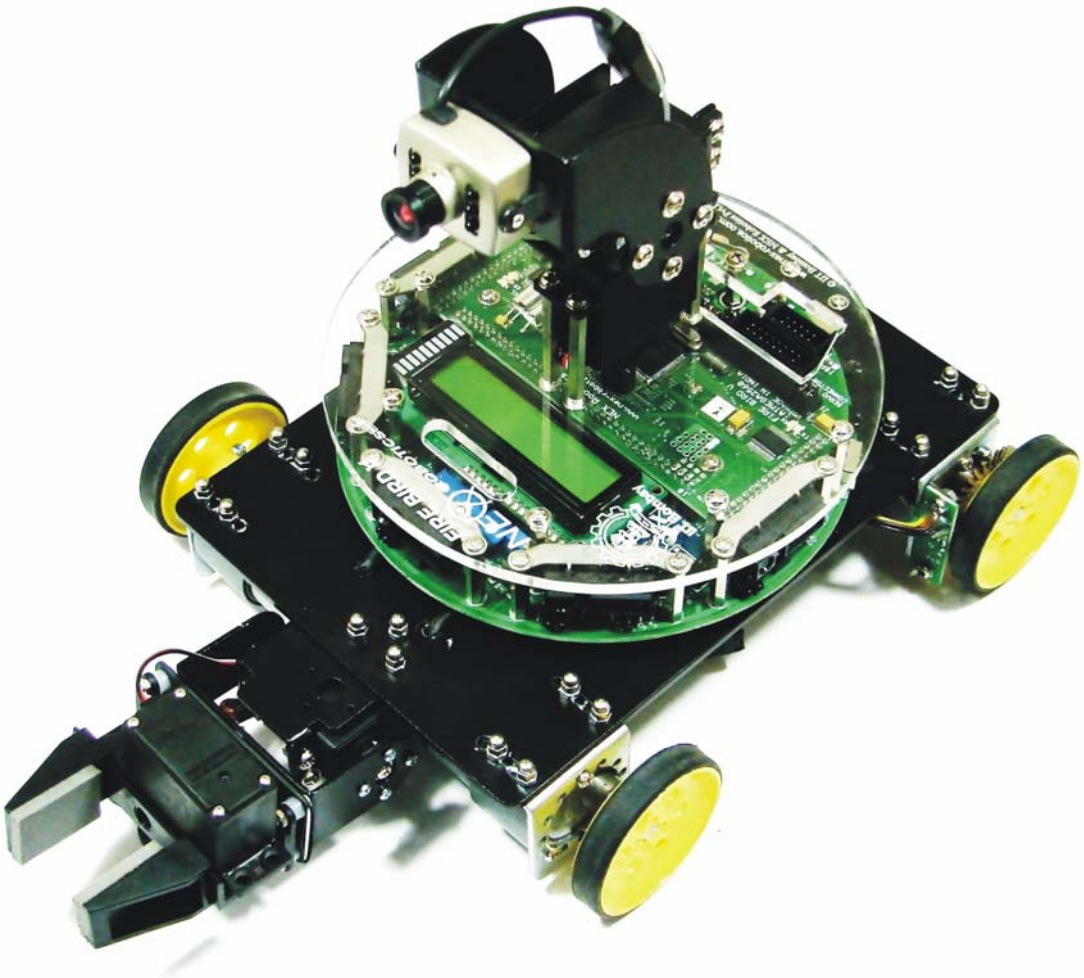
FIRE BIRD V

ATMEGA2560 TANK DRIVE ROBOTIC RESEARCH PLATFORM USER GUIDE



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NEX ROBOTICS
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Manufactured By: NEX Robotics Pvt. Ltd.

FIRE BIRD V

4 WHEEL DRIVE ROBOT WITH GRIPPER 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

⚠Warning

Fire Bird V ATMEGA2560 4 WD Robot with Gripper 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 Tank Drive 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 4 WD Robot with Gripper

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. Theses platforms were made commercially available form 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.

