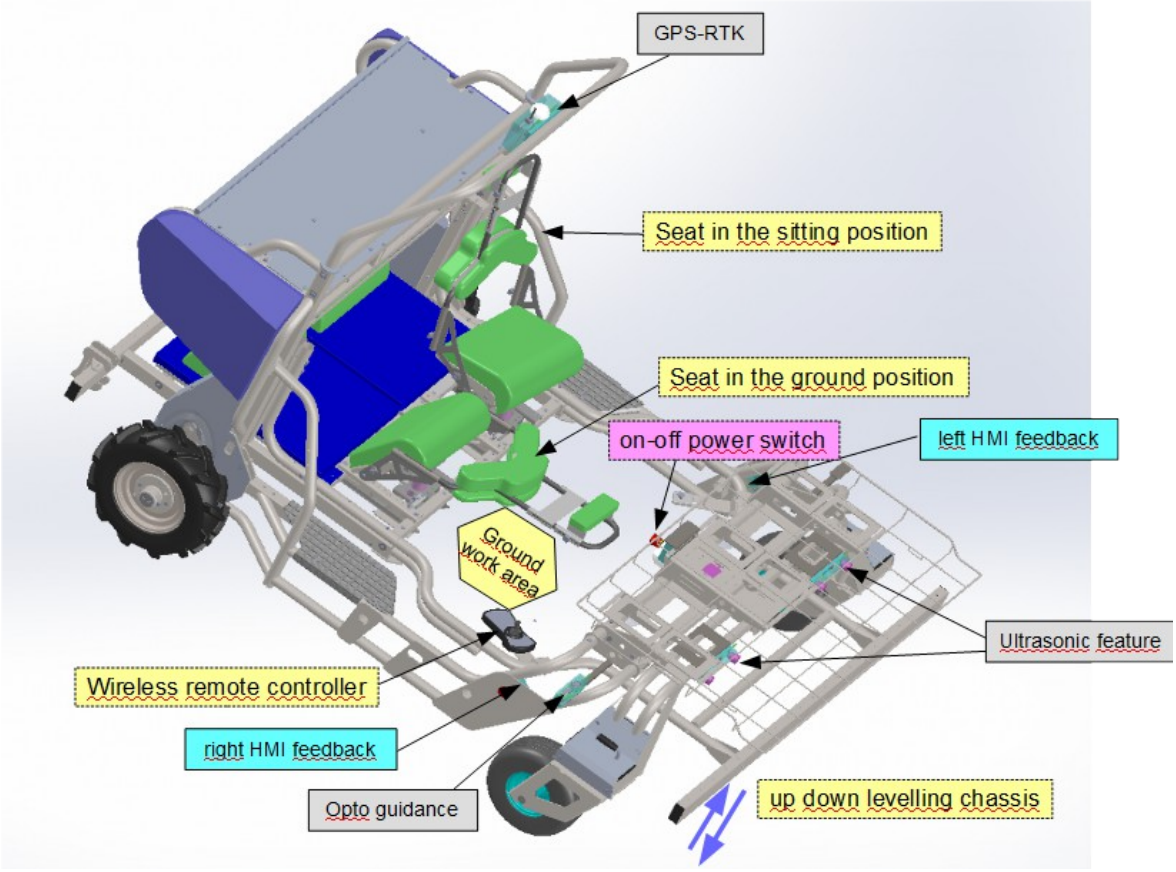
Machine description

The Toutilo is a silent electric machine for multipurpose agricultural uses (sowing, planting, special growing gesture, harvest, transport).

It is designed for one or two people as a mobile workstation with a very precise speed control (from 50 m/h to 2 km/h) and a very precise moving direction



One or two seats are fixed on an up down levelling chassis. This chassis is open in order to define a ground aera of work. The up down levelling chassis has a electric motion control.

The seats are two possible positions : the setting position is a conventional position for transportation for instance, the second position is a very confortable position in order to work inside the ground work aera.

A wireless remote controller is designed for the manuelly choice of speed, direction and up down chassis position.

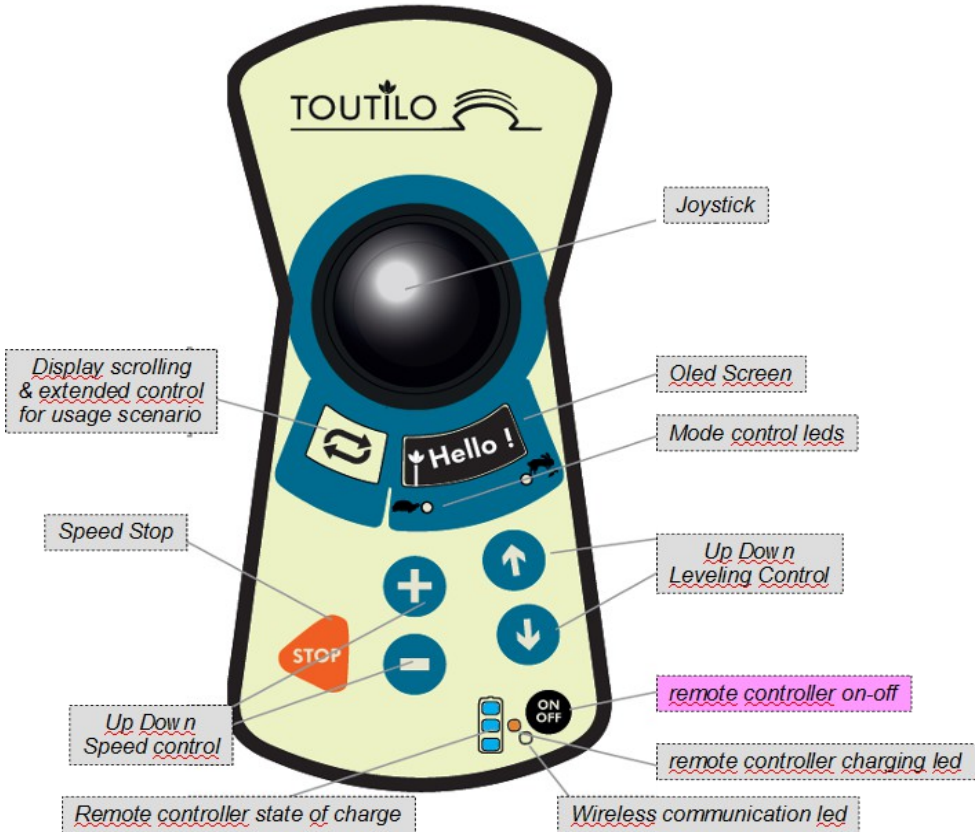
New cobotic features are added recently in order to work hand free, care-free

