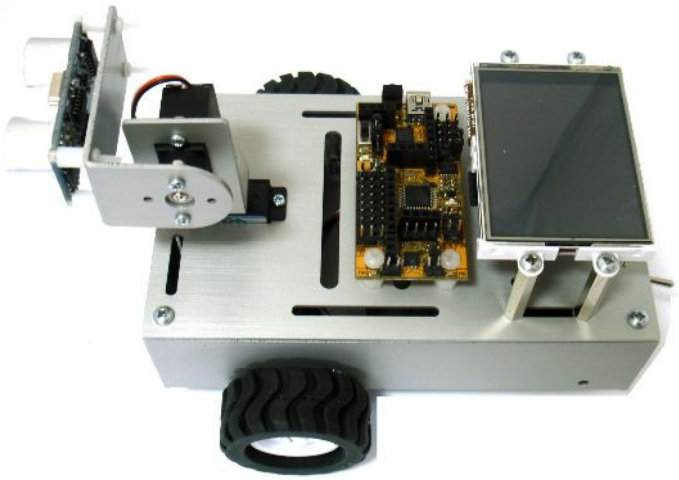
AMEX

Research
Development of Electronics
Prototyping
Microcontroller education systems

AMRobot

Educational mini-robot platform



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Educational mini-robot platform

Platform construction

The **AMRobot** is intended to build an **educational mobile mini-robot** with the capability to choose one of the three types of drive/chassis system: two-wheeled (with a support ball), four-wheeled or tracked drive system (with two silicone tracks).

The **AMRobot** platform is designed for users who are going to learn how to program a mobile mini-robot without the necessity of making the whole mechanical construction of the mini-robot from scratch. The only thing the user has to do is to use screws, nuts, mechanical and electric components and connect them with cables to a microcontroller board and power supply. All components are included in the kit.

The platform is an ideal solution for individual users (beginners and more advanced hobbyists, students and pupils) as well as for users working in teams (for example in secondary schools on innovative technical classes in the range of electronics and robotics).
The platform construction offers a broad range of solutions in mechanical and electrical parts.

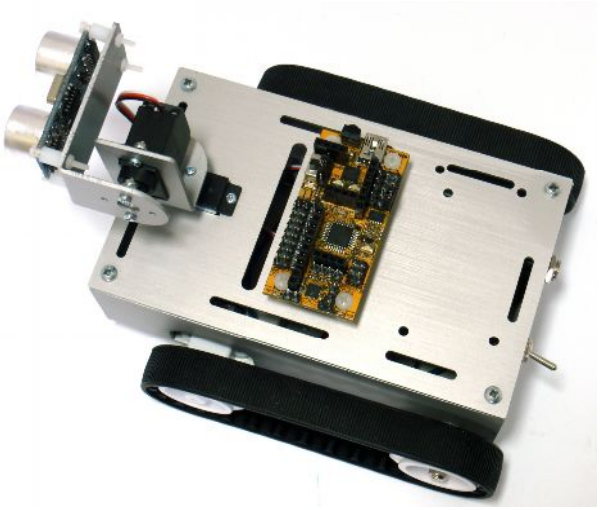
The platform is made of laser-cut, anodized and colored aluminum components. Such a technology ensures high rigidity, endurance and aesthetics appearance. All mechanical components are very well matched to one another which makes the assembly easy. The mini-robot platform itself (without additional enclosure) is composed of only two parts (panels) which are joined together by the means of four spacer sleeves and M3 screws.

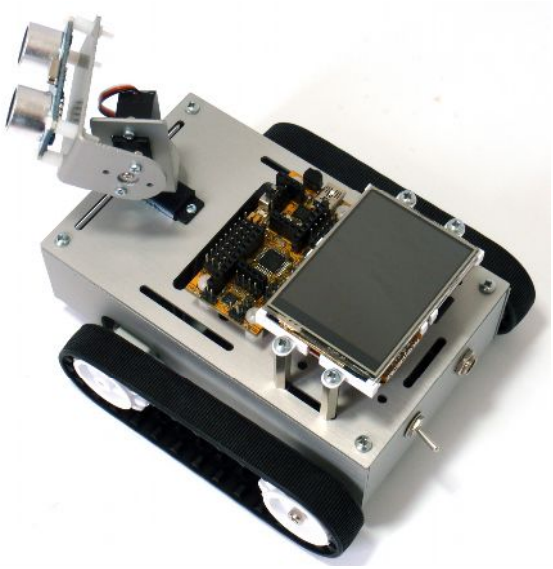
An additional advantage of the platform are small dimensions (140 mm x 125 mm), reliability and construction endurance. These advantages simplify conducting technical classes in the range of robotics in schools and a variety of trainings that require educational equipment mobility for persons conducting the classes.

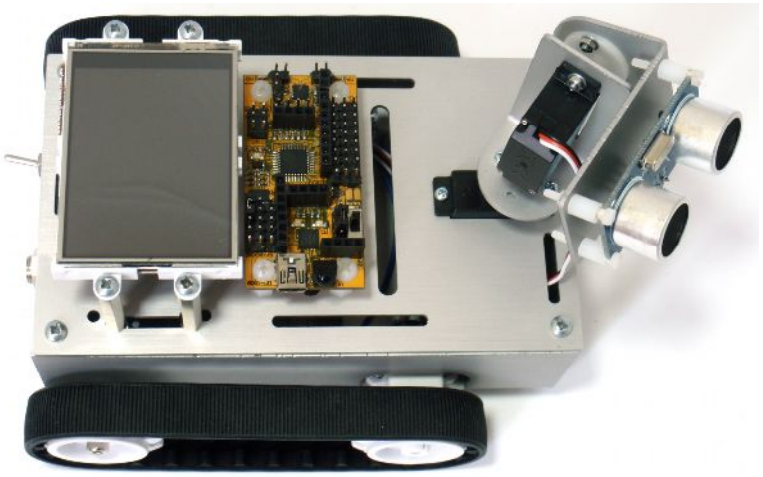
The platform is adapted to install a microcontroller module with motors driver and different sensors such as: three line sensors, ultrasonic distance sensor with scanning circuitry controlled by two miniature servomechanisms, three-axis accelerometer, infrared receiver for wireless communication with microcontroller by the means of compatible remote transmitter. The user can use libraries available in the internet and software facilitating the use of the AMRobot.

