Mars Invaders

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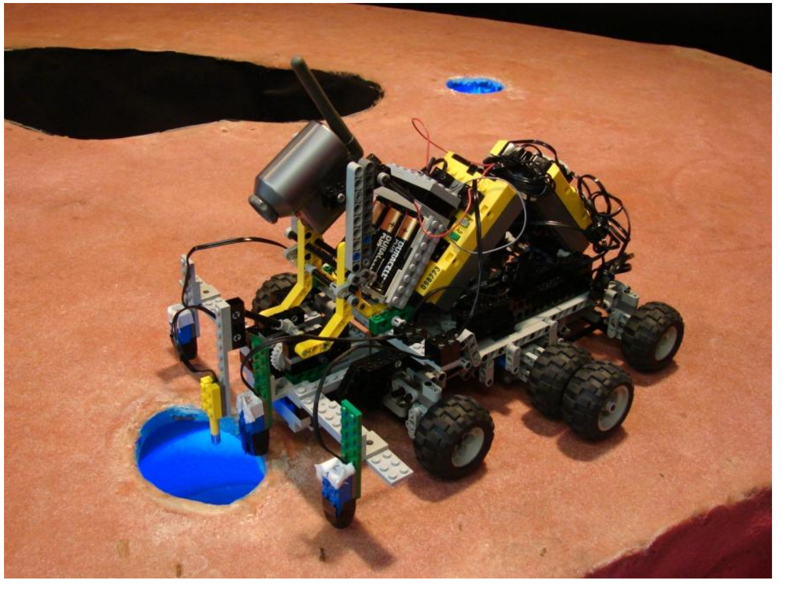


CONTENTS

LINE TRACKING

- Problem definition:

Locate and follow a line in the floor meanwhile measuring the actual length of the line.

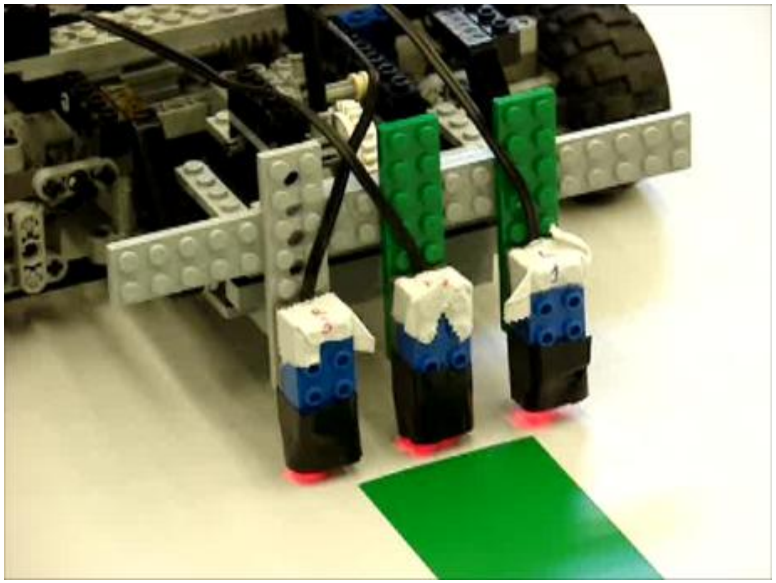
LINE TRACKING

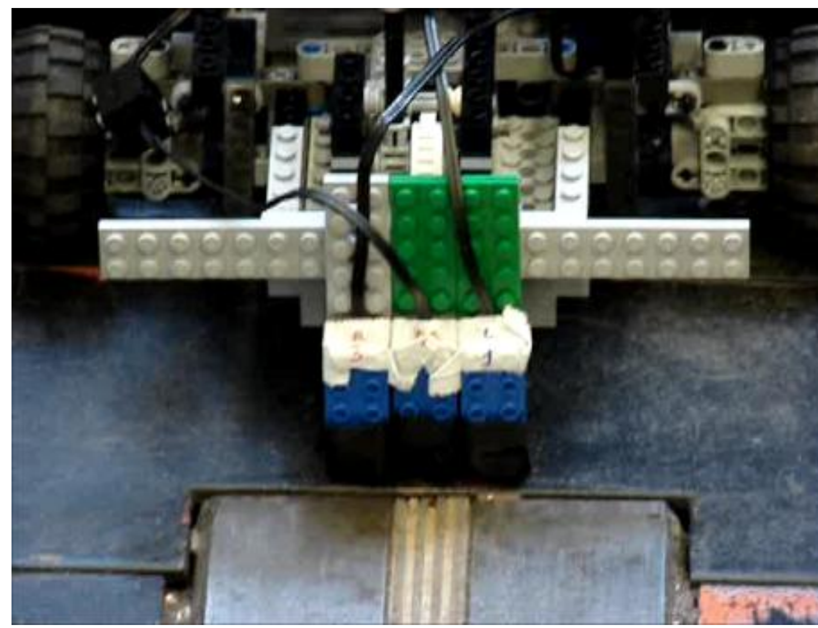
- Considerations:
  - The color of the background and the line are unknown and could change with the lighting.
  - The width of the line is unknown.
  - The light sensor may not have uniform readings.
  - Encoders need to be calibrated to relate the number of counts with the distance.

