From the first steps with Rover to autonomous driving (parallel parking)

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Abstract

Starting with simple commands to let the Rover move we will try to show how a simple model of autonomous driving can be realized.

Step 1

Make the TI-Innovator Rover move FORWARD and BACKWARD, until a certain limit.

Step 2

Include a further ultrasonic sensor to measure the length of possible parking spots

Step 3

Let the Rover find the first suitable parking spot

Step 4

Let the Rover parking parallel

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Step 1 (idea and realization Hans Martin Hilbig)

Make the TI-Innovator Rover move FORWARD, until a certain limit.

Dependent on the distance of the ranger of the rover to a wall the following action is expected.

a) The wall is more than 30cm away:
   The Rover stops and the red RGB LED is on

b) The wall is more 13cm and less then 30cm away:
   The Rover goes forward until the distance is less than 13 cm.

c) The wall is less than 13cm and more than 9cm away:
   The Rover stops and the green RGB LED is on

d) The wall is less than 9cm away:
   The Rover goes backward until the distance is more than 9 cm.

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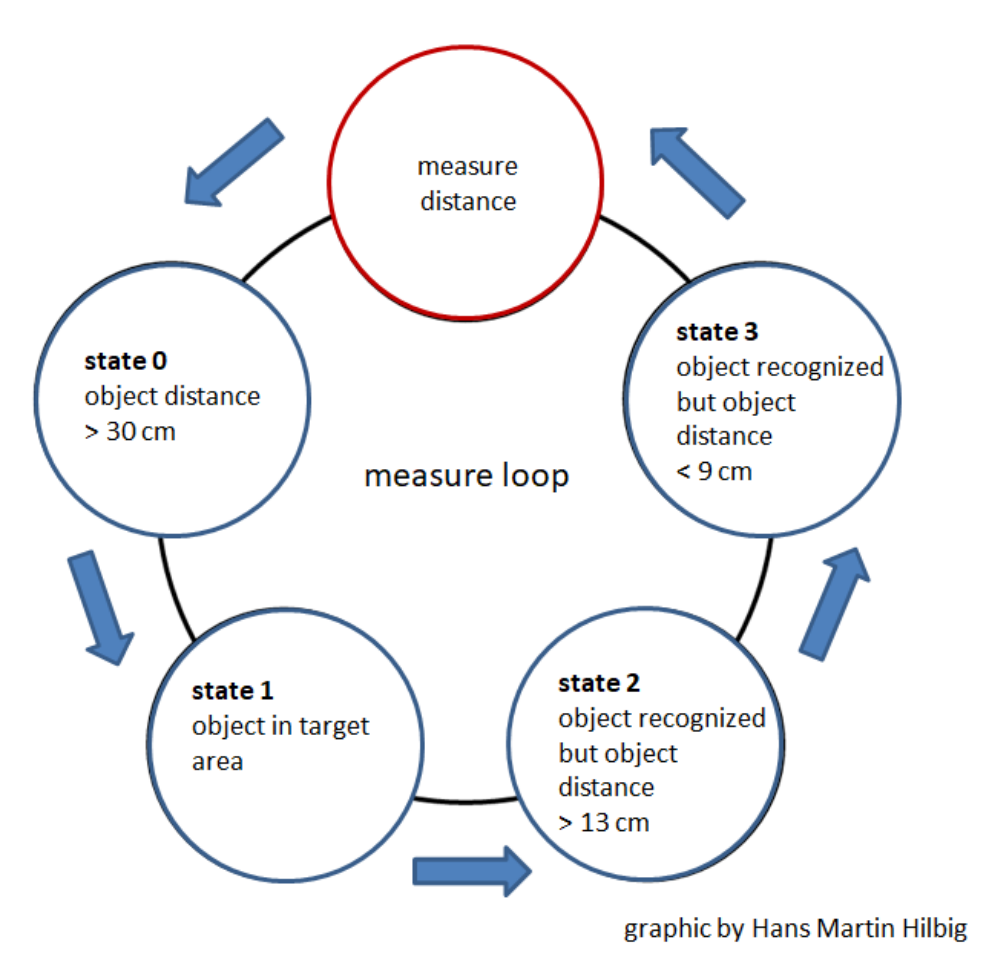
State-Transition-Programming