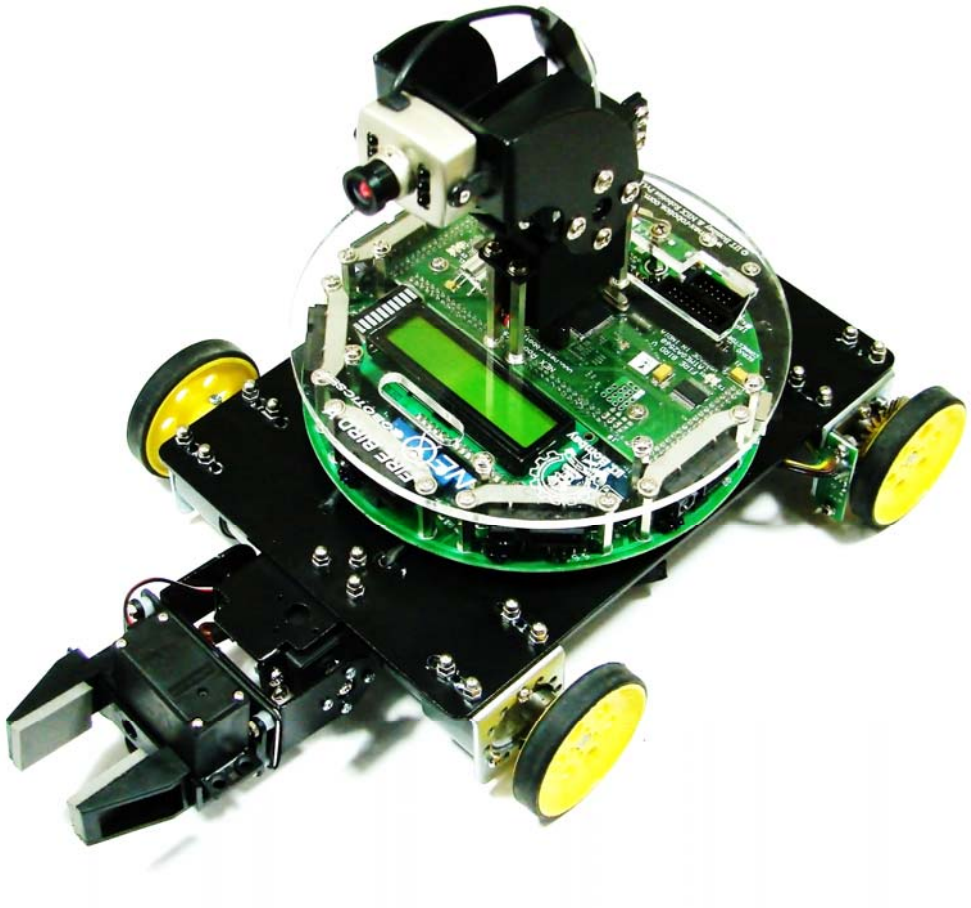

Figure 2.1: Fire Bird V ATMEGA2560 4 WD Robot with Gripper

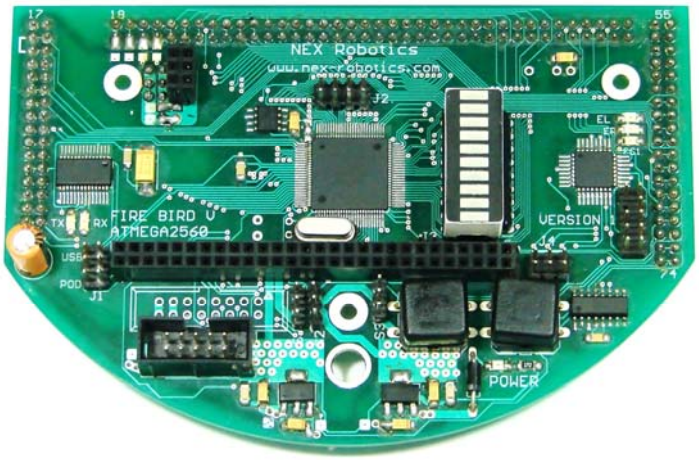

Figure 2.2: ATMEGA2560 (AVR) microcontroller adaptor board on Fire Bird V Tank Drive Robot