LINE TRACKING

- Assumptions:
  - We can change the place of the light sensor depending on the line width.
  - To measure the light values of the background and the line, we can put the robot in front of the line and move towards the line.
  - The rotations of the robot are short, so the length of the line is equal to the distance the robot moves.

LINE TRACKING



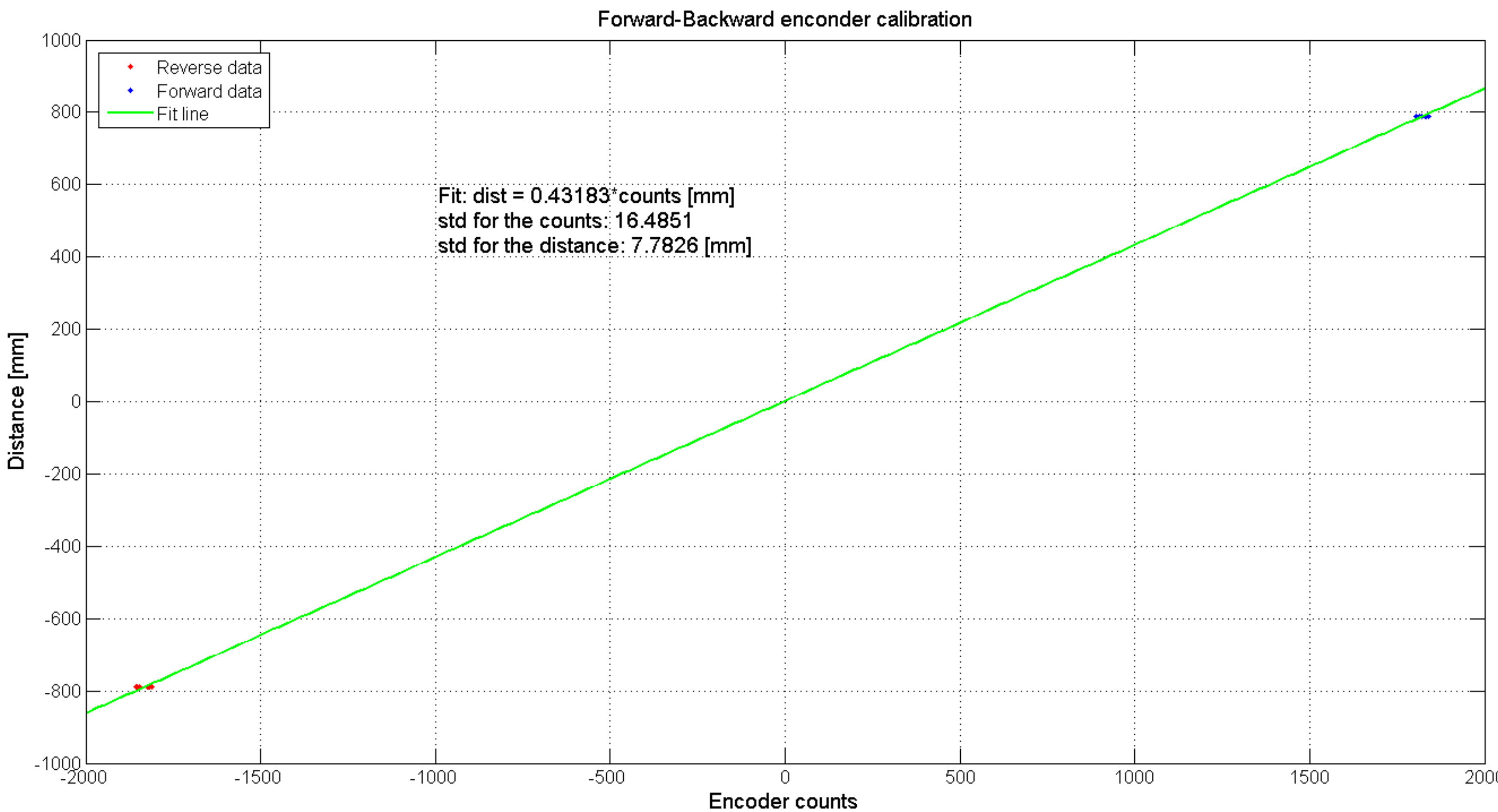


LINE TRACKING

- Sensors calibrations
  - Light sensors:
    - Left sensor is the reference sensor.
    - Middle sensor has an additive correction factor of +4.
    - Right sensor has an additive correction factor +2.
  - Direction encoder:
    - It is used to determine whether or not the wheels are rotated the maximum acceptable value.
    - The direction can move to a maximum of 85 counts from the aligned position.

