frequency between 30Hz to 60Hz. Generic servo motor gives 0 to 180 degrees rotation for pulse width of 1 to 2 milliseconds. 50Hz is considered as ideal frequency.

For servo motor control code explanation refer to chapter 5 section 5.4 from the Software Manual.

Microcontroller Pin	Servo socket	Function
PB5 (OC1A)	S1	Left Servo motor: left front and back legs
PB6 (OC1B)	S2	Right Servo motor: Right front and back legs
PB7 (OC1C)	S3	Center Servo motor: Center left and right legs

Table 2.1: Servo motor connections

2.5 Application example for robot motion control

Located in the folder “Experiments \ Fire Bire V Insect Robot” folder in the documentation CD.

This experiment demonstrates robot walk using 3 servo motors

Concepts covered:

Use of timer to generate PWM for servo motor control.

Simple insect motion using servo motors

Connections: Refer to table 2.1 for connection details.

Note:

1. Make sure that in the configuration options following settings are done for proper operation of the code

Microcontroller: atmega2560

Frequency: 14745600

Optimization: -Os

(For more information read section: Selecting proper optimization options below figure 2.20 in the Software Manual)

3. Robot Control using ‘GUI’ for Fire Bird V ATMEGA2560 Insect Robot

Fire Bird V ATMEGA2560 Insect robot can be controlled by GUI via serial / USB cable or using ZigBee wireless module. To control the robot using GUI, via RS232 serial communication / USB communication or wireless communication load appropriate hex file on the robot. GUI works on at the 115200 baud rate.

3.1 Loading firmware on the robot

Step 1:

Following firmware (.hex file) needs to be loaded on the robot depending on the mode of communication used.

RS232 serial communication: “INSECT_Serial_GUI.hex”

USB communication: “INSECT_USB_GUI.hex”

ZigBee wireless module based communication: “INSECT_XBEE_GUI.hex”

All these hex files are located in the “GUI and Related Firmware \ FB5 Insect Robot” folder.

For information on how to load hex file, refer to chapter 2 of the Software Manual.

Step 2: Connect serial / USB wire link between robot and PC or install ZigBee wireless module on the robot and connect wireless ZigBee USB module to the PC.

Step 3: Install GUI software

3.2 Installing GUI

Copy “FIRE BIRD V Atmega2560 Insect Robot setup” folder which is located inside the folder “GUI and Related Firmware \ FB5 Insect Robot”

Click on setup.exe which is located in the “FIRE BIRD V Atmega2560 Insect Robot setup” folder.

Follow rest of the steps as mentioned in the Chapter 7 of the Hardware Manual.

3.3 Using GUI

After successful installation go to Start -> All Programs -> FIRE BIRD V Amega2560 -> FIRE BIRD V Atmega2560 Insect Robot or click on “FIRE BIRD V Atmega2560 Insect Robot” thumbnail on your desktop location, GUI will open.

Follow same steps as mentioned in the chapter 7 from the Hardware Manual to establish the connection.

