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1. Fire Bird V Basic Configuration

Fire Bird V is a state of the art research platform designed to help you get acquainted with the world of robotics and embedded systems. Because of its innovative architecture and adoption of the ‘Open Source Philosophy’, you will be able to create and contribute to, complex applications that run on this platform. Fire Bird V is designed by NEX Robotics and Embedded Real-Time Systems lab, CSE IIT Bombay.

As a Universal Robotic Research Platform, Fire Bird V provides an excellent environment for experimentation, algorithm development and testing. Fire Bird V is evolved from Fire Bird IV and Fire Bird II which are being used in IIT Bombay to teach embedded systems and robotics. Its modular architecture allows you to control it using multiple processors such as 8051, AVR, PIC and ARM7 etc. Modular sensor pods can be mounted on the platform as dictated by intended applications. Precision position encoders make it possible to have accurate position control. The platform can be upgraded to tank drive and Hexapod insect or any other desired form very easily. It is powered by high performance rechargeable NiMH batteries. A 2.4 GHz ZigBee module provides state of the art secure and multi-channel wireless communication up to a range of one kilometre.

Unique Features:
- Hands-on learning platform
- Detailed tutorials help in interactive learning.
- Ideal for doing research in the areas of robotics, embedded systems, artificial intelligence and sensor networks etc.
- Modular Design: Unique layered design gives versatility in design.
1.1 Fire Bird V Specifications

**Hardware**

- **Microcontroller:** ATMELE ATMEGA2560, P89V51RD2, LPC2148 (ARM7) (under development), PIC18F4550 (under development)

- **Sensors:**
  - Three white line sensors (extendable to seven white line sensors)
  - Five GP2D12, 80cm IR range sensors covering front half part of the robot (Robot comes with one IR range sensor, Four sensors are optional accessories)
  - Eight analog IR proximity sensors covering robot from all sides.
  - Eight analog directional light intensity sensors
  - Two position encoders
  - Battery voltage sensing
  - Battery current sensing (optional)
  - Servo mounted sensor pod (optional)
  - Wireless colour camera (optional)
  - Ultrasound scanner (optional)
  - Gyroscope and Accelerometer (optional)
  - Magnetometer (optional)
  - GPS receiver (optional)

- **Indicators:**
  - 2 x 16 Characters LCD
  - Indicator LEDs
  - Buzzer
  - Battery low indication

- **Operational Modes:**
  - Standalone (Autonomous Control)
  - PC as master and robot as slave
  - Distributed (multi robot communication)

- **Communication:**
  - USB
  - Wired RS232 (serial) communication
  - Simplex infrared communication (From infrared remote to robot)
  - Zig Bee (IEEE 802.15.4) (Wireless) (Optional)

- **Dimensions:**
  - Diameter: 16 cm
  - Height: 10 cm (including sharp sensor)
  - Weight: 750 Gms.

- **Power:**
  - 9.6 Volts, 2100mAH NiMH rechargeable battery pack with 1 hour of operation
  - Auxiliary power supply for extended operation

- **Locomotion:**
  - Two DC geared motors and caster wheel at front as support
  - Top Speed: 24 cm / second
  - Wheel Diameter: 52mm
  - Position encoder: 30 pulses per revolutions
  - Position encoder resolution: 5.44mm
1.2 Software Support

Microsoft Robotics Developer Studio
MATLAB
GUI Based control

Integrated Development Environments

P89V51RD2: KEIL
ATMEGA2560: AVR studio, WINAVR, ICCAVR, Code vision AVR etc.
LPC2148 (ARM7): KEIL, WINARM
PIC18F4550: MPLab IDE
1.3 Fire Bird V basic configuration

Fire Bird V (ATMEGA2560 AVR)  Fire Bird V (P89V51RD2, 8051 core)

Fire Bird V (LPC2148, ARM7TDMI core)

Fire Bird V is a robot with modular architecture. You can add different types of microcontroller adaptor boards to add support of different types of microcontrollers.

