# Abstract:

Over the last three weeks the team 5 has been prepearing *R2D2* to fullfill an obstacle course in the most robust way possible.

# I Introduction:

*R2D2* is a small mobile robot (SMR) form DTU automation lab. It has been design to be small and manageable as well as flexible and durable. The hardware consist of a standard PC (Zotac IONITX, Atom based) with Ubuntu and some more custom electronics. It connects through wireless net.

It has great variety of sensors of which the odometry, 5 IR sensors , a reflection sensor, usually called line sensor, and finally a 180º laser sensor will be used. The camera, kinect and other sensors will not be used for this course. Further description of SMR’s can be found in http://rsewiki.elektro.dtu.dk/index.php/SMR.

The obstacle course consists of a series of 6 obstacles of which only an approximate map was provided. Only one day before the competition the real track is revealed and the last adjustments can be done.

# II task description

The tasks are describe next including the sensors used to succeed and the problems and solutions found.

## A. DISTANCE MEASUREMENT

Based on odometry and some distance measurement the exact position of a box has to be found.

A description...

The options were using IR sensors or laser sensor. After trying different approaches with the IR sensor they were discarded in favor of the laser. The advantages of this last sensor include a greater accuracy and stability as well as the zoneobst plug-in which provides the closest value of every 20º zone. This plug-in solves problems related with the R2D2 orientation or even the box orientation since the IR value would vary depending on these factors.

The last advantage of the laser sensor is its range which provides the possibility of measuring from a further distance reducing this way the odometry error and the time spent on this task.

## B. BOX GATE

The box gate consist of a tunnel with two perpendicular entrances obtracted by a box in the middle of both. The general strategy consist of entering through one of the tunnels to push the box out of the way and then get through the other way to pass through both gates. A description...

In this task the IR sensors are used to detect were the box is, after that, the collision detection has to be turned off and R2D2 runs forward for an amount of time. This is done because the collision detection is off so running an amount of time instead of an amount of distance prevents it from not achieving its objective and staying in that state forever.

The black cross in the middle of the tunnel helps to determine if the way will be clear after removing the box.

## C. GATE ON THE LOOSE

Gate on the loose is an undefined gate placed parallel to a line. A description...

The greatest challenge is to accurately determine the position of the gate to be able to pass through. For this task the side IR’s and the laser were considered but considered the reliability of IR and the fluctuation when obstacles are further than 50 cm the laser sensor was chosen again. With the side-most laser zones it is constantly checked if a gate’s post can be seen, if so, R2D2 will go forward until it finds the second post, then it will go back to be centered on the gate and proceed to pass through. For robustness and fault handling it will afterward back up until it gets the line again and follow the course. If this task fails, all the others can still take place.

## D. WALL

The wall task consist of a wall with a gate on each side. The challenge in this case is to be able to follow a wall in a robust way. The rest of the challenge is supported by odometry and fine tuning with the given gates and wall. In this case different sensors were used by the SMR-CL and C version, this will be discussed in the implementation section.

A description...

## E. WHITE LINE

The white line challenge consists of following a white line. It is an extended case of the black line follower but it presents some other challenges. First of all the white line is less different to the floor so there are more chances to miss it. It also present s a software challenge since the code has to be flexible enough to handle both colors.



## F. GARAGE

The gararge task consist on opening a box’s door and getting inside . This is a challenge based mostly on odometry and only slightly supported by the laser sensor. Once the robot approaches to a certain distance the robot walks with *closed eyes* and performs a series of movements improved by trial and error purely based on odometry to open the door.

A description...

# III implementation

## A. SMR-CL

SMR-CL is a language design specifcly to control autonomous mobile robot. As such it provides several built-in function that facilitate the whole software part. Some of the functions used were follow black line, follow white line, follow wall, drive among others.

On the other hand when handling the laser sensor it was found hard to implement since more complex logic is found behind it.

## B. C

The C code was based on an initial given structure which was modified along the project. Finally a structure of “*States”* and “*sub-states*” was implemented. States correspond to every task and and the conexion between them, substates correspond to everything that has to be done to complete a state. Example of sub-states are follow line, forward or turn.

Some interesting features implemented were follow wall, follow a black line and following a white line. All these features were implemented with the same proportional controller that proved to be robust when empirically tuned. The way this is done is by using the minimum line sensor for the black line, the maximum for the white line and based on the laser the minimum distance to the wall is found and the controller is based on this distance minus the reference distance to the wall.

The laser was extendedly used rather than the IR since it provided more accuracy and a wider range. This also gives the minimun value of a range which was usefull when measuring the distance to the box and following the goal.

# IV result and further work.

F

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A description...