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This is a part of code:

Local variables for the distance and the state

Global while-loop to stop the program with pressing any key

Defining and finding the state

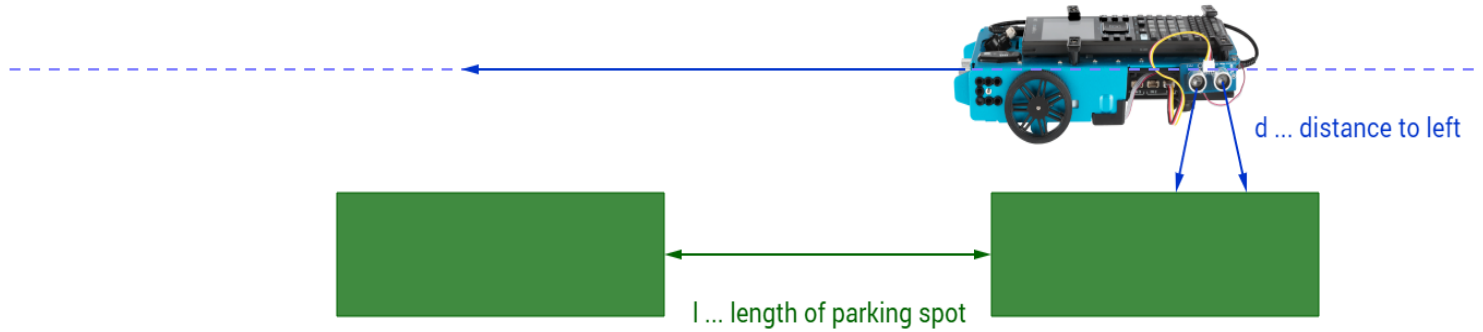
Do some experiments with the program.

```
* testing
Define testing()=
Prgm
© d … distance, s … state
Local d,s
Send "CONNECT RV"
s:=0
While getKey="[ ]"
   Send "READ RV.RANGER"
   Get d
©  DispAt 1, "distance: ", d
   If d > 0.3 Then
     Send "SET RV.COLOR.RED ON TIME 0.1"
     If s=0 Then
        Send "RV STOP "
        s:=0
     EndIf
     ElseIf d ≥0.09 and d≤0.13 Then
        If s>1 Then
           Send "RV STOP "
           s:=1
        EndIf
        Send "SET RV.COLOR.GREEN ON TIME 0.1"
```

Step 2

Include a further ultrasonic sensor to measure the length of possible parking spots.

The Rover should stand by shown.



Step 2

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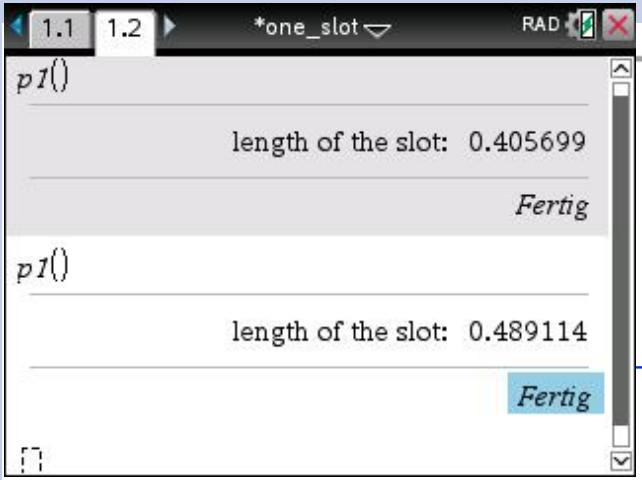