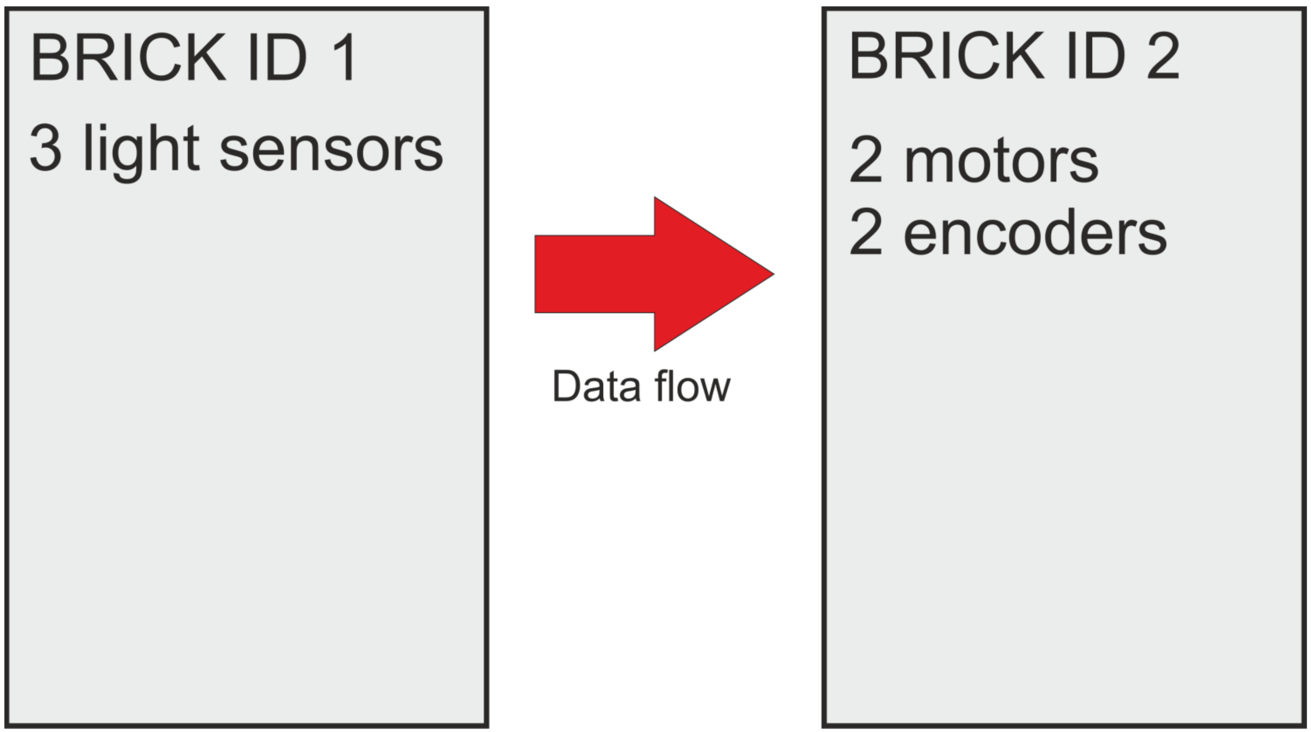
LINE TRACKING

- Sensors calibrations
  - Translation encoder:



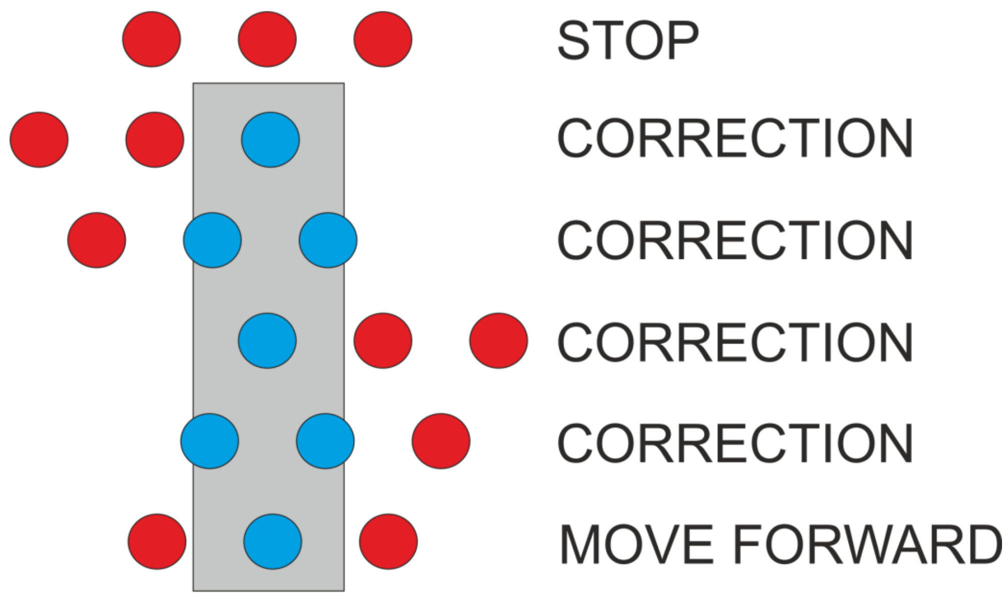
LINE TRACKING

- Hardware architecture



LINE TRACKING

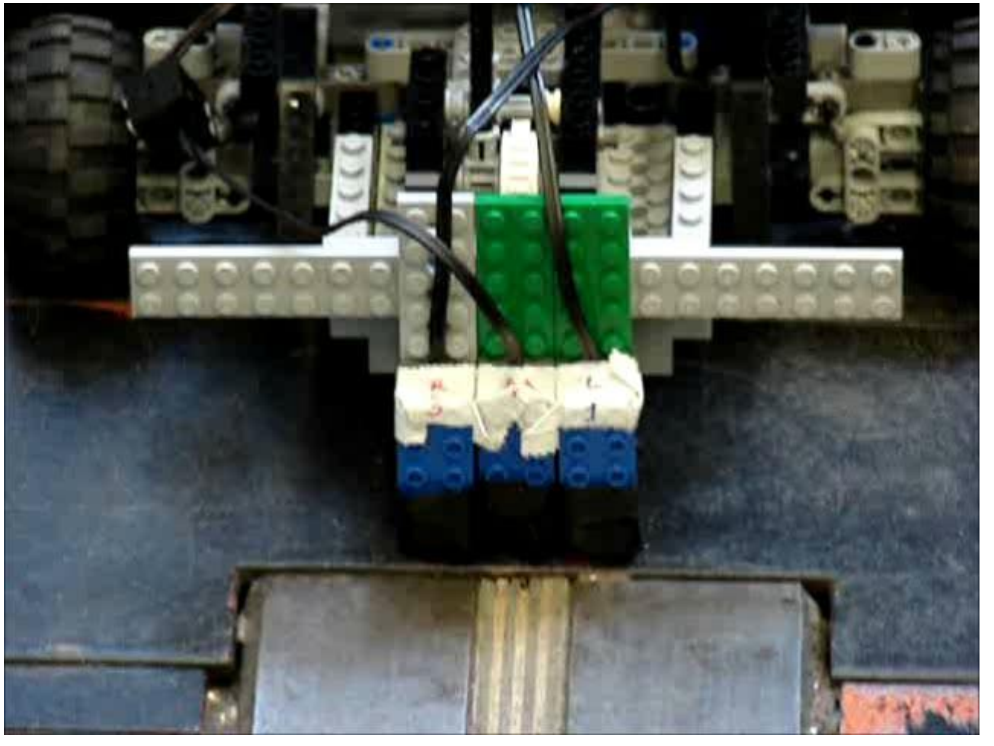
- Algorithm:



- Threshold to determine whether the sensors are on top of the line or not is calibrated at the beginning of the process.

LINE TRACKING

- Results



- Accuracy of the length measure: 7 mm error for a line of 915 mm and 12 mm error for a line of 3000 mm.

MARS MISSION

- Problem definition:

Write software for the Mars-rover such that it finds the three lakes, measures the temperature of the water and sends the outcome to the earth computer.

MARS MISSION

- Considerations:
  - Coordinates of the lakes are received from Earth Computer.
  - The coordinates of the lakes are relative to the position of the robot.
  - Communication with Earth Computer may have delays or even may fail.
  - <u>Crater and edge detection using the light sensors is needed in order to avoid falling.</u>
  - If the Robot is close to one lake, it may be possible that the camera does not detect the lake.