2.1 Fire Bird V Block Diagram:

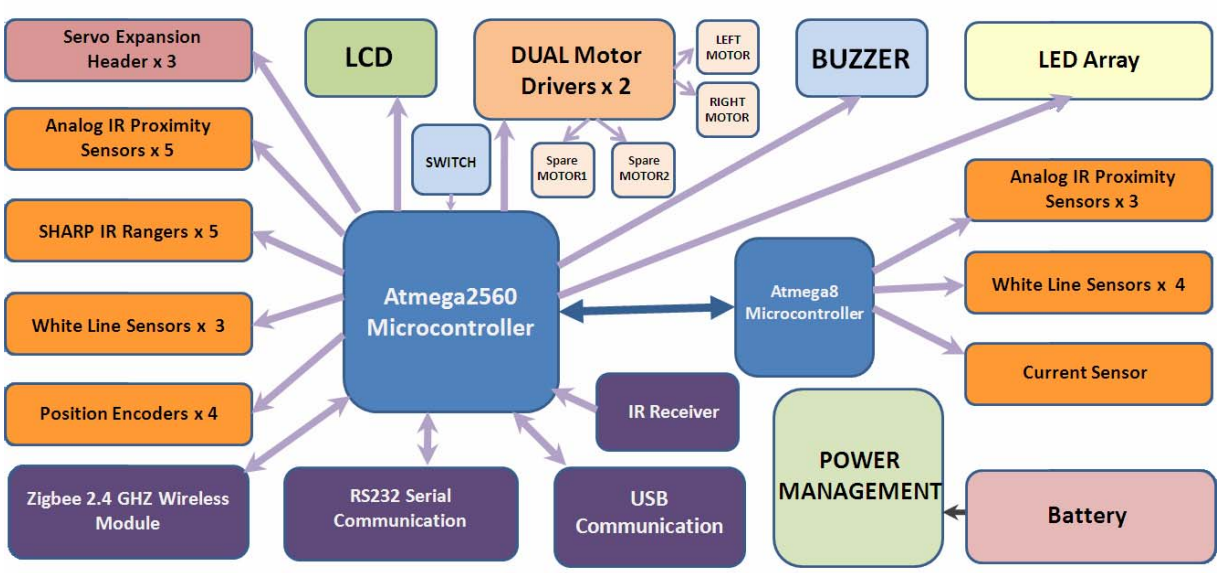

Figure 2.3: Fire Bird V ATMEGA2560 robot block diagram

Note:
All the features of the Fire Bird V ATMEGA2560 4 WD Robot with Gripper except the Battery and Battery charging are exactly same as of Fire Bird V standard model. Use this user guide along with the robot's hardware and software manual.

Performance accuracy of the position encoders in 4 wheel drive robot will be greatly depended on the surface.

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 the "AP" (battery power switched off). You need to charge the battery before first use. Refer to section 2.2 for battery charging.

2.2 Battery Charging

Fire Bird V ATMEGA2560 4 WD Robot with Gripper requires higher current than standard configuration robot. In order to fulfill this additional current requirement while keeping weight low, 11.1V, 1300mAh lithium polymer battery (Product code: NR-BLiPo-3-1300) is used. It can supply discharge current up to 26 Amps.

Never allow battery to go below 9.3V. Robot's battery low indication threshold is set at 9.9V. When battery voltage drops below 9.9V, Battery low buzzer will start beeping.

In multi-celled Lithium Polymer battery pack, it is possible for the individual cells to develop differences in there 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 ATMEGA2560 4 WD Robot with Gripper comes with its own NR-BLIC-02 or NR-BLIC-03 balance charger form 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-3-1300

Figure 2.6: Connecting battery charger NR-BLIC-02 to the robot

Figure 2.7: Connecting battery charger NR-BLIC-03 to the robot

Note:
Battery is fitted with the well-crow stripe. You can also remove the battery for charging.

⚠Warning

In case of Fire Bird V ATMEGA2560 4 WD Robot with Gripper 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 impendence, 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 3.1V per cell i.e. 6.2V for 2 cell battery packs or 9.3V for 3cell battery packs. After this critical value battery voltage falls very rapidly. Robot will start giving battery low warning after battery voltage reaches 9.9V. 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. For proper operation never allow battery discharge below 9.9V. Robot will start giving beeping sound when battery reaches 9.9V. To ensure long life charge battery at least once a month and discharge it till robot starts giving battery low warning. Charge the battery, now robot can again be stored for a month. For faster battery discharge load “Motion_Control_Simple” program which is located in the “Experiments” folder in the documentation CD.

2.4 Gripper Arm

Gripper arm contains two servo motor. For moving arm up and down, and for gripping and ungripping action servo motors are used. It is very important that servo motors should not be kept in the stalled condition for more than few second. Else it will damage the servo motor and the voltage regulator supplying power to the servo motor.