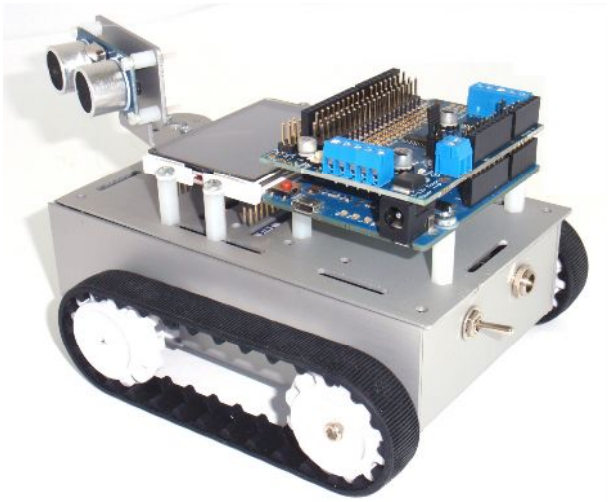
The kit includes a CD with assembly instructions of the AMRobot platform and example software to demonstrate among others the control of the motors and software-controlled servomechanisms, graphic display and a variety of sensors.

The platform is available in three colors: silver, golden and black. Other colors are available for special orders: red, green and blue.
The following pictures show the AMRobot platform with three versions of drive system.









eneloop
eneloop
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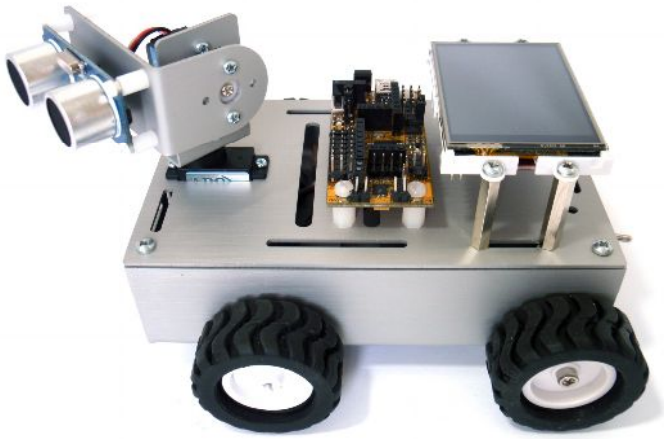

