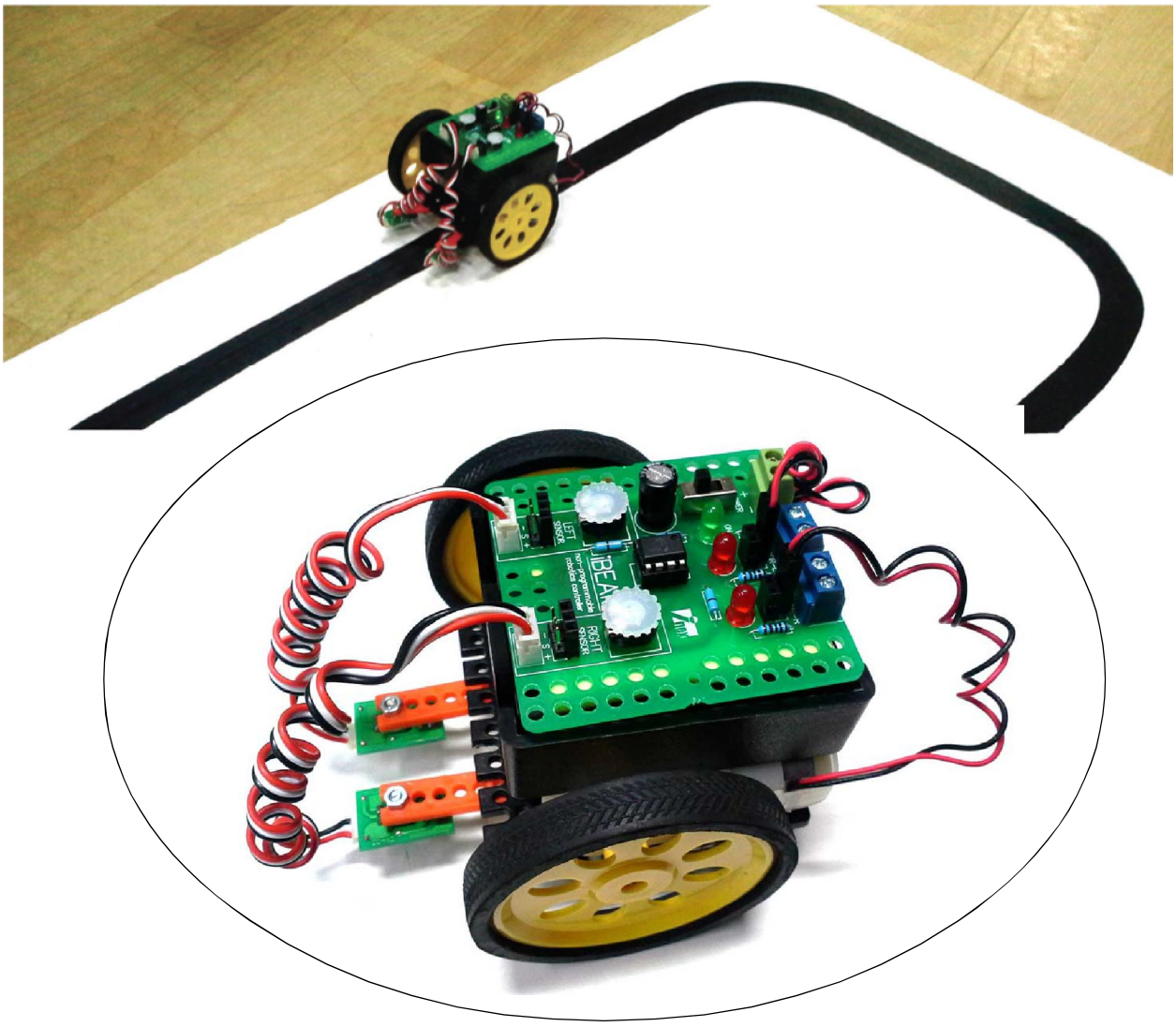
iBEAM

Line tracking BEAM robot kit



INNOVATIVE EXPERIMENT

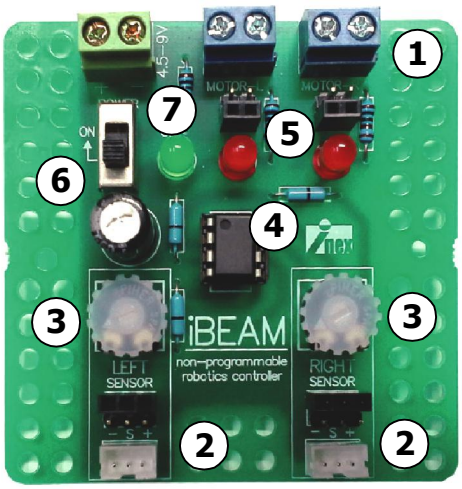
World Robot Games

iBEAM

Non-programming line tracking robot from Basic Electronic circuit

This is the simplest line tracking robot with BEAM robotics. Learn about both the basic electronics and operation of the simple automatic control system.

iBEAM controller board specification



(1) 2 of DC motor outputs. Drives 3 to 6V motor

(2) 2 of analog sensor inputs suitable for any analog sensor. Line tracking sensor is recommended for iBEAM robot.

(3) 2 of sensitivity knobs. It is used to adjust the reference voltage.

(4) Use L272M; the power Op-Amp for driving DC motor.

(5) 2 of motor LED status

(6) On-board power switch

(7) Power LED indicator

● No require any programming skill and knowledge.

● Wide range supply voltage +3 to +9V. Require 500mA current consumption for driving DC motors. Battery AA 4 pieces are required (not included in the kit). Alkaline battery is recommended.

1. Introduction

When talking about the autonomous robot is almost 100% think of robots that require programming. It may be forgetting that robot may occur from the very basic electronic circuit. The concept of a simple system is receiving an input signal from the sensor to process and control to the motor outputs.