Fire Bird V in basic configuration with any of the microcontroller socket:
Rs. 16875  (Inclusive of all taxes)
1.4 Fire Bird V Microcontroller Adaptor Boards

1.4.1 ATMEGA2560 adaptor board

ATMEGA2560 is one of the most powerful microcontroller in the AVR family. ATMEGA2560 adaptor board exploits full capabilities of the Fire Bird V robot. It has two microcontrollers to control all the modules of the robot.

Specifications:

Microcontroller: ATMEGA2560 (Master) (working at 11.0592MHz)
ATMEGA8 (slave)

Sensor support: Five Sharp IR range sensors (GP2D30, GP2D12 and GP2Y0A02YK)
Eight Analog IR proximity sensors
Eight directional light intensity sensors
Three white line sensors (expandable up to seven white line sensors)
Battery voltage sensing
Battery current sensing

Locomotion: Four DC motors with PWM based velocity control and position encoder

Indicators: Three position encoders
LCD display in 4 bit mode
8 bit LED display
Motion status indication

Expansion slot: SPI, I2C, UART, 18 servo motor control pins

Communication: Onboard RS232 communication
USB communication using FT232
Wireless ZigBee communication
IR remote control based on RC5 communication standard (Code support not provided)

Robot configurations supported:
Basic configuration
Omni directional robot
Insect
Tank
Hexapod

ATMEGA2560 adaptor board: Rs. 3937.5 (Inclusive of all taxes)
1.4.2 P89V51RD2 adaptor board

P89V51RD2 is 8051 core based microcontroller. It uses ADC0808 analog to digital converter for accessing analog sensors. P89V51RD2 is interfaced to the basic modules of the robot.

Specifications:

Microcontroller: P89V51RD2 working at 11.0592MHz

Sensor support: One Sharp IR range sensor (GP2D30, GP2D12 and GP2Y0A02YK)
Two analog IR proximity sensors
Two directional light intensity sensors
Three white line sensors
Battery voltage sensing

Locomotion: Two DC motors with PWM based velocity control and position encoder

Indicators: Two position encoders
LCD display in 4 bit mode
Motion status indication

Communication: Onboard RS232 communication
Wireless ZigBee communication
IR remote control based on RC5 communication standard (Code support not provided)

Robot configurations supported:
Basic configuration
Tank

P89V51RD2 adaptor board: Rs. 3937.5 (Inclusive of all taxes)
LPC2148 is a feature reach ARM7TDMI microcontroller from NXP (formerly Philips). LPC2148 adaptor board for Fire Bird V contains LPC2148 microcontroller as master and two ATMEGA8 microcontrollers as slave. These three microcontrollers work together to access all the modules of the Fire Bird V robot.

Specifications:

- **Microcontroller:** LPC2148 (ARM7 TDMI core) (Master) (working at 60 MHz)
  - Two ATMEGA8 (slave)
- **Sensor support:**
  - Five Sharp IR range sensors (GP2D30, GP2D12 and GP2Y0A02YK)
  - Eight Analog IR proximity sensors
  - Eight directional light intensity sensors
  - Three white line sensors (expandable up to seven white line sensors)
  - Battery voltage sensing
  - Battery current sensing
- **Locomotion:** Three DC motors with PWM based velocity control and position encoder
- **Indicators:** Three position encoders
  - LCD display in 4 bit mode
  - Motion status indication
- **Expansion slot:** SPI, I2C, UART, 18 servo motor control pins
- **Communication:**
  - Onboard RS232 communication
  - True USB 2.0 communication
  - Wireless ZigBee communication
  - IR remote control based on RC5 communication standard (Code support not provided)

Robot configurations supported:
- Basic configuration
- Omni directional robot
- Insect
- Tank

**LPC2148 adaptor board: Rs. 3937.5 (Inclusive of all taxes)**
2. Avatars of Fire Bird V

2.1 Fire Bird V Tank Robot

Fire Bird V Tank has tank drive for enhanced mobility. It is powered by Lithium Polymer battery. All the other features of this robot are similar to Fire Bird V ATMEGA2560 robot.