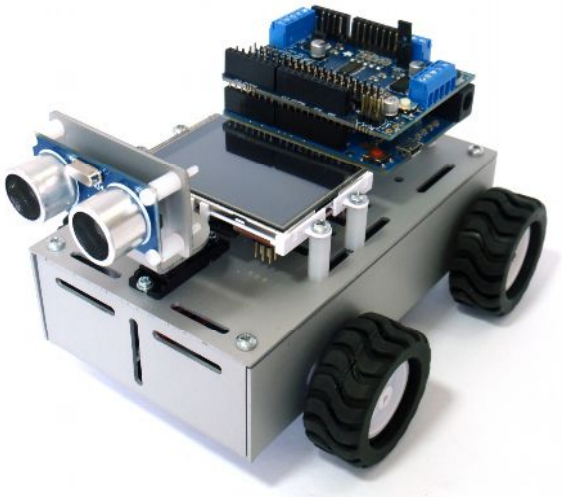

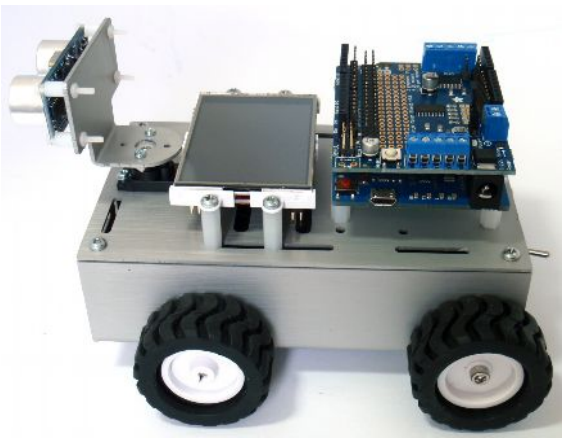

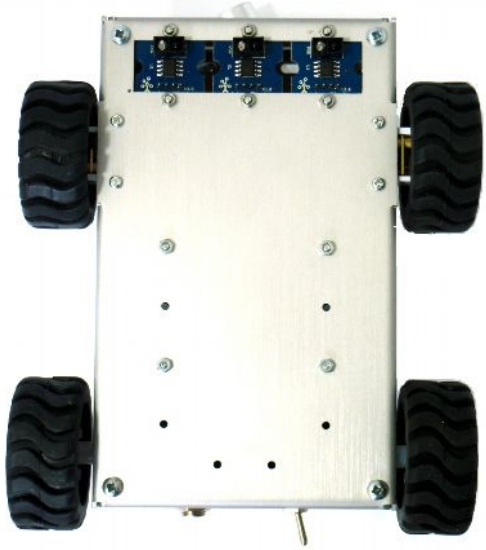

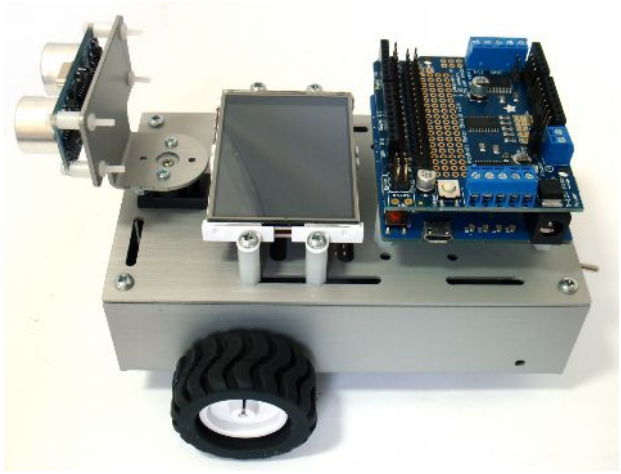

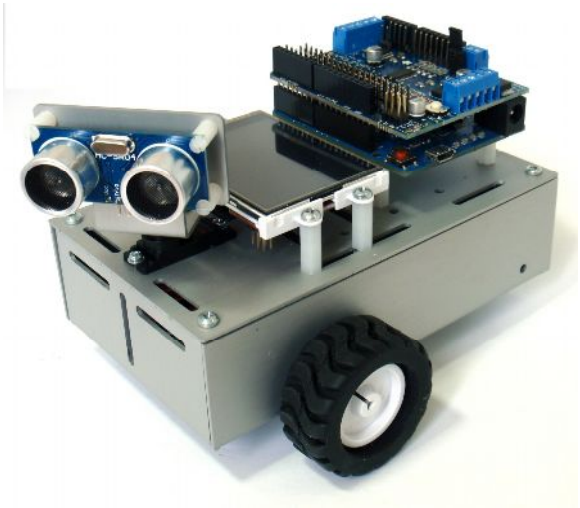

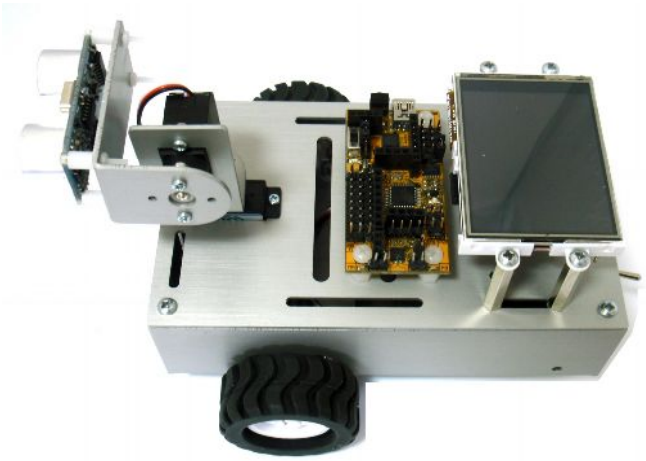

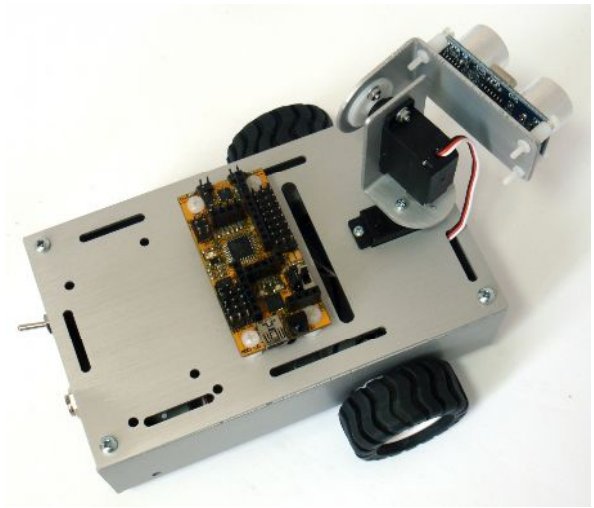

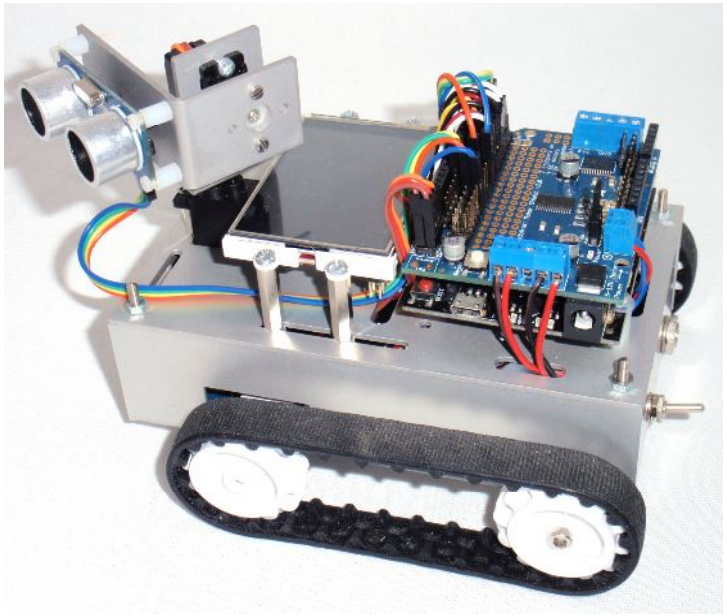

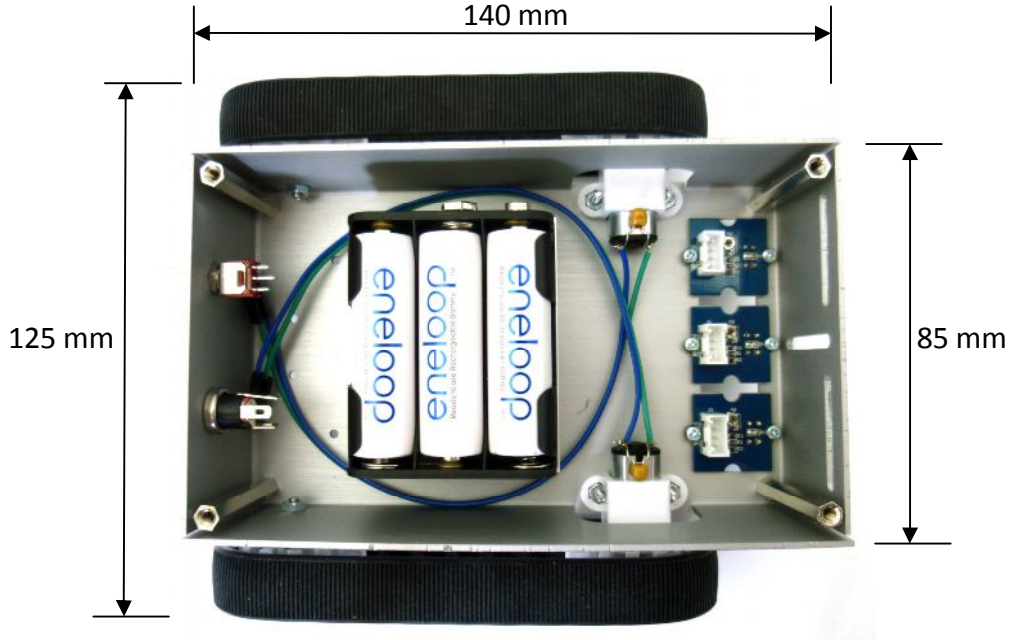
140 mm
125 mm
85 mm
eneloop
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The platform construction enables an easy change of the chassis type by replacing the front drive wheels and assembling two additional rear wheels. One can possibly add two silicone tracs. In the two-wheel robot version, one has to additionally install a supporting ball in the rear lower part of the platform. The possibility of changing the driving system has great educational advantages because of possible modification of software responsible for the motors control. The type of the driving system has an influence on traction properties and mini-robot movement dynamics.

The upper part of the platform includes mounting holes for the servomechanism of the scanning unit (in the range of 180 degrees; horizontally and vertically) which can be used, for example for ultrasonic distance meter, color mini-camera or miniature robot arm. Two versions of the scanning module can be used: horizontal-only scanning (180 degrees) or horizontal and vertical scanning (180 degrees in horizontal and vertical axis)

The additional holes placed in the upper part of the platform are intended to mount microcontroller module together with motors driver and an intelligent, graphic display with touch pad. The graphic display is not required but it can be very useful in more advanced versions of software (for example for adjusting rotating speed of motors, power supply voltage monitoring, changing software configuration without the need of the use of external computer). This expands educational and operating values of the mini-robot for more advanced users.

The lower part of the platform is equipped with holes to mount drive motors, two additional rear wheels and supporting ball. There is also a rectangular slot to mount 3 line sensors. It is also possible to mount a servomechanism-driven grasper or a bumper in the form of a plow in the mini-sumo competition ring.

To drive the mini-robot, two **Pololu HP** micro motors with a metal 150:1 or 210:1 gear are used. The change of chassis configuration does not require to replace drive motors but only change the wheels in the chassis. Despite of small dimensions of the motors they have high torque ensuring good movement dynamics. The user can experimentally change movement parameters (in software) obtaining optimal traction properties for this type of mini-robot. The motors can work with encoders placed under each of them. The use of encoders is recommended for more advanced users who can use PID type control that enables to achieve optimal movement parameters during turning – depending on, for example, current speed of the mini-robot and information gathered from the line sensors or ultrasonic sensor of distance between the mini-robot and an obstacle.