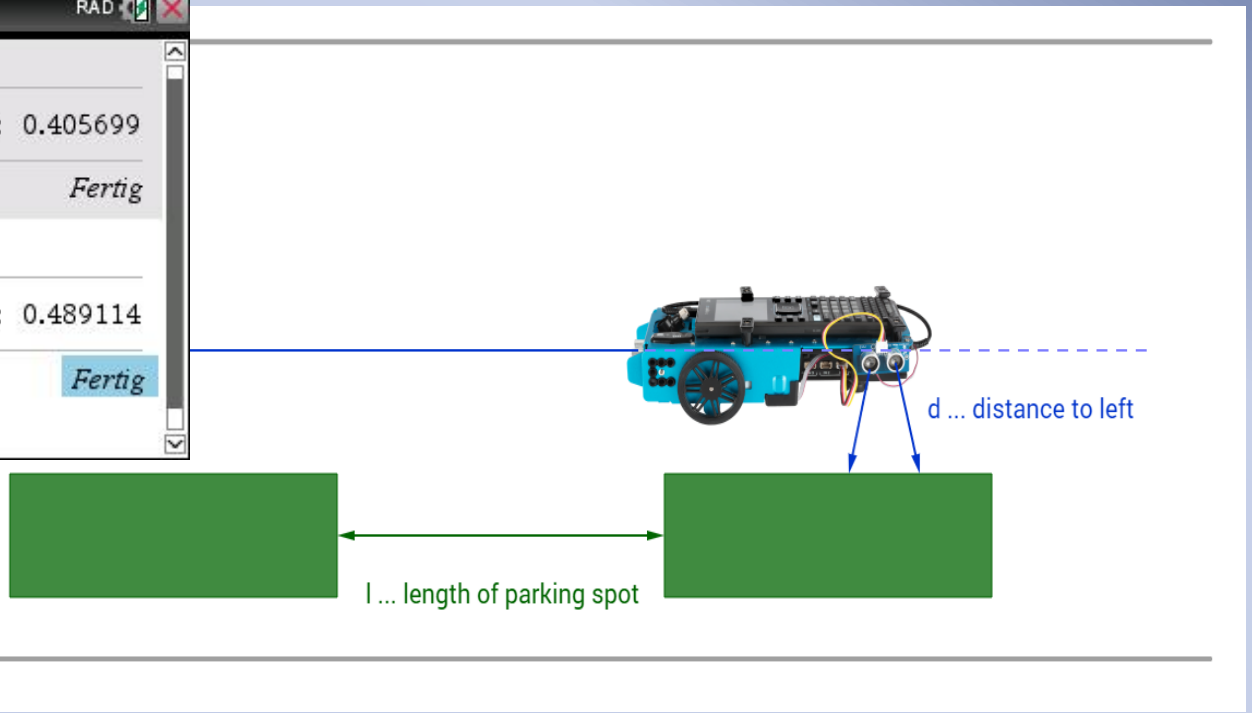

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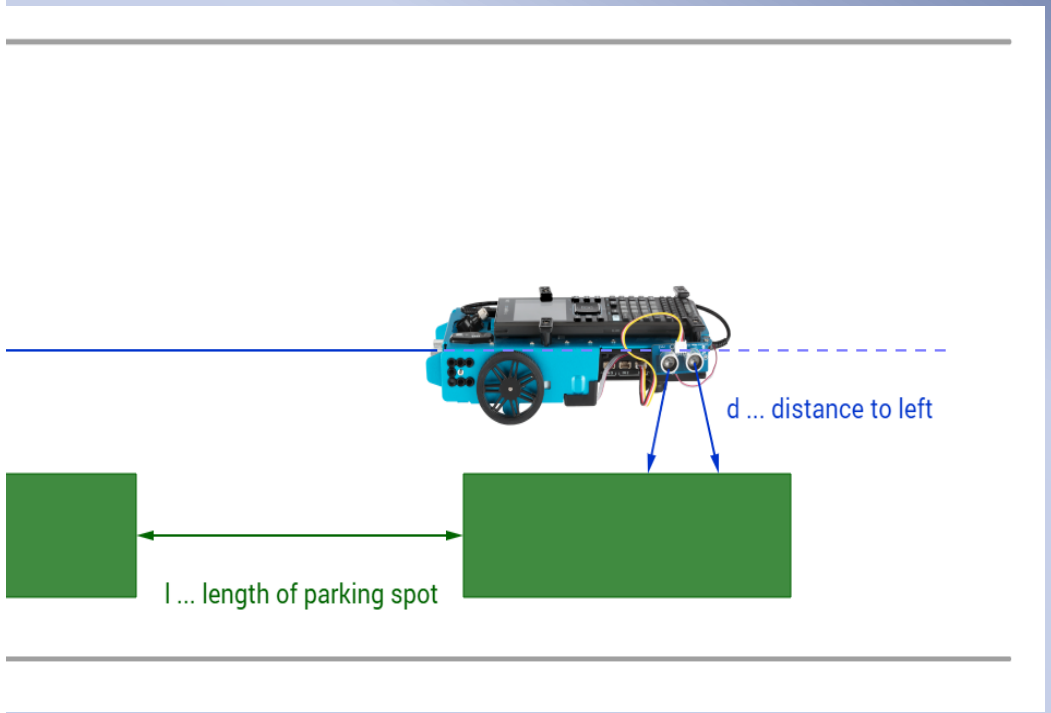
a part of code

```
* p1
Define p1()=
Prgm
© var d … distance to the left
© var l  … length of the parking spot

Local d,l
d:=0: l:=0

Send "CONNECT RV"
Send "CONNECT RANGER 1 TO IN 1"
Wait 0.1

While d<0.3
    Send "RV FORWARD"
    Send "READ RANGER 1"
    Get d
EndWhile
Send "RV STOP CLEAR"

While d≥0.3
      Send "RV FORWARD"
      Send "READ RANGER 1"
      Get d
EndWhile
Send "READ RV.WAYPOINT.DISTANCE"
Get l
Disp "length of the slot:  ",l

Send "RV STOP CLEAR"
```