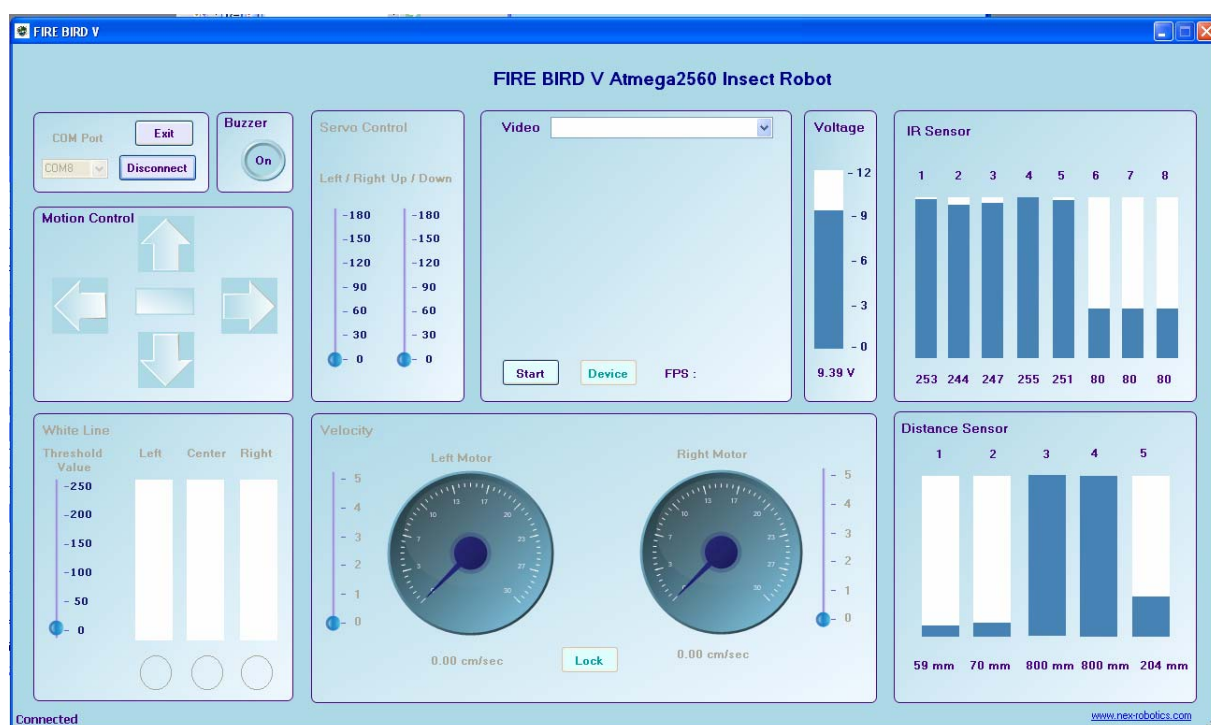


Figure 3.1: GUI showing robot's data

⚠ Warning:

While using USB communication, ensure that the appropriate jumpers are in place. For more details refer chapter 6 of the Hardware Manual.

Note:

For robot connection between robot and PC using USB / serial link or via wireless link, refer to chapter 6 and 7 of the hardware manual.

If you have Wireless camera pod from NEX Robotics and USB TV Tuner card then you can also see the video on the GUI.

For more information on the installation and usage process, refer to documentation of the wireless camera pod.

Follow these steps for video acquisition:

1. Connect USB TV Tuner card with PC and wait for 5 seconds.
2. Start the Fire Bird V robot's GUI
3. In the video window, select devices as USB TV Device. This option will be visible only if USB TV Tuner card is installed and connected.
4. Press start button to acquire the video.

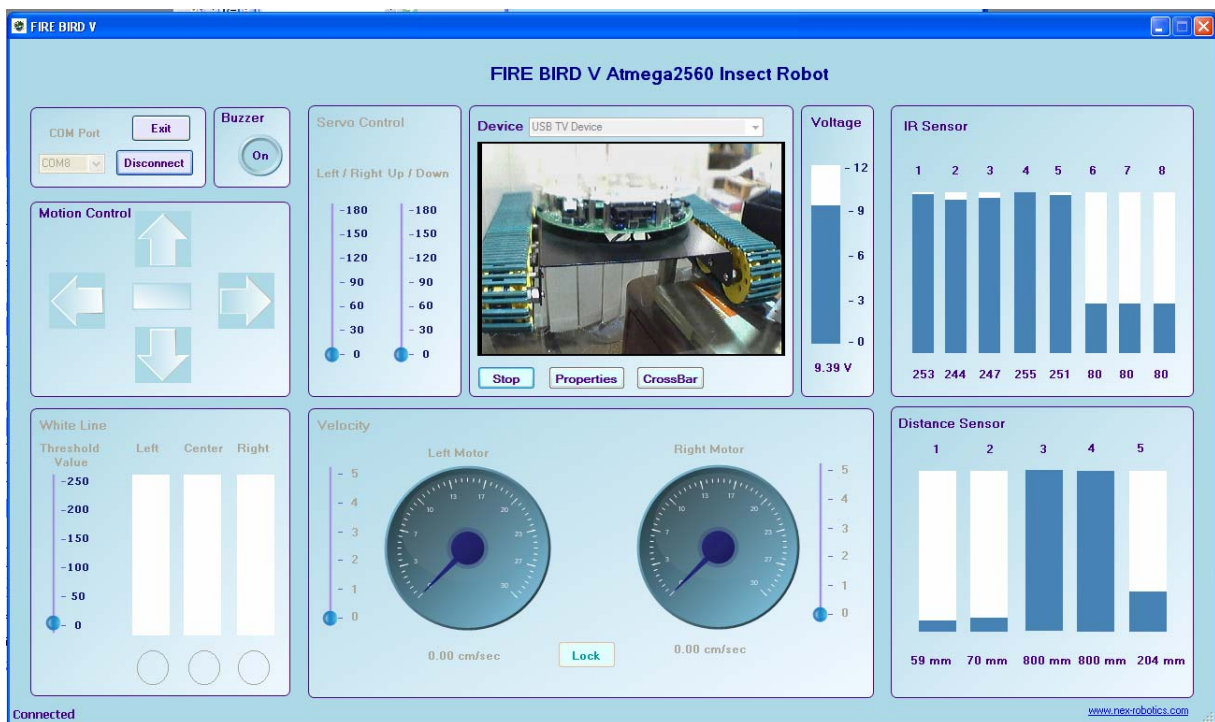


Figure 3.2: Video display on the Fire Bird V robot's GUI