The platform can be controlled by any microcontroller module with a motor driver, for example the Arduino module (there are additional appropriate mounting holes prepared for Arduino module).

Power supply system

The assembled AMRobot platform is powered from 6 cell (AA size) high quality NiMH battery packet (*Eneloop* type by Sanyo). The nominal battery voltage is 7,2V and capacity of 2000 mAh. The battery is placed in a container located between two angles placed in the lower part of the platform. The battery is charged with the use of external charger connected to a socket placed at the lower part of the platform. There is no need to open robot enclosure to charge the battery. The manufacturer of *Eneloop* type battery declares its endurance as 1800 charge cycles. The user can also employ other types of battery (NiMH battery with nominal voltage of 7.2V that is, 1.2V per single cell after disassembling the battery container). The battery capacity should be in 1800 – 2500 mAh range.

It is not recommended to use alkaline R6 batteries (the maximum power supply voltage should not exceed 8V). Besides, the cost of using rechargeable batteries is much lower than alkaline ones.

Specification

The AMRobot platform is offered in three mechanical versions which only differ in drive type, with the use of the same Pololu motors with 1:150 or 1:210 gear. When choosing the version one has to specify the motors gear. Higher gear (210:1) ratio ensures higher torque at lower rotating speed.
The electronic part of the platform (microcontroller module, driver, sensors etc.) can be offered as a separate product in order for the user to individually configure the robot. Each version of the platform has the possibility to mount Arduino Uno, Leonardo modules and also motors drivers or a complete Dagu controller (compatible with Arduino) with integrated motors controller and additional sensors.

Mechanical part

Version 1:
Two-wheeled platform with supporting ball caster and two motors (1:150 or 1:210 gear).

Version 2:
Four-wheeled platform (2 active front wheels and 2 passive rear wheels (1:150 or 1:210 gear).

Version 3:
Platform with tracked drive system (two silicone tracks and two motors: 1:150 or 1:210 gear).

Each drive system type (version 1, 2 or 3) can be additionally purchased for the platform already used in the robot (without the need of replacing the motors).