Supported microcontroller adaptor board:
- ATMEGA2560 adaptor board
- P89V51RD2 adaptor board
- LPC2148 ARM7 TDMI adaptor board

| Fire Bird V Tank Robot: Rs. 20812.5 (Inclusive of all taxes) |
2.2 Fire Bird V Omni directional robot

Fire Bird V Omni Directional robot

Fire Bird V Omni Directional Robot is based on Fire Bird V ATMEGA2560 platform. It has three omni directional wheels 120 degrees apart. By changing velocity and direction of the wheels robot can move in any direction without changing its orientation.

Supported microcontroller adaptor board:  
ATMEGA2560 adaptor board  
LPC2148 ARM7 TDMI adaptor board

| Fire Bird V Omni directional Robot: Rs. 19350 (Inclusive of all taxes) |
2.3 Fire Bird V Insect

Fire Bird V Insect is a small six legged robot. It has three pair of legs driven by one servo each. Robot can navigate itself using Sharp IR range sensors. It can be controlled wirelessly using ZigBee wireless module.

Supported microcontroller adaptor board: ATMEGA2560 adaptor board

| Fire Bird V Insect Robot: Rs. 19687.5 (Inclusive of all taxes) |
2.4 Fire Bird V Hexapod

Fire Bird V Hexapod is based on Fire Bird V ATMEGA2560 platform. It has six legs, each leg has 3 degree of freedom (3 DOF). Robot has 18 NRS-995 dual bearing high torque metal gear servo motors. Robot is powered by 7.4V, 1800mAh, 20C Lithium Polymer battery. Robot can be controlled by modified Sony PS2 wireless remote control. Fire Bird V Hexapod robot is perfect for college robotics labs.

Supported microcontroller adaptor board: ATMEGA2560 adaptor board

Fire Bird V Hexapod Robot: Rs. 54562.5 (Inclusive of all taxes)
2.5 Fire Bird V 4 Wheel Drive Robot with Gripper

Fire Bird V ATMEGA2560 4-Wheel Drive Robot with Gripper has 4 wheel differential drive for enhanced mobility. It has a servo motor based gripper for picking up objects. It is powered by Lithium Polymer battery. All the other features of this robot are similar to Fire Bird V ATMEGA2560 robot.

Supported microcontroller adaptor board: ATMEGA2560 adaptor board

Fire Bird V 4 Wheel Drive Robot with Gripper: Rs. 21937.5 (Inclusive of all taxes)
3. Robot Accessories

3.1 Sharp IR range finder sensor

For accurate distance measurement, the robot uses IR Range sensors. These sensors give distance from the obstacle with the millimetre accuracy. These sensors use triangulation to measure the distance from any obstacle hence their reading does not get affected by the ambient light. The robot can be fitted with five such IR range sensors as shown in the picture below.

Fire Bird V in default configuration comes with a single sharp IR range sensor fitted on the front side (position 3). Other four sensors need to be added as “add on” accessories. Robot comes with GP2D12 (80cm) sensor.

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Range</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP2D120</td>
<td>4cm to 30cm</td>
<td>Rs. 1664 (inclusive of all taxes)</td>
</tr>
<tr>
<td>GP2D12</td>
<td>10cm to 80cm</td>
<td>Rs. 1664 (inclusive of all taxes)</td>
</tr>
<tr>
<td>GP2Y0A02YK</td>
<td>20cm to 150cm</td>
<td>Rs. 1872 (inclusive of all taxes)</td>
</tr>
</tbody>
</table>
3.2 Wireless communication

Fire Bird V robot has dedicated socket for wireless 2.4GHz ZigBee communication module. ZigBee wireless module is directly interfaced with the robot’s serial port. This module can be used by many robots to communicate with each other and with PC at the data rates up to 115Kbps. In order to communicate with a PC over wireless channel, you can use the ZigBee USB module. ZigBee wireless modules are available with 100 meters or 1000 meters communication range. Example codes for communication are provided with the documentation.