The operation similar as programmable robots is very easy to make it happen without using microcontroller or programmable controller. The device used is the Operation Amplifier or Op-Amp. It is created a voltage comparator circuit between the voltage from the sensor with the reference voltage of the circuit. The results were compared to control the motors used to drive the robot works or does not work. Sometime call the Op-Amp as "**Analog computer**".

2. What is BEAM robotics ?

BEAM robotics is a style of robotics that primarily uses simpleanalogue circuits, such as comparators, instead of a microprocessor in order to produce an unusually simple design. While not as flexible as microprocessor based robotics, BEAM robotics can be robust and efficient in performing the task for which it was designed. Robots that use both analog and microprocessor electronics are known as "mutants".

BEAM robots may use a set of the analog circuits, mimicking biological neurons, to facilitate the robot's response to its working environment.

The word "BEAM" in BEAM robotics is an acronym for Biology, Electronics, Aesthetics, and Mechanics.

More information about BEAM robotics visit *http://www.beam-wiki.org*.

3. iBEAM robot overview

3.1 Operation Diagram

iBEAM robot is the simple autonomous robot that using this concept. iBEAM use the key component Op-Amp integrated circuit to work with line tracking sensors and simple mechanical parts. The robot moves along the black line automatically without any microcontroller and no programming. iBEAM is a Non-programmable robot. Figure 1 shows the operation diagram of iBEAM robot.

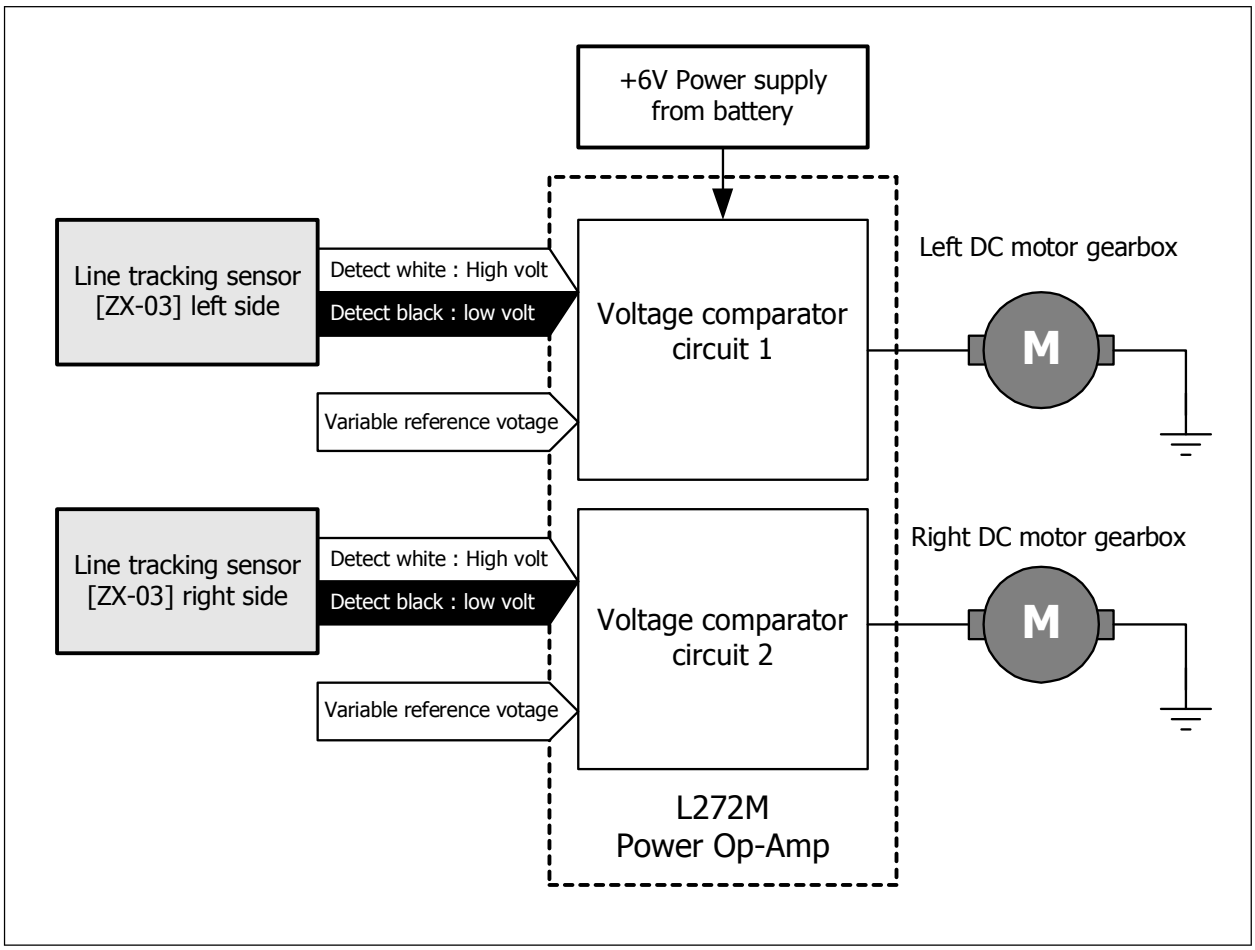


Figure 1 : iBEAM robot operation diagram

3.2 iBEAM controller board circuit description

Figure 2 is a schematic diagram of the iBEAM controller board. Heart of the circuit is IC1 the power Op-Amp ICs; L272M. It is constructed to the voltage comparator circuit that compared voltage between the sensor voltage and the reference voltage. IC1 has 2 Op-Amp circuits. Output of each circuit is connected to drive the DC motor.