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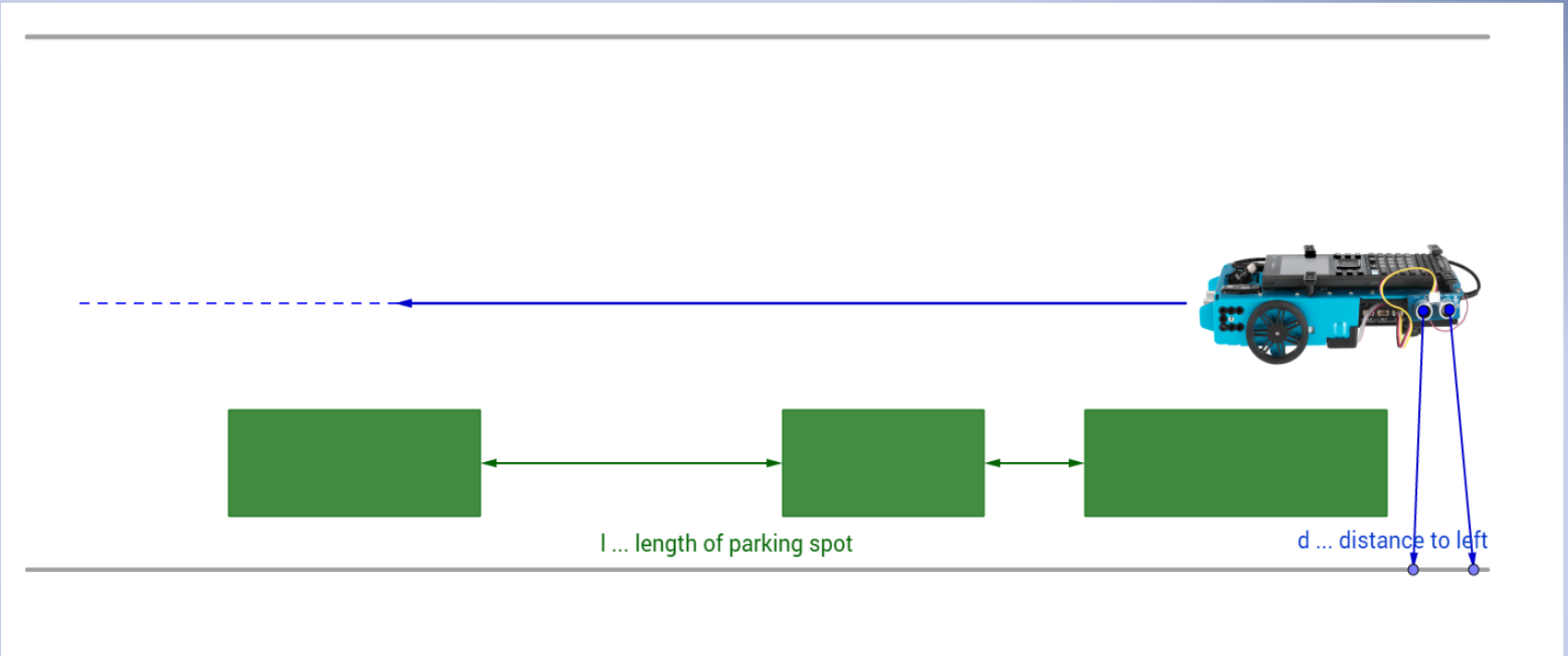
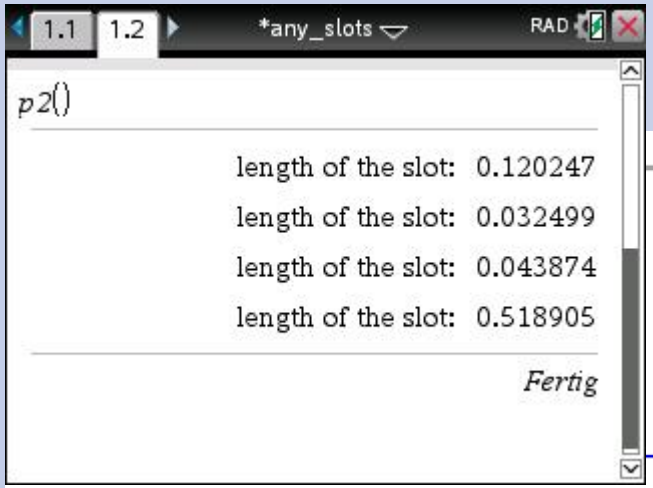
Step 3

Let the Rover find the first suitable parking spot



Step 3

Let the Rover find the first suitable parking spot



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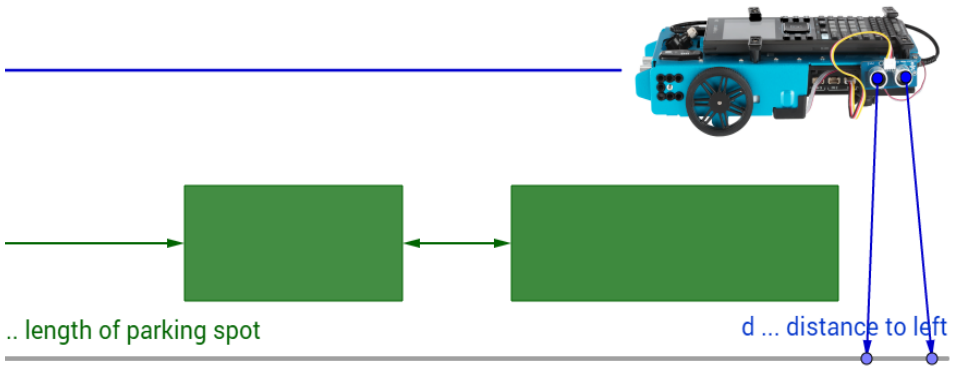
```
* p2
Define p2()=
Prgm
© var d … distance to the left
© var l … length of the parking slot

Local d,l
d:=0

Send "CONNECT RV"
Send "CONNECT RANGER 1 TO IN 1"
Wait 0.1

…

Send "READ RV.WAYPOINT.DISTANCE"
Get l
Disp "length of the slot: ",l

If l<0.5 Then
© recursive call
   p2()
Else
   Send "RV STOP CLEAR"
EndIf

EndPrgm
```