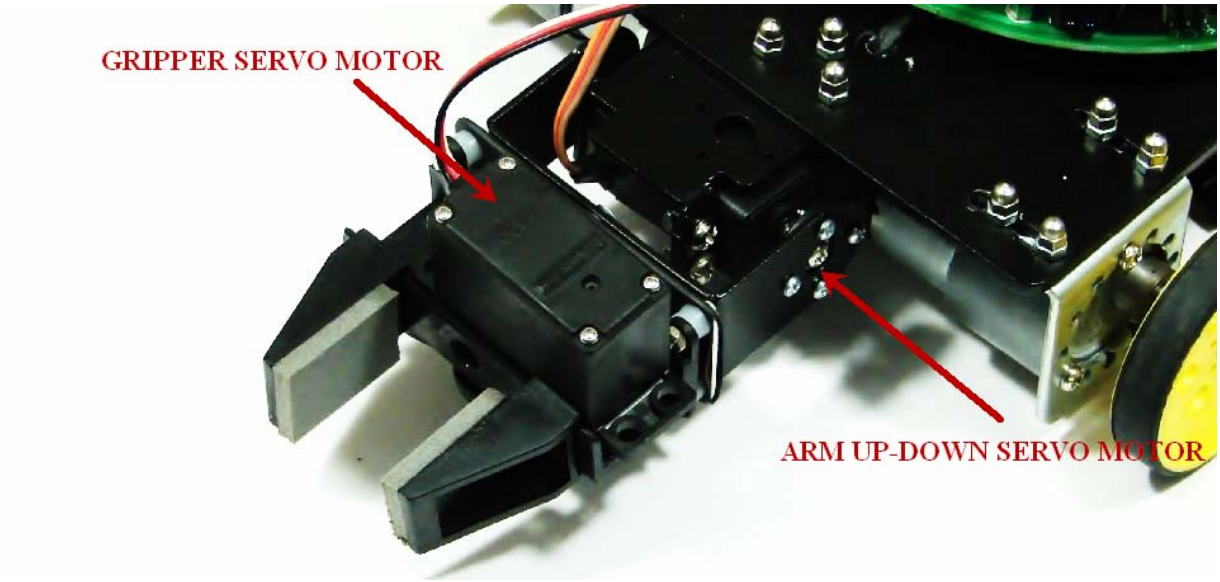

Figure 2.8: Gripper

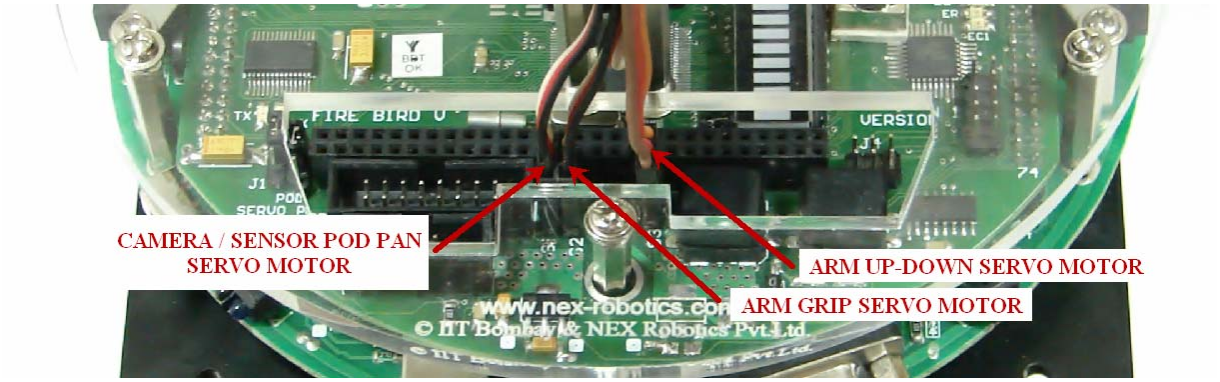

Figure 2.9: Servo motor Connections

2.5 Application example for robot motion control

Located in the folder "Experiments \ Fire Bird V ATMEGA2560 4 WD Robot with Gripper" folder in the documentation CD.

This experiment demonstrates robot walk using 3 servo motors

Concepts covered:
Servo motor control, robot motion control

Connections:

Servo motors:
PORTB 5 OC1A --> Servo 1: Camera pod pan servo
PORTB 6 OC1B --> Servo 2: Grip servo
PORTB 7 OC1C --> Servo 3: Robot arm up/down servo

Motion control:
There are two components to the motion control:
1. Direction control using pins PORTA0 to PORTA3
2. Velocity control by PWM on pins PL3 and PL4 using OC5A and OC5B.

Connection Details:
L-1---->PA0; L-2---->PA1;
R-1---->PA2; R-2---->PA3;
PL3 (OC5A) ----> PWM left; PL4 (OC5B) ----> PWM right;

Note:

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

Microcontroller: atmega2560
Frequency: 11059200
Optimization: -O0 (For more information read section: Selecting proper optimization options below figure 2.20 in the Software Manual)

2. 5V supply to these motors is provided by separate low drop voltage regulator "5V Servo" which can supply maximum of 800mA current. It is a good practice to move one servo at a time to reduce power surge in the robot's supply lines. Also preferably take ADC readings while servo motor is not moving or stopped moving after giving desired position.

3. Look carefully at the functions object_grip(); and object_ungrip();
After gripping and ungripping the object it is making grip servo free to reduce current consumption. Never ever allow grip and arm up down servo to stall for more than 10 to 15 seconds in order to avoid damage to the servo motor and the voltage regulator because of over heating.

2.6 GUI

For Fire Bird V ATMEGA2560 4 WD Robot with Gripper use the same GUI which is used for Fire Bird V ATMEGA2560 Robot.