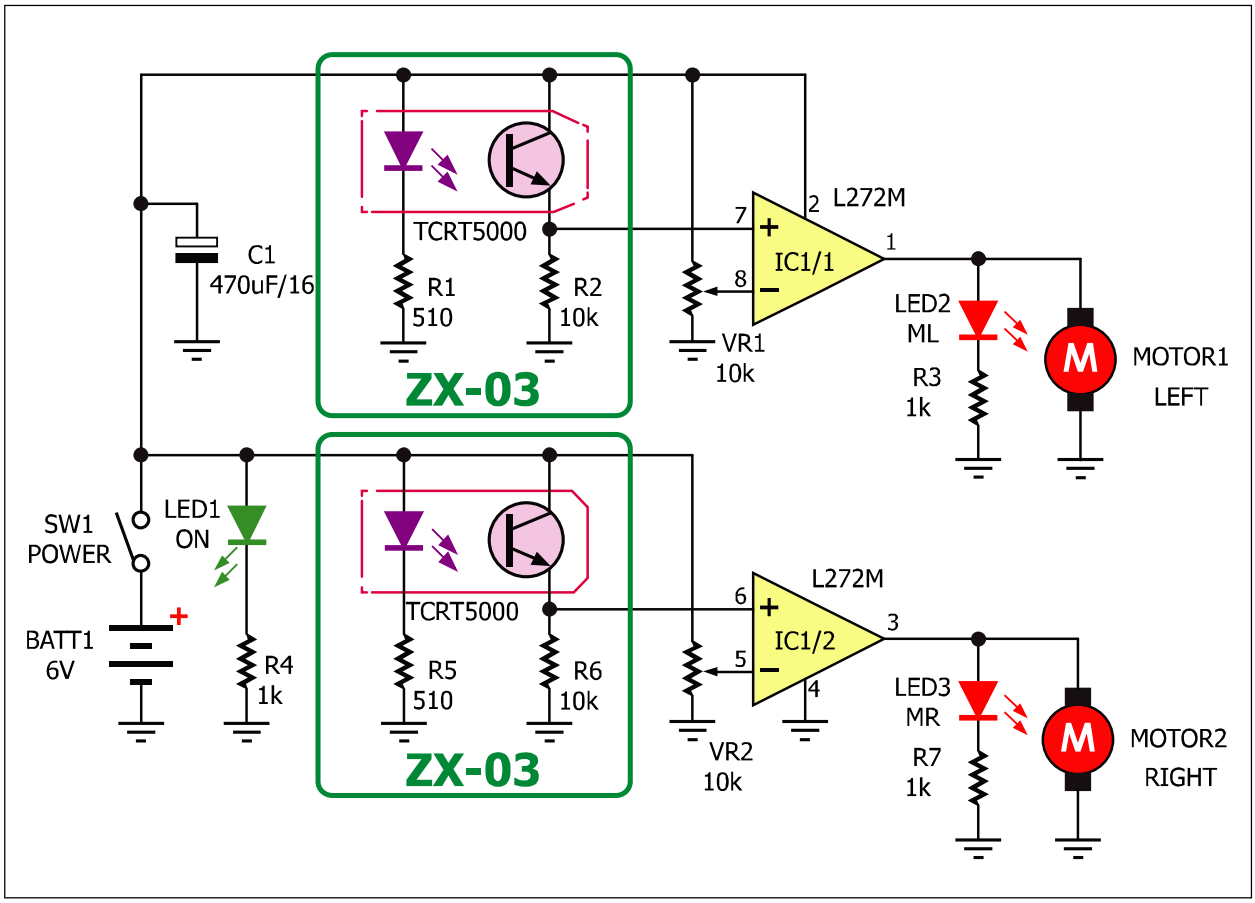


Figure 2 : Schematic diagram of iBEAM controller board that used in iBEAM robot

Non-inverting input (+) of each Op-Amp is connected to the IR reflector sensor; ZX-03, which was used as a black line detector. While the inverting input (-) is connected with VR1 or VR2 variable resistor that used as the voltage reference for comparison with voltage from ZX-03 sensor in each Op-Amp.

When the apply voltage at the non-inverting input is greater than the inverting input. The output voltage of the Op-Amp is high nearby the supply voltage. It can drive the DC motor that connected at the output terminal. In the other hands, in case the sensor voltage is lower than reference voltage that set by VR1 or VR2. Output of the Op-Amp is 0V. The DC motor at the output will stop.

This controller board takes the voltage comparator operation to control the DC motor working by using the operation of line tracking sensors to set the condition of movement.

This circuit drives 2 of 3 to 6V DC motors. In iBEAM kit choose the DC motor gearbox model BO1 with 87:1 gear ratio.

The supply voltage is wide range from +3 to +9V. Use 4 pieces of AA Battery. The alkaline type or rechargeable battery also is recommended. iBEAM controller board also works with 2 cells of Li-Po batteries (7.4V) and 1000mAH or higher.