<table>
<thead>
<tr>
<th>ZigBee wireless module 100 meters for robot</th>
<th>NR-RF-02</th>
<th>Rs. 1950.75 (inclusive of all taxes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZigBee wireless module 1000 meters for robot</td>
<td>NR-RF-03</td>
<td>Rs. 2812.5 (inclusive of all taxes)</td>
</tr>
<tr>
<td>ZigBee USB module for PC with ZigBee wireless module 100 meters</td>
<td>NR-RFUSB-01</td>
<td>Rs. 2812.50 (inclusive of all taxes)</td>
</tr>
<tr>
<td>ZigBee USB module for PC with ZigBee wireless module 1000 meters</td>
<td>NR-RFUSB-02</td>
<td>Rs. 3674.25 (inclusive of all taxes)</td>
</tr>
</tbody>
</table>
3.3 Gyroscope and Accelerometer module

Gyroscope and Accelerometer Module along with other sensor modules is used for more accurate navigation for the robot. It can also be used as a joystick to give direction and velocity commands to the robot. Gyroscope and Accelerometer Module consists of LY510ALH yaw gyroscope and ADXL335 3 axis accelerometer. This module if mounted on the robot can be used to track yaw angle (orientation) of the robot and acceleration / tilt angle along the 3 axes.

Specifications

- Operating Voltage : 5V
- Gyroscope: LY510ALH Yaw gyroscope
- Gyroscope range: +/- 100 degrees per second
- Accelerometer: ADXL335 3 axis accelerometer
- Accelerometer range: +/- 3G along 3 axis
- Self test function for gyroscope and accelerometer

| Gyroscope and Accelerometer module: Rs. 4599 (Inclusive of all taxes) |
3.4 GS405 GPS Receiver

SPK-GPS-GS405 is a Global Position System receiver module based on SiRF Star III high-sensitivity chipset solution which includes a built-in Sarantel omni-directional Geo-Helix SMP passive antenna. Because of this antenna it can receive signal even inside vehicle without any need for an external antenna. The receiver module can track 20 satellites simultaneously. GS405 can be used for applications such as navigation, mapping, surveying, security, agriculture and so on.

Specifications:
- Supply: 5V, 75mA, less than 250mW, built in RTC power battery (3V)
- Chipset: GRF3w&GSP3f (SiRF StarIII technology)
- Data output: Full duplex TTL UART interface
- Protocol: NMEA-0183@4800bps (Default)
- Protocol message: GGA, GSA, GSV, RMC / per second
- No of Satellite simultaneously tracked: 20
- Position accuracy:
  - 10 meters, 2D RMS
  - Time to Fix (Open sky and stationary position)
    - Re-acquisition: 0.1 seconds average
    - Snap start: 1 seconds average
    - Hot start: 8 seconds average
    - Warm start: 38 seconds average
    - Cold start: 42 seconds average
- Dynamic conditions
  - Altitude: 18000 meters (60000 feet)
  - Velocity: 515 meters / second (1000 Knots / hour ) maximum
  - Acceleration: less than 4G.
  - Jerk: 20 meters / second³ maximum
- Size: Length (with Antenna) 52mm, Width: 25.6mm, Weight: 16gms

GS405 GPS Receiver: Rs. 9562.5 (Inclusive of all taxes)
3.5 Wireless camera with Servo Pod for Pan and Tilt

Wireless camera mounted on the servo pod       Wireless camera with accessories

Wireless camera with Servo Pod for Pan and Tilt control can be mounted on the top of the robot. Camera transmits video and the audio information on 2.4GHz channel. The wireless receiver module receives the video and audio information. It gives composite video output which can be captured on PC using a PCI or USB based capture card.

| Wireless colour camera with the servo pod: Rs. 6300 (inclusive of all taxes) |

3.6 TV Tuner Card for Wireless Camera

USB TV tuner card

TV tuner card for wireless camera is used for capturing and displaying video on the GUI for the Fire Bird V robot. It can also work with the Matlab. This enables user to implement image/video processing algorithms in real-time.

| TV Tuner card for wireless camera: Rs. 4725 (inclusive of all taxes) |
3.7 Servo Motor Based Gripper

Gripper arm is used to pick and place an object. It can be fitted in front of Fire Bird V tank robot and Fire Bird V 4-Wheel Drive robot.

Gripper arm contains two servo motors. One dual bearing, 6.8Kg/cm NRS 785 servo motor is used for moving arm up and down and a Futaba 3003 servo motor is used for gripping and un-gripping action.

Multiple robots equipped with such a gripper can form a chain of robots which can be very helpful in certain algorithms.