Motors specification (Pololu)

Small, light and robust Pololu motors with metal gear are used in the AMRobot mini-robot platform as drive units. The motors can be powered from voltage in 3 to 9V range. The optimal voltage at which power to durability ratio is most favorable is 6V. In the AMRobot platform nominal battery voltage is 7.2V (6 x 1,2V).

Pololu HP motor (150:1)
Power supply voltage: 3V - 9V
Gear: 150:1
Rotating speed without load (6V): 200 RPM
Idle current at 6V: 70 mA
Current consumption at locked shaft condition: (6V) 1600 mA (Note: when Adafruit or Dagu drivers are used automatic current limit is activated in case of locked motor shaft)
Torque: 2.9 kG cm (0.284 Nm)
Motor body dimensions: 24 x 10 x 12 mm.

Pololu HP 210:1 motor

Power supply voltage: 3V - 9V
Gear: 210:1
Rotating speed without load (6V): 140 RPM
Idle current at 6V: 70 mA
Current consumption at locked shaft condition: (6V) 1600 mA (Note: when Adafruit or Dagu drivers are used automatic current limit is activated in case of locked motor shaft)
Torque: 3.6 kG cm (0.353 Nm)
Motor body dimensions: 24 x 10 x 12 mm.

Electronic part

Microcontroller module

The AMRobot platform can be equipped with a microcontroller module such as *Arduino Uno, Arduino Leonardo* with additional *Adafruit* motor driver or *Micro Magician Robot Controller V2* by Dagu which is a perfect combination (on single small PCB) of fully Arduino compatible microcontroller module with a motor driver. This PCB is also equipped with 3-axis accelerometer and infrared receiver for wireless communication by the means of compatible remote controller.

The alternative solution is to employ other controller (also from Dagu) such as *Dagu Arduino Mini Driver Board* which is an ideal solution for beginners.
The following description depicts specification of two types of microcontrollers modules with integrated Dagu Arduino motor driver and also *Adafruit* module which works with *Arduino Leonardo* microcontroller.

It is worth noticing that AMRobot platform can be equipped with virtually any types of microcontroller modules and motor drives. To install them it requires to drill additional holes in the upper board of the platform. The existing holes are prepared to install *Arduino* and *Dagu* modules mentioned above.

Apart from using typical Arduino modules it is also possible to install a connector board instead of common *Arduino* modules. The connector board can work as an mechanical interface between other types of microcontroller modules and motor drives (such as *Pololu*

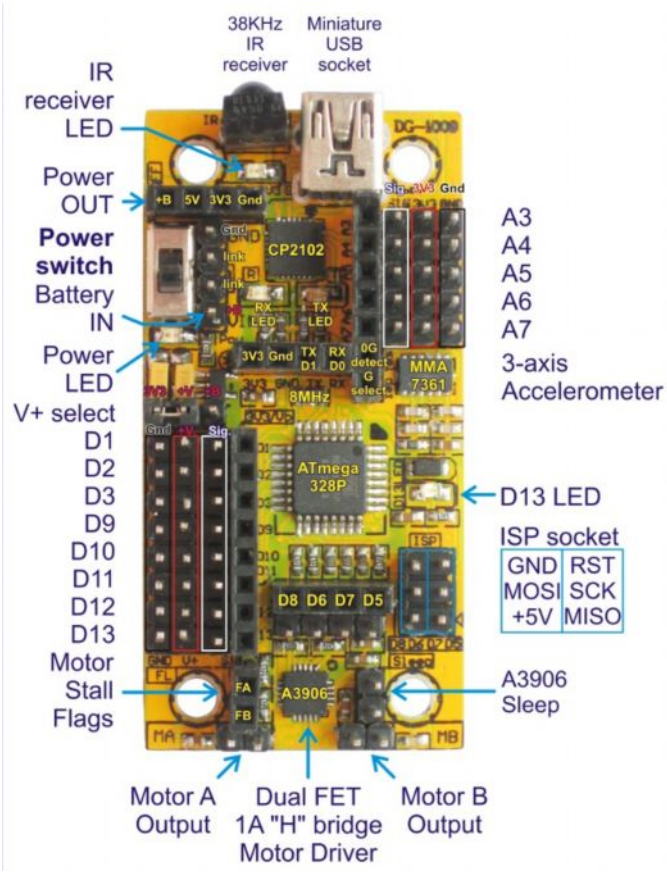
type *A-Star 32U4 Micro* based on Leonardo module and two-channel dc current motor driver type *TB6612FNG* by *Toshiba)*

The following pictures show some of microcontroler modules and their specifications. They are recommended to use in the AMRobot platform.
You can also find example software (with comments) in the AMRobot user's manual.

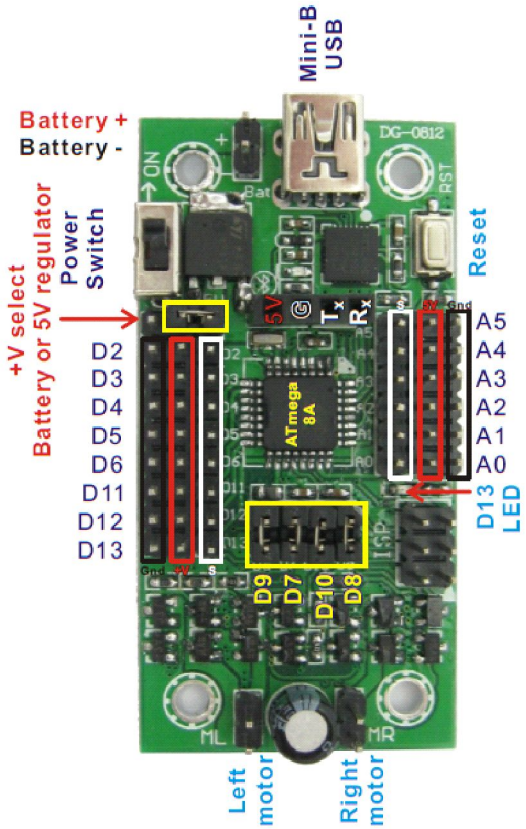
DAGU microcontroller module and drivers

(pcb boards dimensions: 30 mm x 60 mm)

DAGU Arduino Micro Magician robot controller V2



DAGU Arduino Mini Driver Board



Dagu Arduino Micro Magician robot controller module specification

The ***Dagu Arduino Micro Magician robot controller*** is a perfect controller intended for small robots. Despite its small PCB dimensions (30 mm x 60 mm) it is fully equipped with features that do not exist in other controllers. It includes all important functions needed to control mini-robots. The V2 version of the controller is fully compatible with Arduino IDE programming environment.