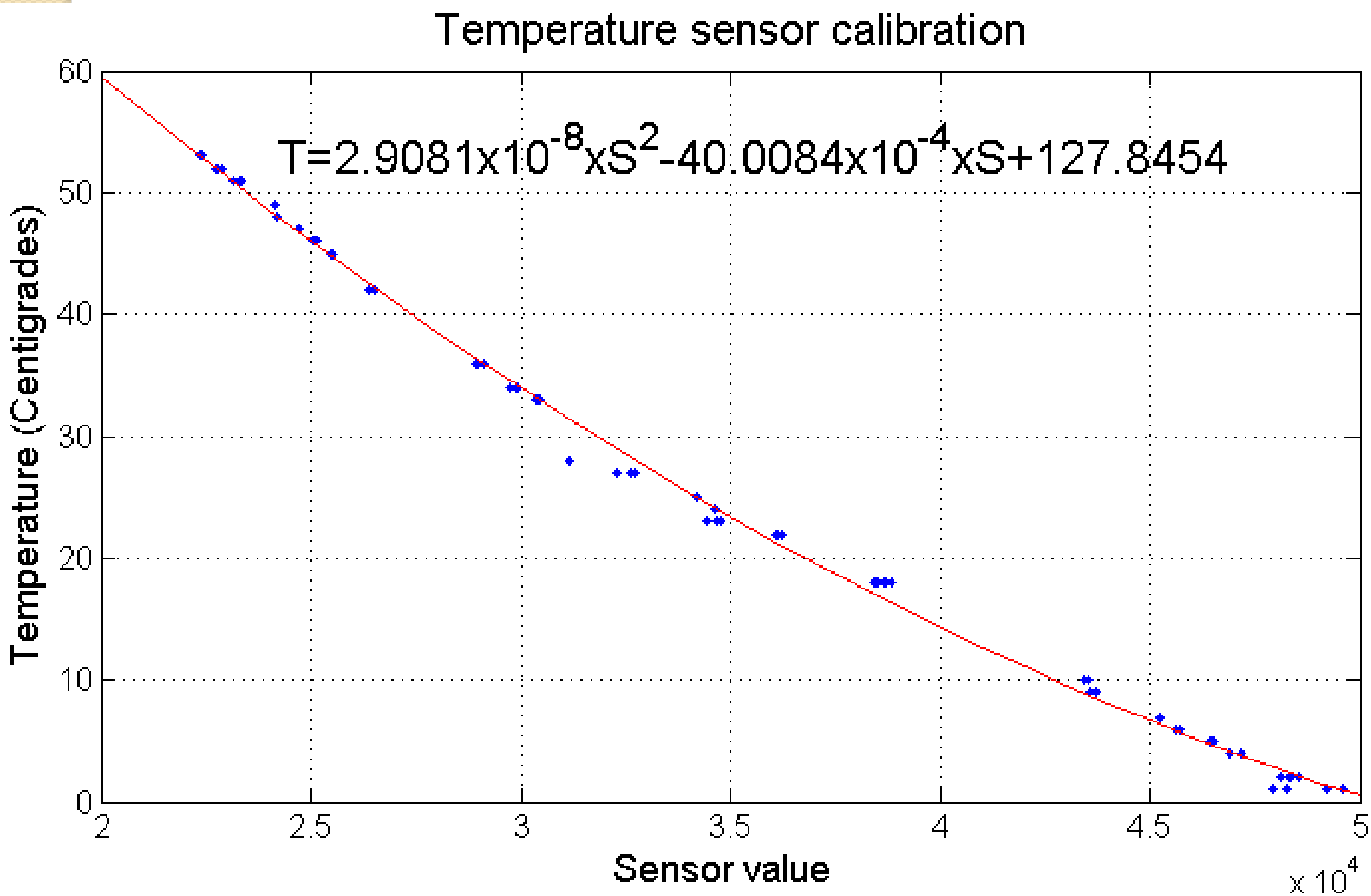
MARS MISSION

- Assumptions:
  - Lighting conditions are not uniform in all the mars stage.
  - Light sensors can be calibrated to detect the edge and the crater in any lightning condition.

MARS MISSION

- Requirements:
  - Edge detection should be the task with highest priority.
  - If more than one lake is detected at the same time, robot should move to the closest one.
  - If there is not any lake coordinates (Beginning condition) search around until a lake is found.
  - If there are old lake coordinates, keep them until new coordinates are received.