Servo Motor Based Gripper: Rs. 3150 (inclusive of all taxes)
3.8 Sharp IR Range Sensor with Servo Pod for Pan and Tilt control

Servo Pod is used to point sensor in desired direction using Pan and Tilt action of the servo motors. Using Servo Pod, robot can make detailed map of the surrounding in 3D. Servo pod can be fitted with 4 different types of Sharp IR range sensors with sensing range from 4cm to 500cm. Servo pod comes with the interfacing cable for the Fire Bird V robot and the application example code.

Specifications:
Degrees of Freedom: Pan 180 degrees, Tilt 180 degrees
Servo motor: Two NRS785 high torque plastic servo motor with double bearings
Sensor: GP2D120 / GP2D12 / GP2Y0A02YK0F / GP2Y0A700K0F

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Sensing Range</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo Pod with GP2D120</td>
<td>4cm to 30cm</td>
<td>Rs. 2800 (incl. of all taxes)</td>
</tr>
<tr>
<td>Servo Pod with GP2D12</td>
<td>10cm to 80cm</td>
<td>Rs. 2800 (incl. of all taxes)</td>
</tr>
<tr>
<td>Servo Pod with GP2Y0A02YK0F</td>
<td>20cm to 150cm</td>
<td>Rs. 2890 (incl. of all taxes)</td>
</tr>
<tr>
<td>Servo Pod with GP2Y0A700K0F</td>
<td>100cm to 500cm</td>
<td>Rs. 4400 (incl. of all taxes)</td>
</tr>
</tbody>
</table>
3.9 AVRISP mkII USB Programmer

Introduction
AVR In-System Programmer mkII is used for field upgrades of AVR Flash microcontrollers. The AVRISP mkII combined with AVR Studio® can program all AVR® 8-bit RISC microcontrollers with ISP Interface. If you are using ATMEGA2560 AVR microcontroller based robot for some serious work then this is the most recommended ISP programmer for your robot.

Specifications
- AVR Studio compatible (AVR Studio 4.12 or later)
- Supports all AVR devices with ISP interface
- Programs both flash and EEPROM
- Supports fuses and lock bit programming
- Upgradeable to support future devices
- Support target voltages from 1.8V to 5.5V
- Adjustable programming speed (50Hz to 8MHz SCK frequency)
- USB 2.0 compliant (full speed, 12Mbps)
- Powered from USB, does not require external power supply
- Target interface protection
- Short-circuit protection

AVRISP mkII USB Programmer: Rs. 4275 (inclusive of all taxes)
4. Robot programming using Microsoft Robotic Developer Studio (MRDS)

Nex Robotics in collaboration with ERTS Lab, CSE, IIT Bombay has added support for Microsoft's robotics development studio on its robotics development platforms. Microsoft® Robotics Developer Studio 2008 (RDS) is a Windows-based environment for hobbyist, academic and commercial developers to create robotics applications for a variety of hardware platforms. RDS includes a .NET-based REST-style, services-oriented runtime consisting of two components: Concurrency and Coordination Runtime (CCR) and Decentralized Software Services (DSS). The Concurrency and Coordination Runtime (CCR) makes it simple to write programs to handle asynchronous input from multiple robotics sensors and output to motors and actuators. The DSS application model makes it simple to access, and responds to, a robot's state using a Web browser or Windows-based application. Microsoft Visual Programming Language (VPL) enables anyone to create and debug robotics programs very easily. The Visual Simulation Environment (VSE) enables a novice user with little to no coding experience to develop interesting applications in a game-like environment. NEX robotics has developed simulated models for its robots for use in VSE.

- Non-programmers can create robot applications using a visual programming environment.
- Simulate robotics applications in 3D physics-based virtual environments. Interact with robots using Windows or Web-based interfaces
- Lightweight REST-style, services-oriented runtime
  - Makes Asynchronous Programming Simple
  - Real-time Monitoring of Robotics Sensors and Response to Motors and Actuators
  - Reuse Modular Services Using a composable model
Visual Programming Language in Microsoft Robotics Developer Studio
Simulation in Microsoft Robotics Developer Studio