Double H-bridge (FET):

- Works in 2.5..9V power supply voltage range
- Low turn-on bridge resistance (1,1Ω).
- Automatic electronic brake function (this function is ideal for small robot in case when fast stopping the robot is required)
- Current limit set to 910 mA – protection against high current caused by locked motor shaft or short circuit.
- motor stall information signal (FA and FB pins status change)
- Sleep function – in order to limit Power consumption when motors are not in use.
- Arduino library containing commands for simple use of DC and stepping motors

3-axis accelerometer

- measurement range: ±1,5G (default setting). It can be set to ±6 G.
- 0G acceleration detection (0G det signal) for use with an external interrupt to turn off the servo or drive motor in case of crash/collision (to protect the gear)
- angle of depression measurement (robot to base) as protection against fall
- Arduino library includes acceleration sensor commands (direction detection and acceleration magnitude measurement during collision with obstacle)

Infrared receiver (IR) with LED status:

- IR receiver signal fed to digital input D4 enables remote control of the mini-robot by the means of remote TV transmitter
- Arduino library contains a decoder of received commands from TV remote transmiter compatible with Sony standard (SIRC) offering 128 virtual buttons.
- Additional IR receivers can be connected to other ports – for reading signals from receivers with the help of software decoder

Servomechanisms control (up to 8 servomechanisms)

- Up to 8 miniature servos can be driven by the controller (servos are powered from the main battery)
- Servos are protected with a diode against reverse polarity

DAGU Arduino Mini Driver Board controller specifiaction

The DAGU Arduino Mini Driver Board controller is a simplified version of the previous one. This controller also includes two H-bridges for dc motors and is compatible with Arduino IDE. The maximum current is 2A. Up to 8 servos can be connected. Bluetooth and Xbee modules can also be connected to the port available on the controller PCB. Programming of the module is accomplished by USB interface. The module is capable of reading signals from different types of sensors handled by analog and digital inputs.
More detailed information concerning both *DAGU* modules can be found in the AMRobot platfrom user's manual and in software examples.

ADAFRUIT controller module specification

The Adafruit controller module is a new, improved shield for motors control: DC, stepping motors and servos. The shield includes 4 H-bridges which enables to drive as many as 4 dc motors or 2 stepping motors. For the needs of AMRobot platform only 2 bridges are used to power two Pololu HP motors. The control is accomplished by I2C interface available in the Arduino Leonardo microcontroller module. Unlike other solutions, this controller does not use PWM signals from Arduino module but it has its own PWM driver (type TB6612 MOSFET) by Toshiba) that delivers current of 1.2A per channel (continuous) and 3A (pulse). The controller has built-in thermal and overvoltage protections (internal diode). Only two terminals (SDA and SCL) are required to control the motors. The controller PCB includes two servos connectors and 18-26 AWG cable connectors.

For the needs of the AMRobot it is required to mount additional connectors (in the place of free soldering pads in the field prepared for the user). It facilitates connecting of line sensors and ultrasonic distance meter which have to connected to appropriate terminals of Arduino Leonardo microcontroller module. The driver board is fixed to appropriate Arduino Leonardo board PCB connectors.
The Arduino library contains commands to drive motors. Software examples (with comments) are given in the AMRobot user's manual.

NOTE:
The AMRobot kit requires to be assembled by the user. We can deliver fully assembled and configured AMRobot platform (electronic and mechanical part) for special order (with additional cost)

Battery and charger is not included, we suggest purchasing combination.

The AMEX company is going to prepare and public on its website free demonstration software and articles in the field of electronics and robotics intended for beginners and more advanced users of the AMRobot educational platform.