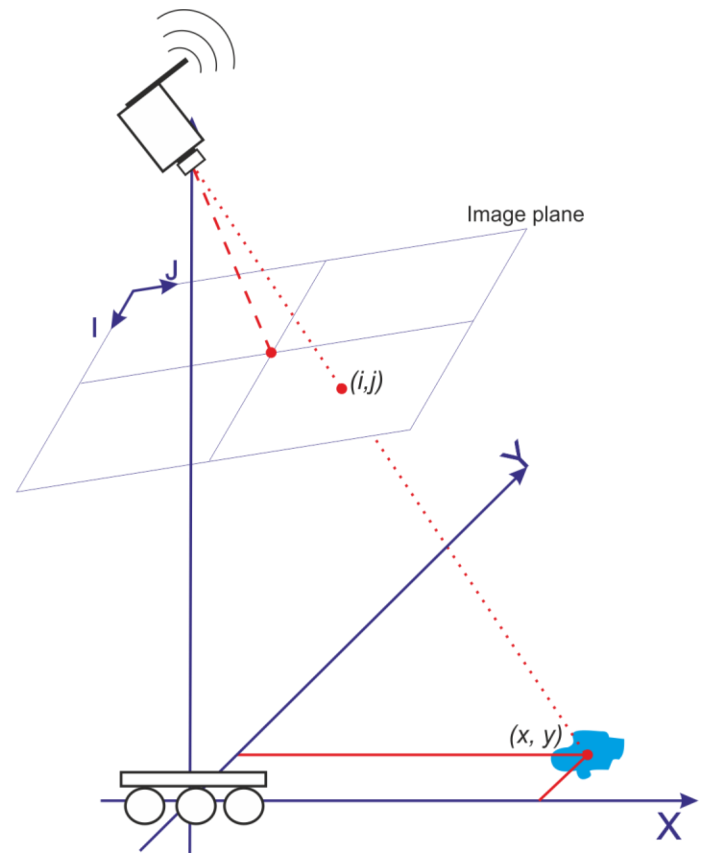
MARS MISSION



MARS MISSION

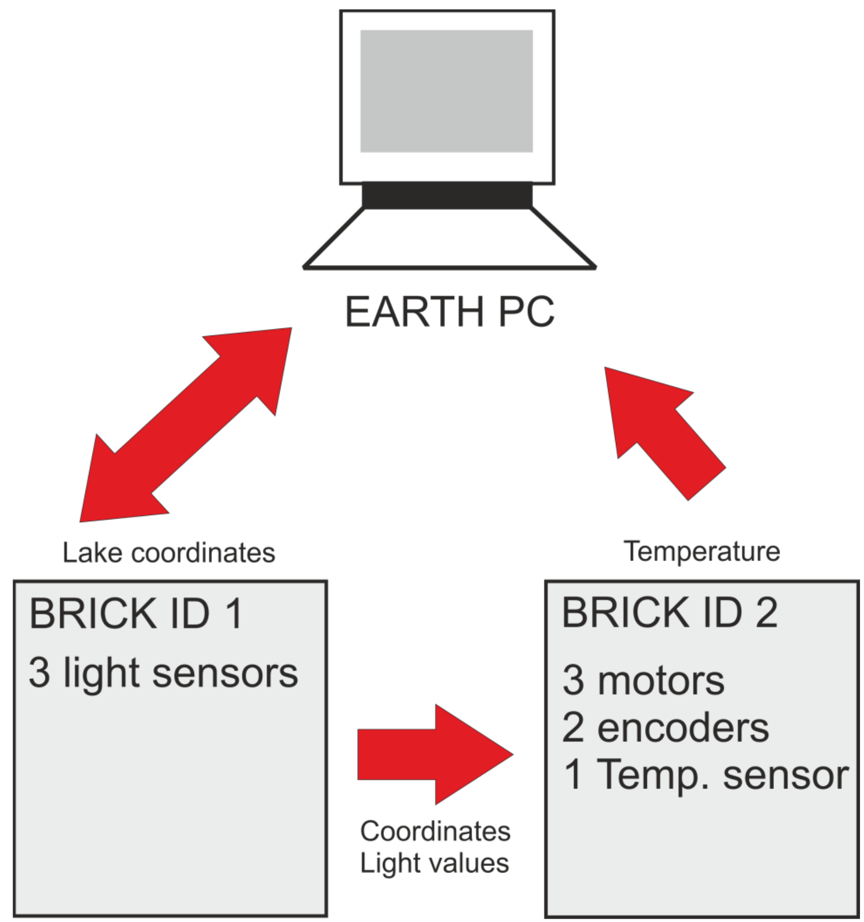
- Camera calibration:
  - Projection model (Pinhole) from the image to the mars plane.
  - The (x,y) coordinates are relative to the robot position.

$$\begin{bmatrix} wx \\ wy \\ w \end{bmatrix} = H \begin{bmatrix} j \\ i \\ 1 \end{bmatrix}$$