4. Construct the iBEAM robot

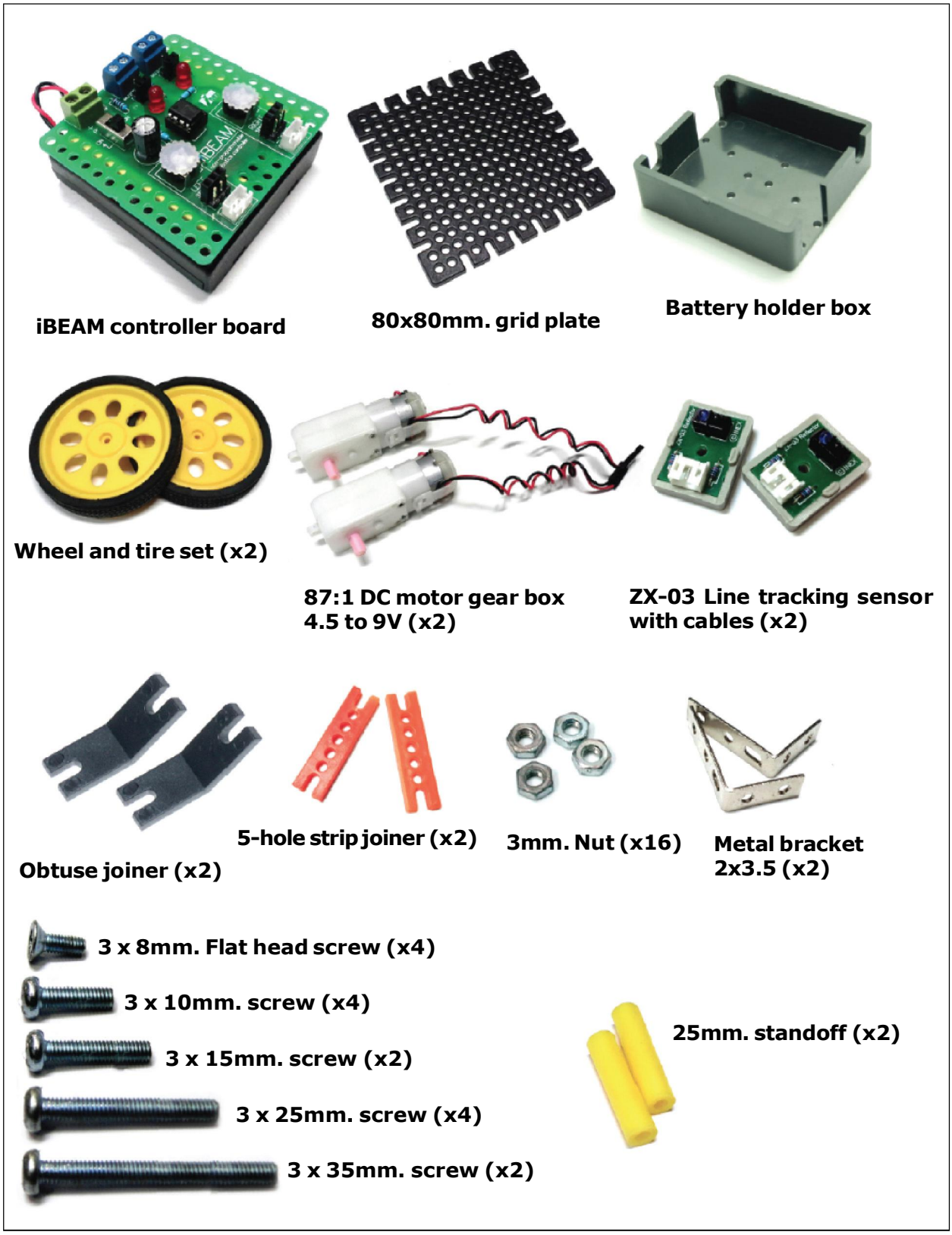
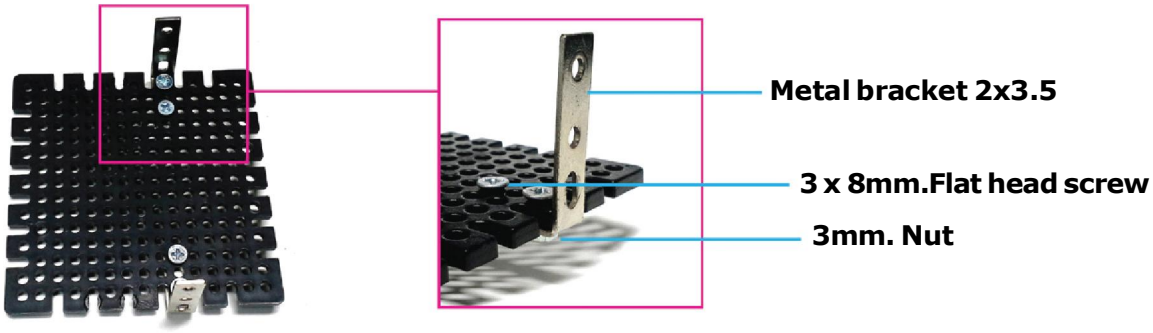
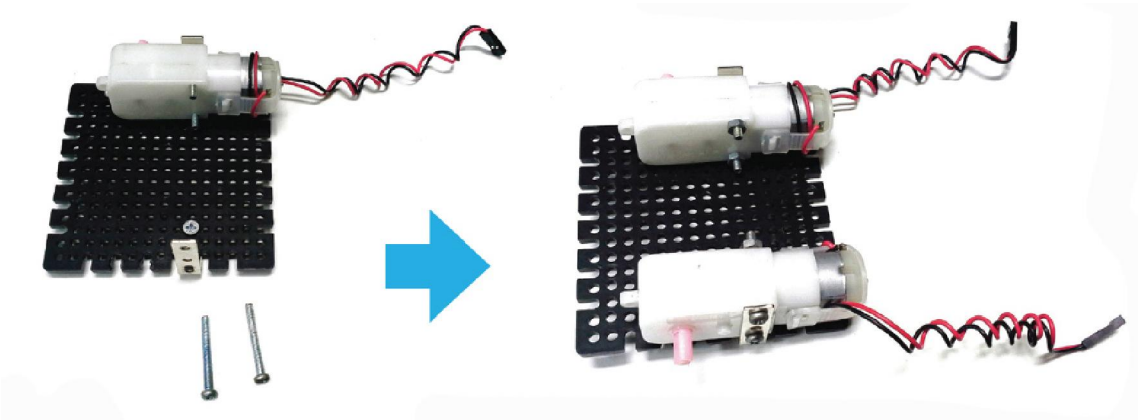


Figure 3 : Part list of iBEAM robot

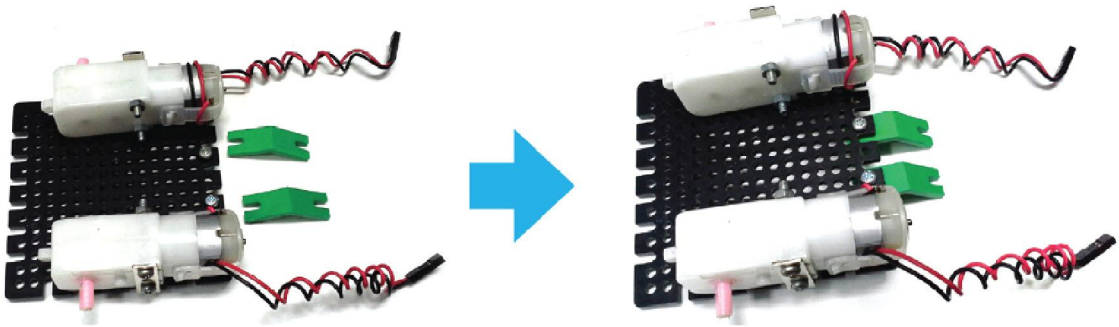
(1) Attach the metal brackets with the grid plate by using 3 x 6 mm. flat head screws and 3mm. nuts as the photo below.