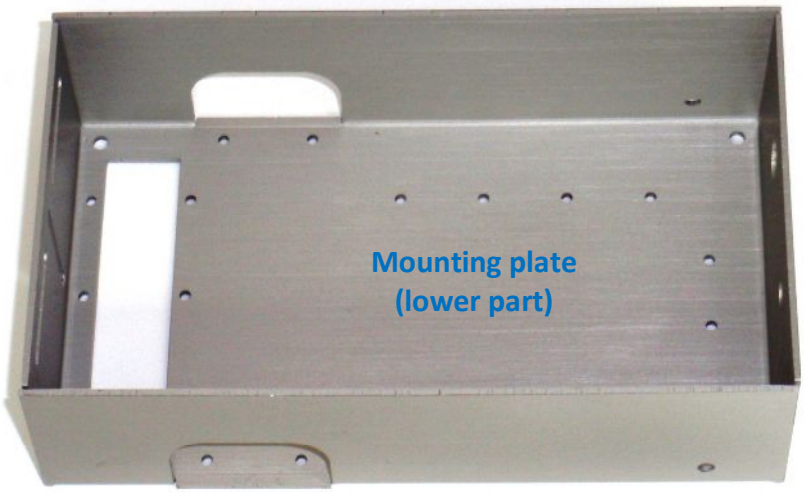
ANNEX

AMRobot platform components

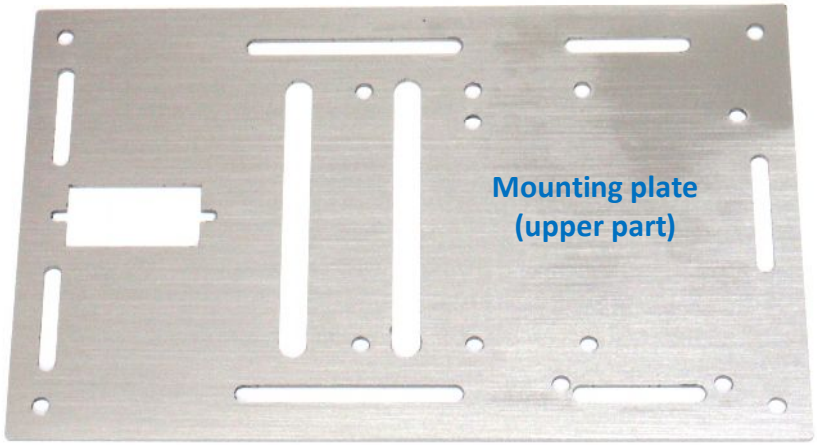
Mounting plates, components for the scanning device, power supply connector, switch and NiMH (6 x AA) battery container

servos for scanning device

Power supply connector and switch



scanning device



Battery container

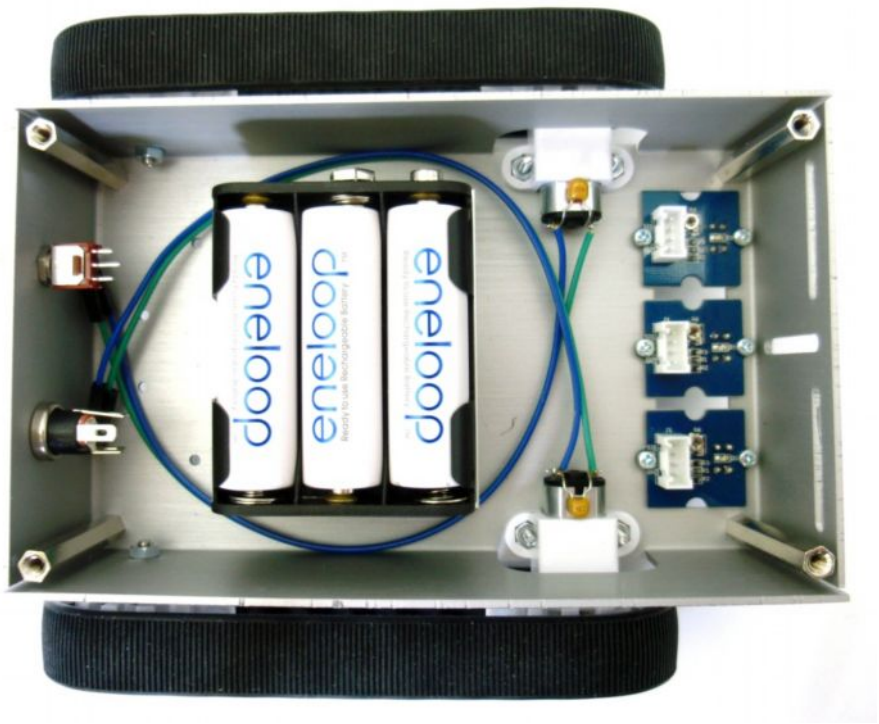
Supporting ball caster (½”) (for 2-wheeled version)

Motors, fasteners and front wheels (42 mm x 19 mm) – for 2 and 4 wheel drive system

Rear wheels (42 mm x 19 mm) for 4-wheeled drive system

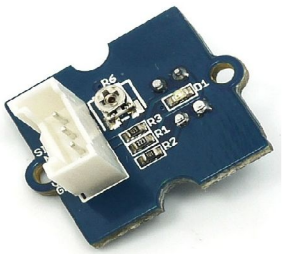
Track set with 2 front and rear drive wheels

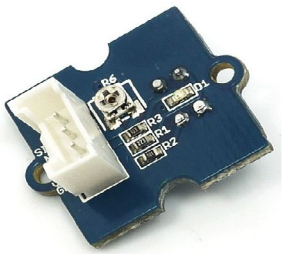
Mini-robot platform inside view (lower mounting plate) with assembled components