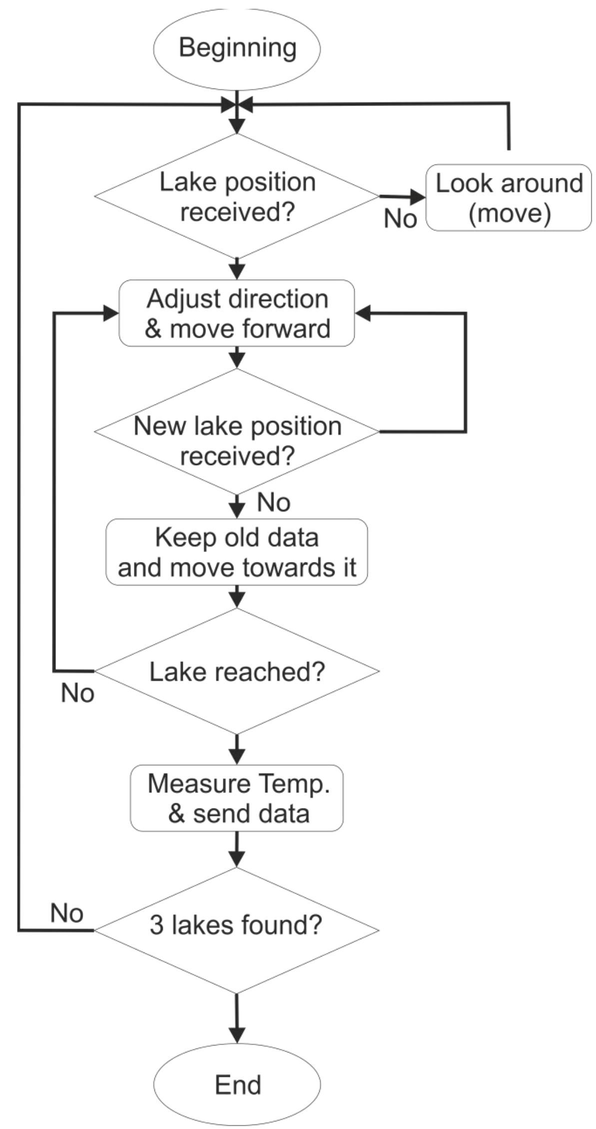
MARS MISSION

- Hardware architecture



MARS MISSION

- Software structure:
  - Brick 1: Read 3 light sensors, read lakes coordinates and send updated data to brick 2.
  - Brick 2: 4 threads: IR reading, Motion control, Temperature measure & sending, falling avoidance.
  - At most 2 threads are working in parallel.