(2) Attach another side of metal bracket with BO-1 DC motor gearbox by using 3 x 25mm. screws and 3mm. nuts. Turn the motor shaft to outside following the photo.

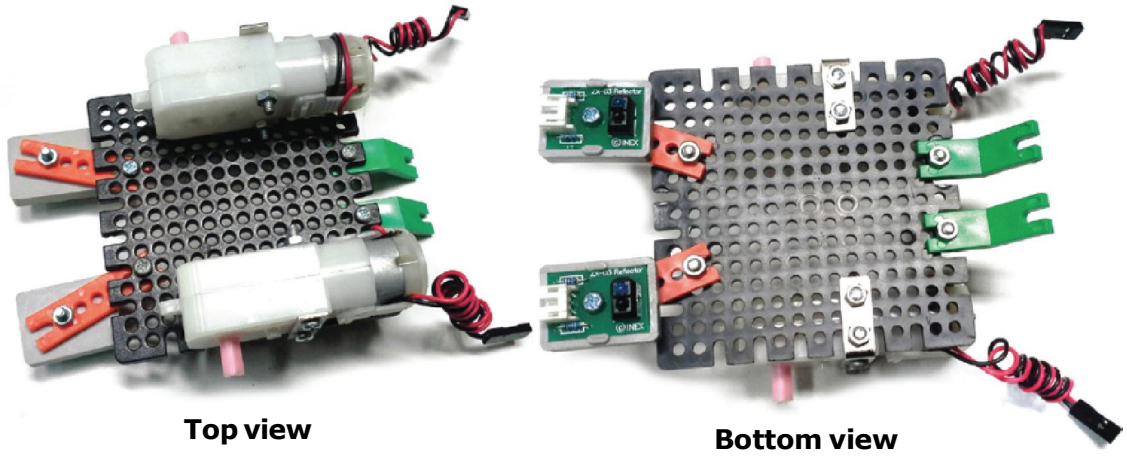


(3) Attach the obtuse joiner 2 pieces with thr grid plate that used as robot chasis by insert the 3 x 10mm. screw through hole of grid plate and obtuse joiner. Tighten with 3mm. nut following the photo.

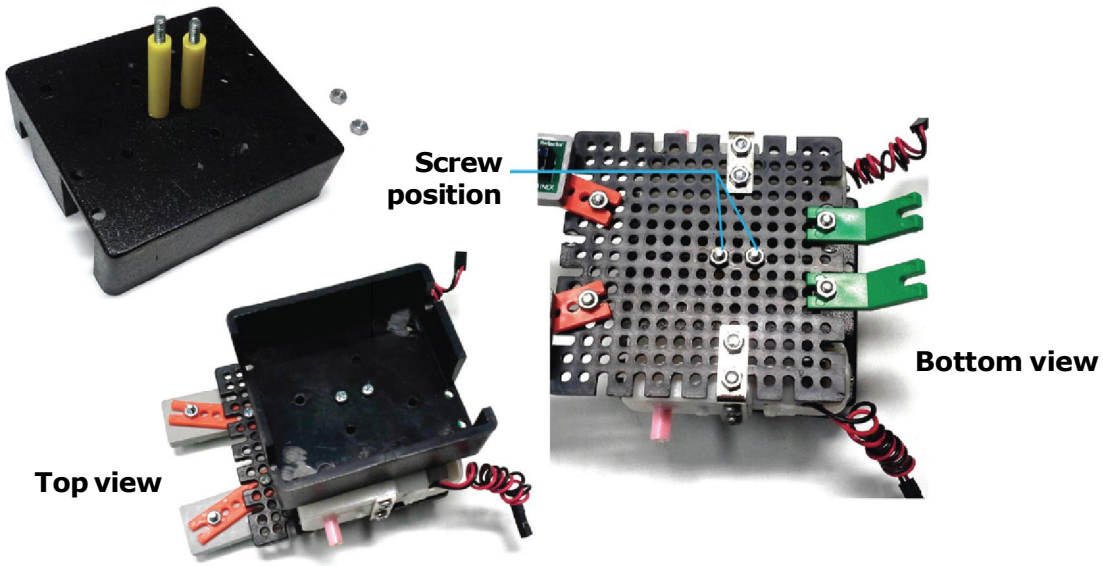


(4) Fix the 5-hole strip joiner with ZX-03 line tracking sensor by using 3 x 15mm. screw and 3mm. nut. Do 2 sets.

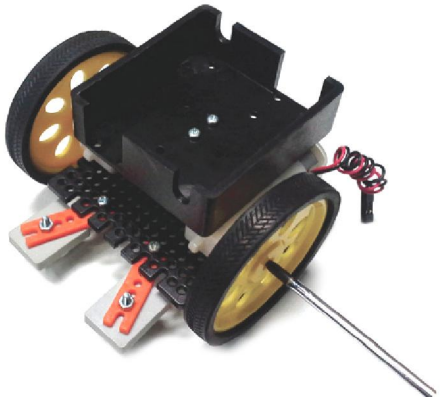
(5) Attach the ZX-03 sensors with robot chasis by using 3 x 10mm. screws and 3mm. nuts.