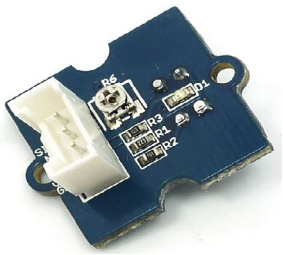


The assembly principle of motor to lower mounting plate

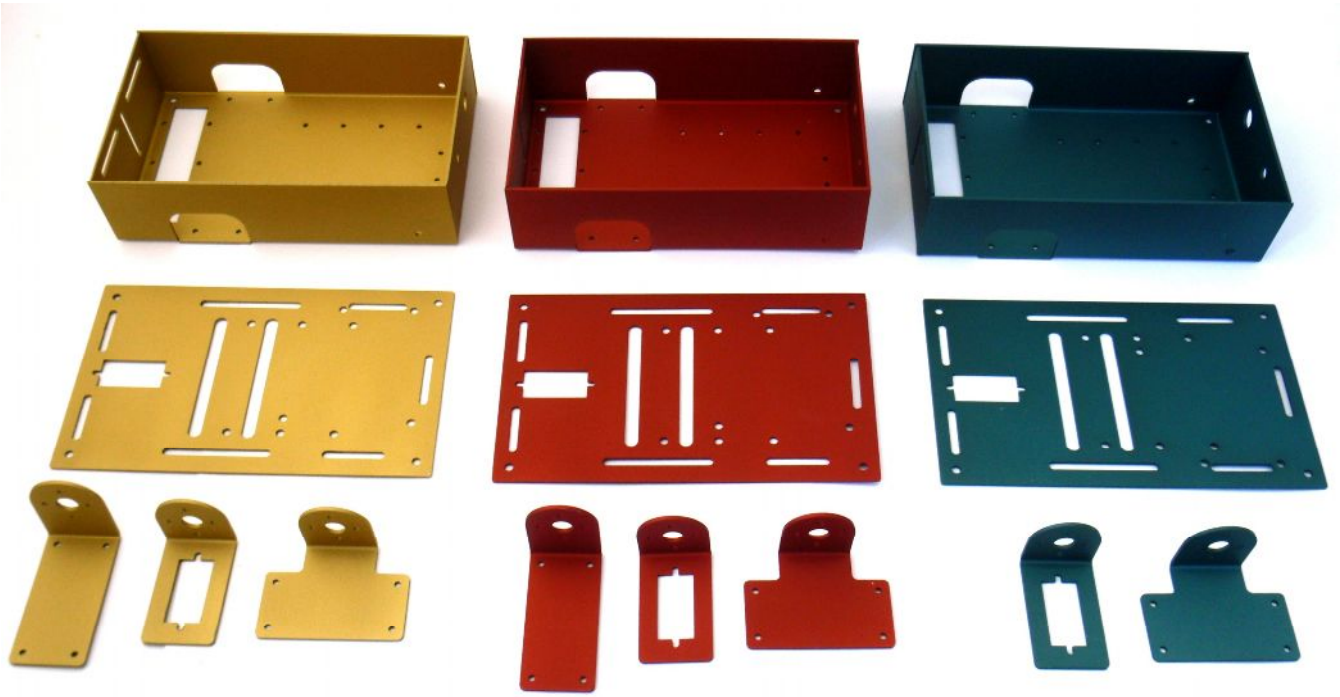
Line sensors

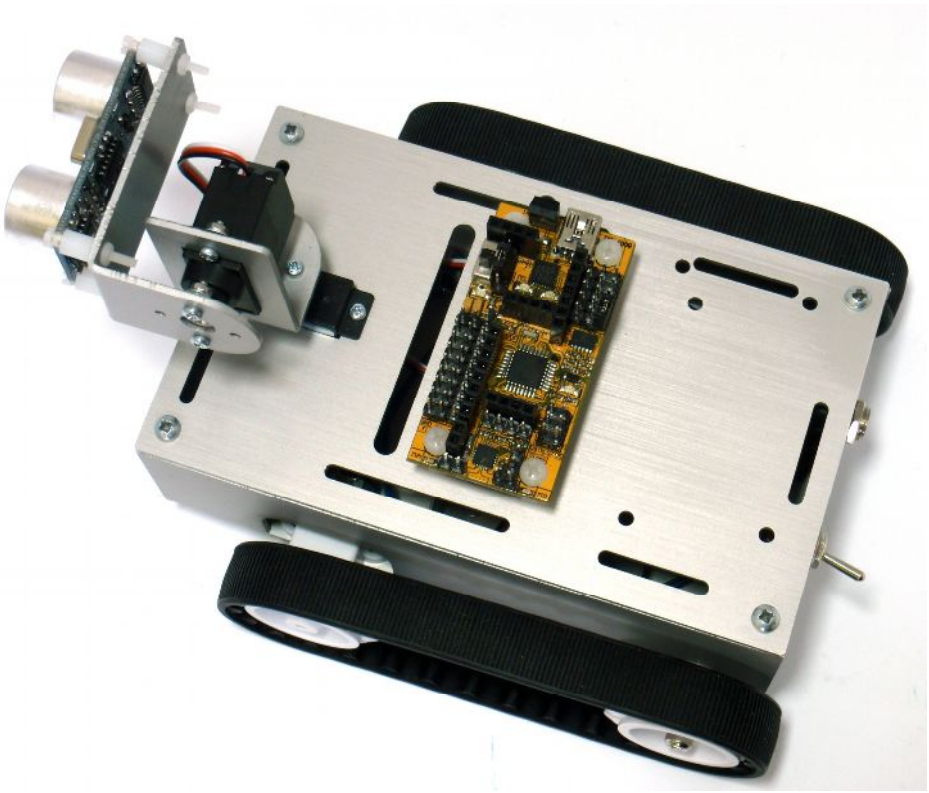






The platform is available in different colors





Graphic display module

An important feature of the AMRobot educational mini-robot is the possiblility to install (on the upper mounting plate) an intelligent graphic display by *4D Systems*, which can work without any master microcontroller.
The graphic display installed in the mini-robot can be very useful when the user needs to change software configuration or motor control parameters, settings of PID regulator etc.
A display with touch panel eliminates use of mechanical push-buttons. Besides, it enables the monitoring of robot status in the form of graphic messages that is valuable supplement of functions performed by software. Additionally, the display includes memory for storing graphic files, animations and audio and video files (built-in µSD connector)

For the needs of the AMRobot platform it is possibile to use any display available, however it is recommended to use an intelligent graphic display by *4D Systems* that can be quickly configured by external master microcontroller (*Arduino* for instance) through serial interface (UART). It can also work as a standalone device. The choice of work mode is accomplished by a public configuration file available on *4D Systems* website.
An external control mode with the use of serial interface is a convenient solution in case of using any external microcontrollers.

The use of above intelligent graphic display virtually eliminates the risk of failure when designing graphic interfaces even by less experienced users.

4D Systems also offers free **4D-Workshops IDE** programming environment and powerful **4D-ViSi Genie** graphic editor for simple and intuitive positioning of graphic components used for example, for measurement and control devices used in robotics and automatics. These include for example, push-buttons, measurement instruments, sliders, knobs, switches etc.
No programming language command is needed because the code for the display is created automatically when the user positions graphic components in the editor.