MARS MISSION

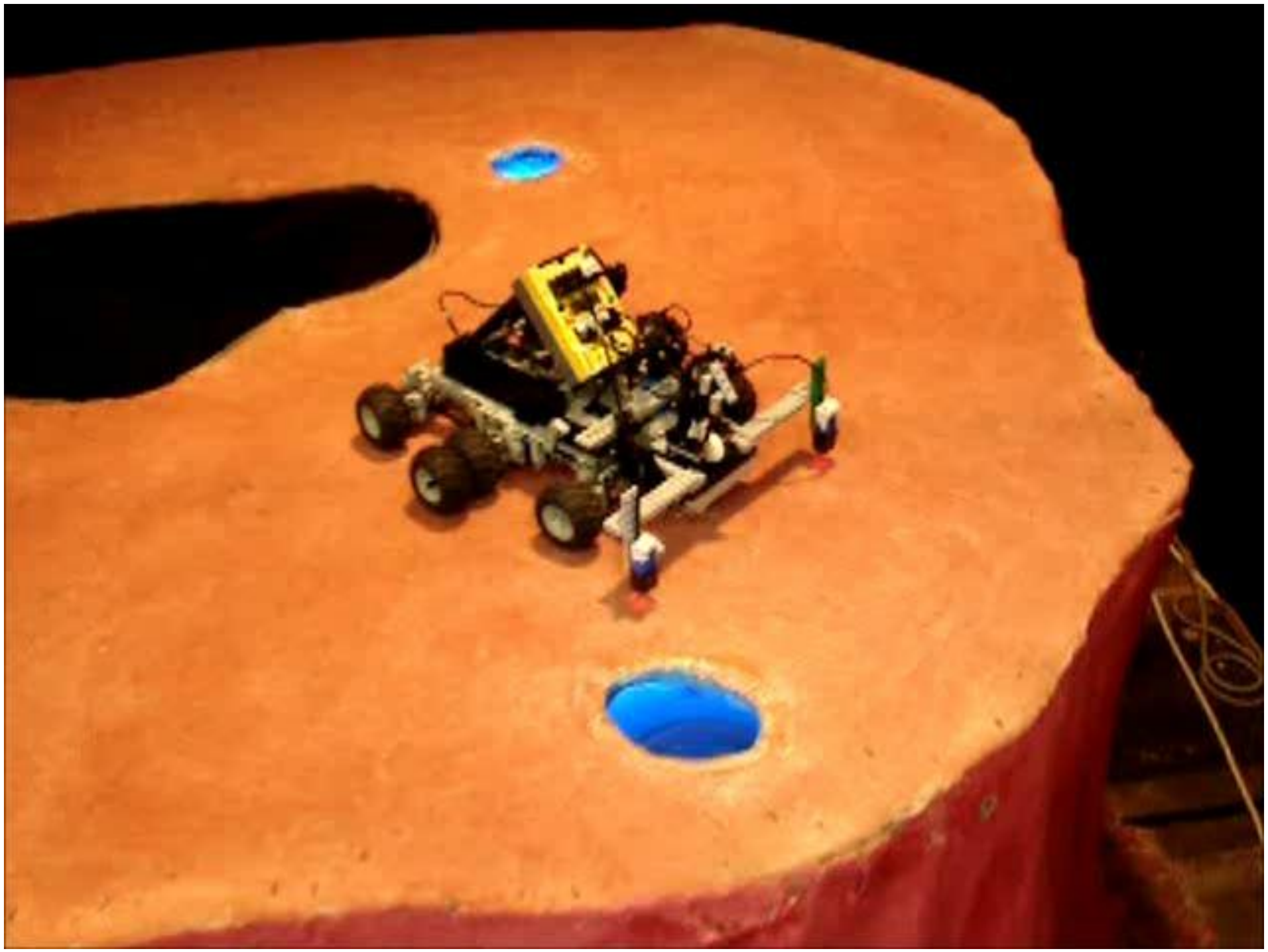
- Falling avoidance:
  - Depends on the lightning, then static thresholds are not suitable.
  - Adaptive thresholds used, they are updated when we are sure we are on the mars platform.

MARS MISSION

- Rotation radius:
  - To adjust the direction of the rover towards the lake, we need to know how long is the rotation radius.
  - After several calibrations, the estimated radius is 405 mm.

MARS MISSION

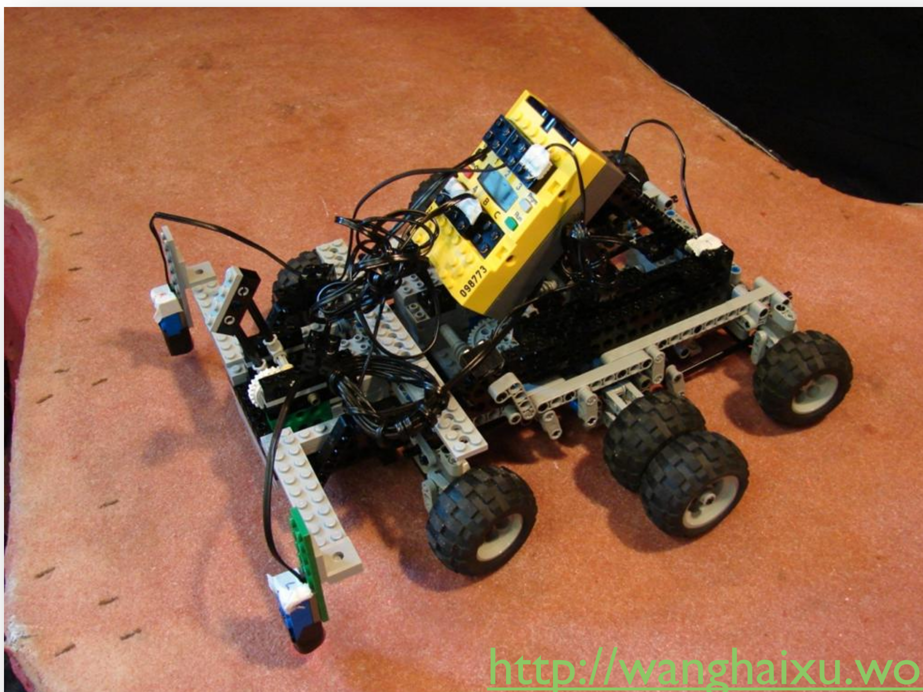
- RESULTS



CONCLUSIONS

- We improve our team work skills.
- We gained experience on software design and developing.
- We managed to solve the hardware and the technical difficulties.
- We managed to integrate all the different sensors data and actuators, to obtain the desired performance.

THANKS!



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