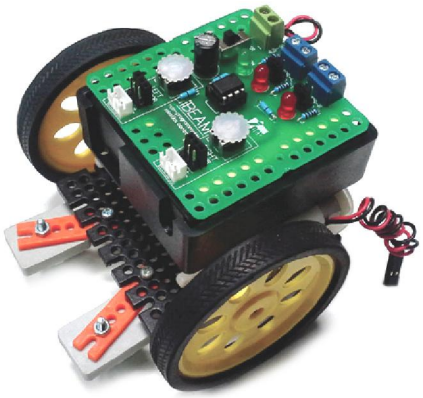
(6) Insert 3 x 35 mm. screw through battery holder box and 25mm. standoff. Do same 2 sets then attach with robot chasis.



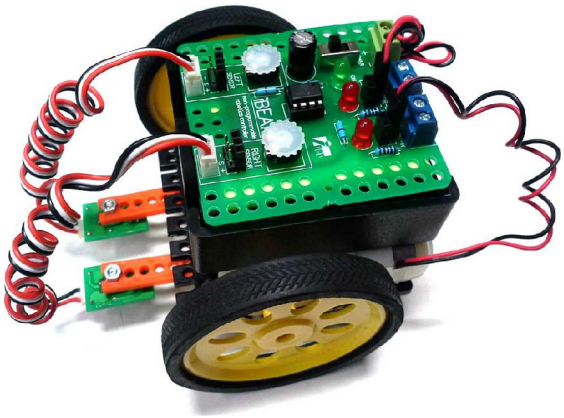
(7) Insert the plastic wheel with motor shaft and fix by using 2mm. tab screw. Do both of DC motor gearboxes.



(8) Put 4 of AA batteries into battery holder at the back of controller board. Place the controller board in the battery holder box following the photo below.



(9) Connect both ZX-03 sensor boars to LEFT and RIGHT sensor input of iBEAM controller board following the sensor position.



(10) Next, connect the motor wires to the controller board. Firstly, do not concern about pole. Try to turn the wheel each side and observe the motor's LED status. If LED is on, it mean connection is correct. If not, change the connection to opposite and try again.

Now the iBEAM robot ready to test and RUN !!

5. Testing

(1) Turn on. The green LED on the iBEAM robot is on. If not, check the battery connection to make sure tightened and correct pole.

(2) Place robot on the white floor. Turn the Sensitivity Knob in clock wise direction to end. If motor on, it will stop and red LED of motor status must off.

(3) Lift the robot and adjust the the Sensitivity Knob in anti-clock wise direction to end. Both motor must on and the red LEDs of motor status must on. If not, check the sensor connection and installation.

If all complete, iBEAM robot ready to tracking line testing.

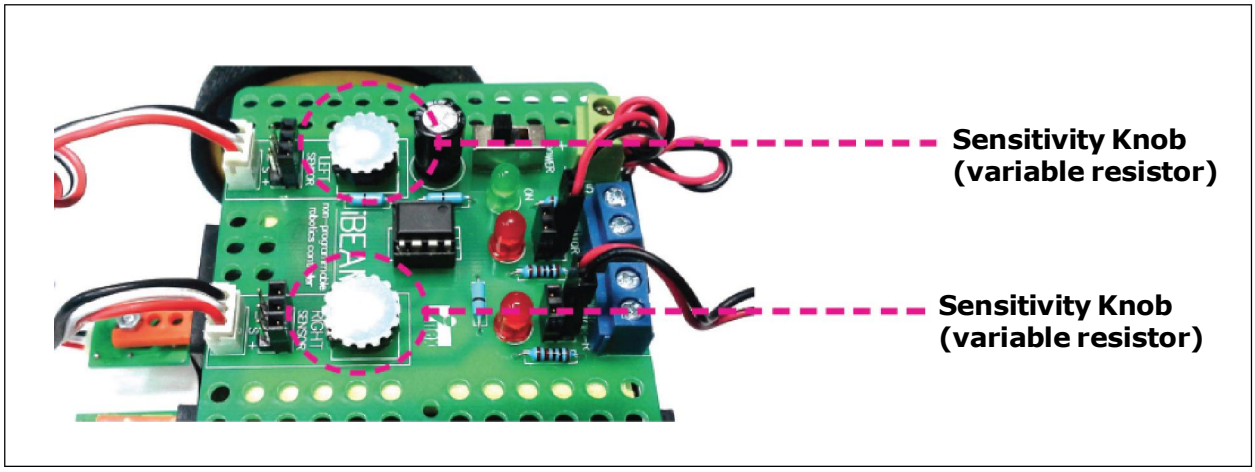


Figure 4 : Position of the Sensitivity Knob on the iBEAM controller board

6. Make the demonstration field

The demonstration field for iBEAM robot is easy to make. It includes white surface with black line. User can make their own field using the items below (not provided in this kit) :

1. Polypropylene board or PP board white and Black sheet. Size is 90 x 60 cm. However the sizing can change depending on your applications and resources.

2. Black electrical tape 1 inches width 2 rolls. 3M brand is recommended.

3. Scissors or a Cutter

Making is easy. Attach the black tape on the PP board with any shape. The black line must continue and no any crossing.