a part of code with recursive call

Idea by two 11th graders
B.Gerlach and K. Volkenand



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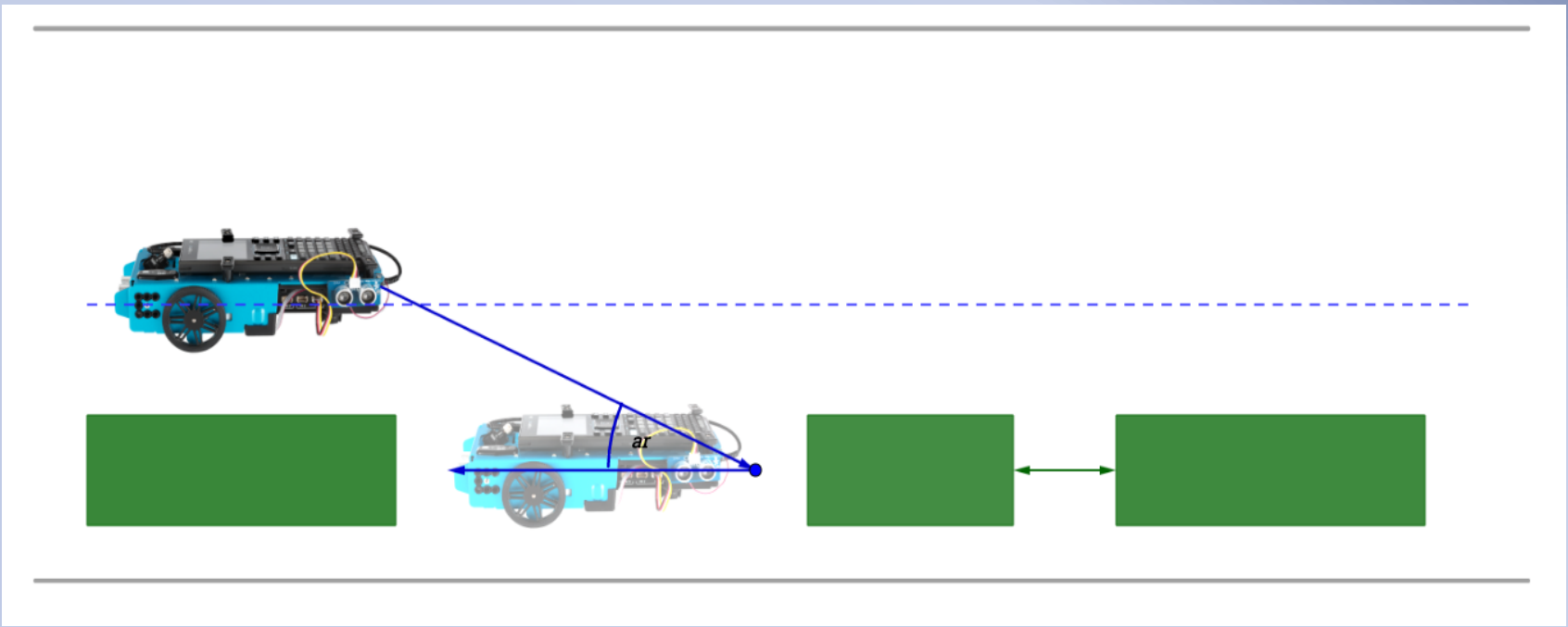
Step 4