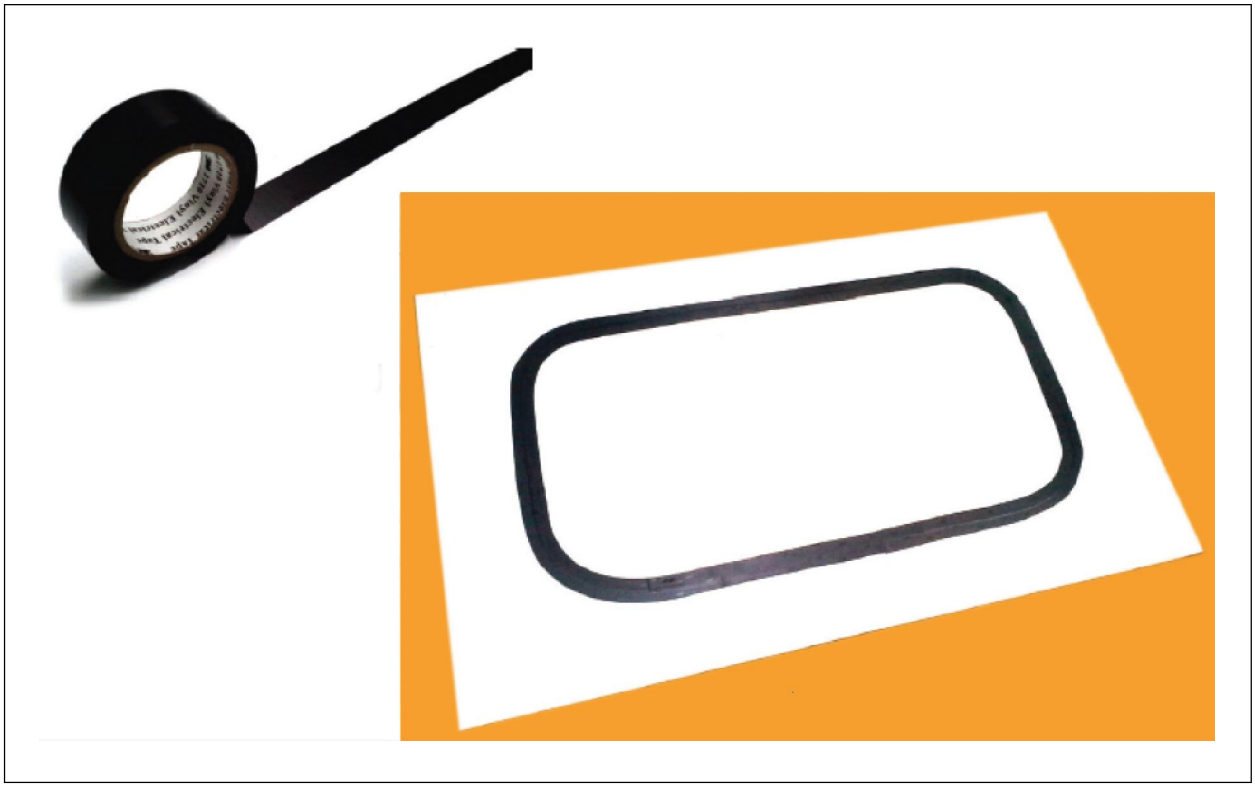


Figure 5 : The demonstration filed preparation

7. Calibration iBEAM robot to move along the black line

(1) Place the iBEAM robot on the white floor. Lift the robot 3 cm. above the floor. Adjust the Sensitivity Knob until all motor stop.

(2) Place the iBEAM robot over the black line. iBEAM robot will move along the black line following the figure 6.

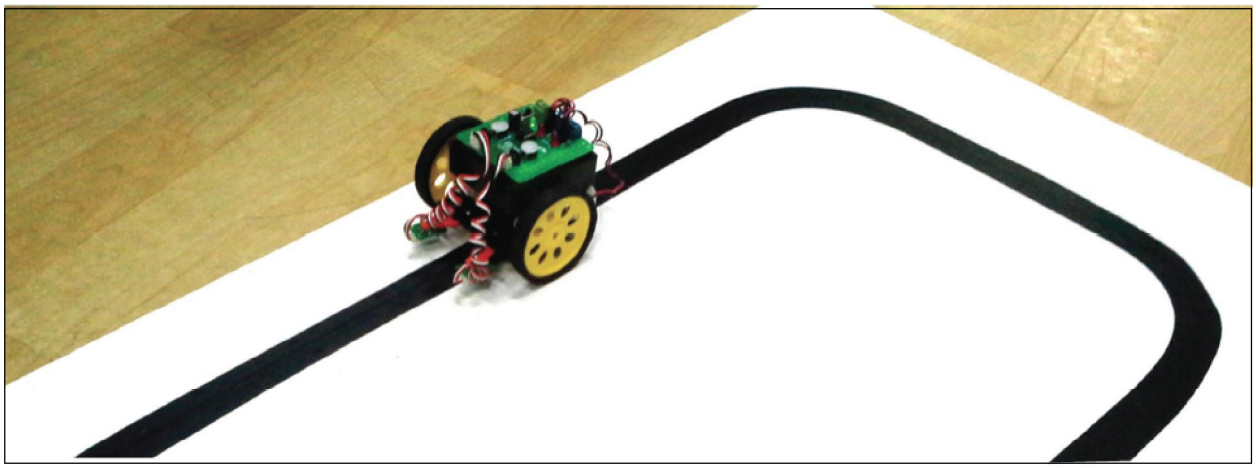


Figure 6 : iBEAM robot is moving along the black line

8. How to iBEAM move ?

Refer the figure 7, the first scenario is the left and right line tracking sensors detect the white floor. It means the iBEAM robot is over the black line. The sensors apply voltage high level (nearby the supply voltage) to the voltage comparator circuit that used the power Op-Amp ICs. This case the sensor voltage is greater. The Op-Amp drives the high voltage to both DC motors at the output. Robot will move forward.

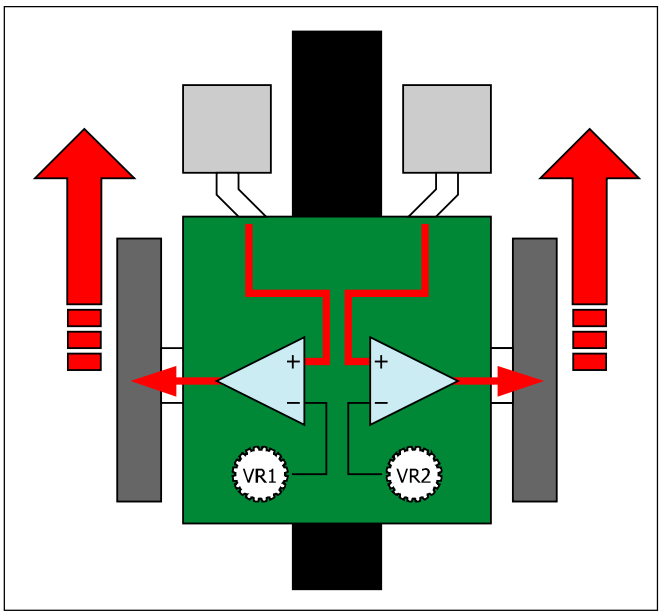


Figure 7 : Illustrated forward movement operation of iBEAM robot

Whenever the left sensor detecs the black line and the right sensor detects the white surface, the left sensor gives low voltage that lower than the reference voltage. It causes one comparator circuit apply the zero voltage to output. The ouput DC motor will be stop immediately while another one motor still operate continue because the right sensor also detects the white surface. The robot will be turn left slowly following the figure 8.

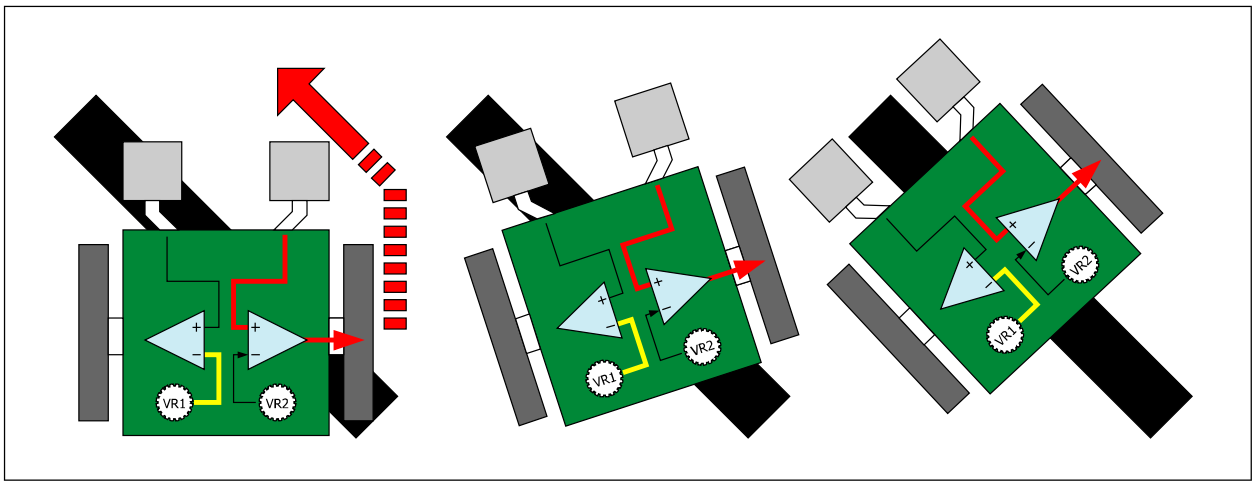


Figure 8 : Illustrated the iBEAM robot moves along the line to the left

In the other hands, the left sensor detects the white surface and right sensor detects the black line. The right sensor send low voltage to output. The output motor at right side will be stop immediately while another one motor still operate continue because the left sensor also detects the white surface. The robot will be turn right slowly following the figure 9.

Final scenario, the iBEAM robot does not move if both line tracking sensors detect thew black line.

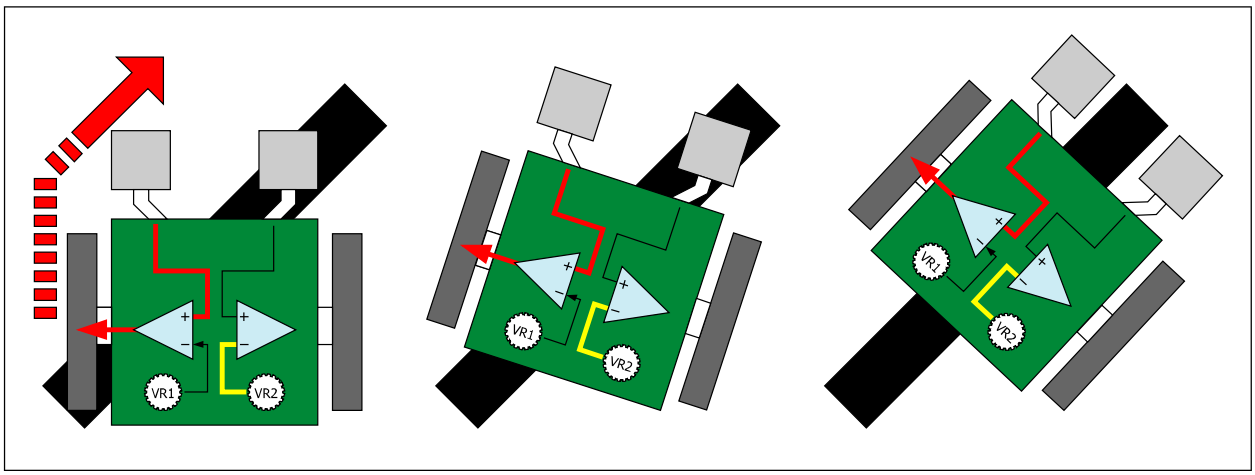


Figure 9 : Illustrated the iBEAM robot moves along the line to the right

9. Summary

The simple autonomous robot is built upon the BEAM concept charming and helpful especially in the basic electronic circuits. Easy to understand and can extend to the next step of control circuit.

The iBEAM robot also has fun when use in the line tracking competition. The robot that can move from start to finish fastest and without moving out of the line is the winner.

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