Let the Rover parking parallel



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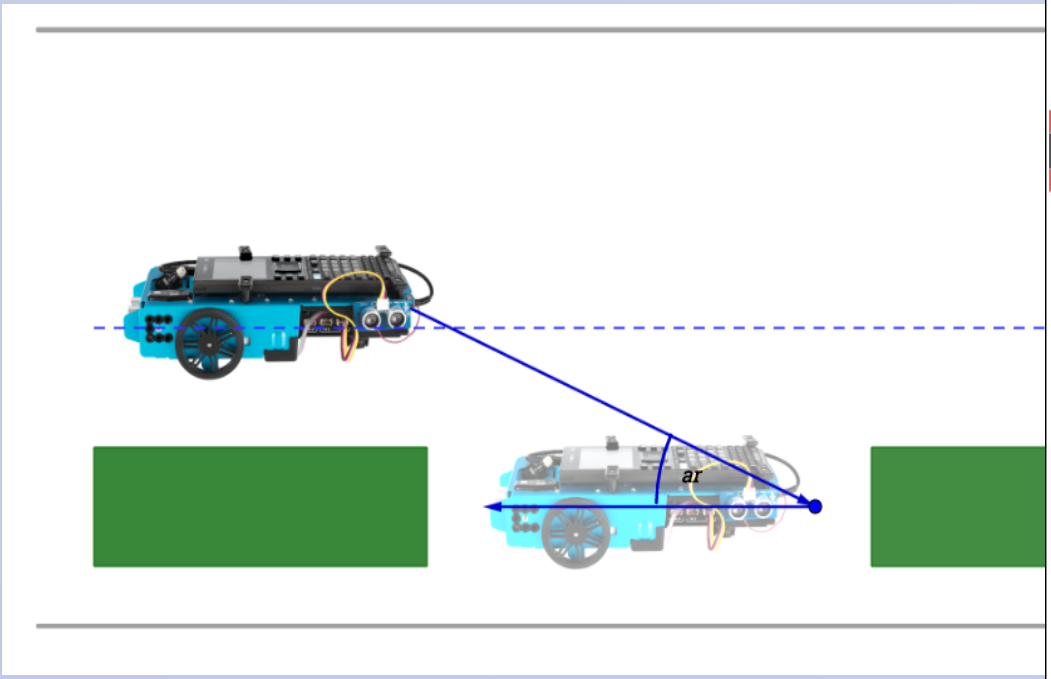
a part of code with Mathematic of backward parking



p3

```
© --- parking ---
  Disp "length of the last slot:  ",l
  lcorr:=l+d/2
  Wait 2
  Disp "corrected length: ",lcorr

  ar:=tan^-1((3·d)/(2·lcorr))·180/π

  Disp "angle right: ",ar

  back:=√(d^2+4/9·lcorr^2)

  If ar<15 Then
    Send "RV BACKWARD 0.1 M"
    backcorr:=back+0.04/d
  Else
    backcorr:=back+0.06/d
  EndIf
  Send "RV RIGHT EVAL(ar)"

  Send "RV BACKWARD EVAL(backcorr) M"
```

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Programming language: TI-BASIC

TI-BASIC is a programming language based of BASIC from Texas Instruments for programming of TI-Graphic and CAS-calculators and the Hub

View also:

TI-BASIC Developer (english):
http://tibasicdev.wikidot.com/starter-kit

TI Codes (TI-Nspire Technology)
https://education.ti.com/en/activities/ti-codes/nspire/10-minutes

TI Rover: important commands
TI-Innovator_Technology_Guidebook_EN_V_1_3 from page 29