as opto guidance, GPS-RTK traject planning, voice recognition, ultrasonic control.

All this features are under control of a usage scenario interpreter.

Remote controller

The remote controler is the basic HMI of the machine with visual and buzzer feed-back.



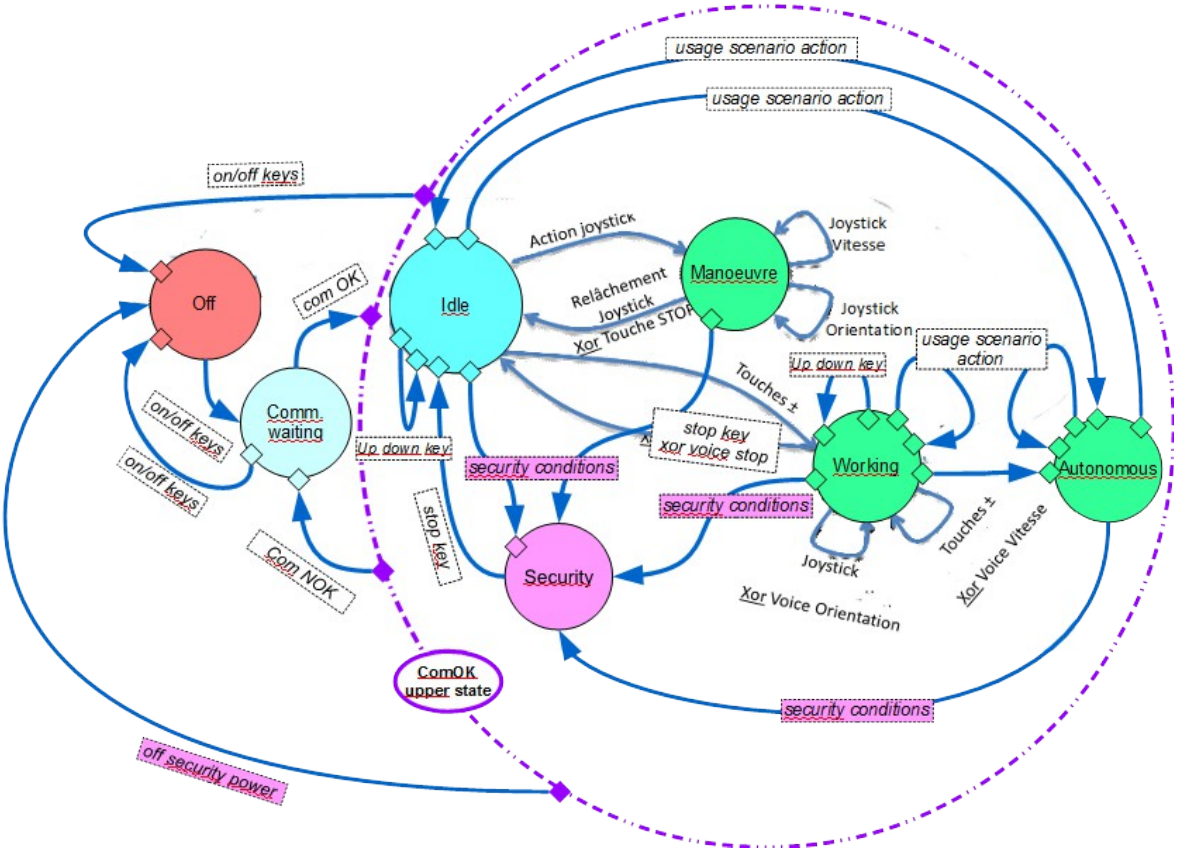
The link beetween remote controller action and machine is defined by the following logic with the following states :

- ***Off mode*** : the machine is in the off ode if the power key is off or the remote contoller is off

- ***Communication waiting mode*** : is a transition mode with the power key is on and the remote controller is on. Two digital communication are waiting : the wireless communication between remote controller and machine and the internal RS485 communication betwween power electronic and OpenDrive electronic.

  In this state all electric power drivers are switching off

- ***Com OK upper state*** : when the digital communications are OK, the machine go in a upper state for all the logical state of the machine



- ***Idle mode*** : in this mode, machine is ready and waiting user action with mode leds off.

  In this state the up down leveling is active.

- ***manoeuvre mode*** : this mode is for quick manoeuvre motions with the agile har led on. the joystick action is the only condition to enter in this mode

- ***working mode*** : this is the main state for working with the serious tortoise led on. The only condition to enter in this mode is the +/- keys use.

- ***Autonomous mode*** : in this mode, the machine is autonomous for displacement with the two har and tortoise leds on.

  The usage scenarios are necessary for entering in this mode.

- ***Security mode*** : in all the logic precedent modes, the security watch is active (motion, over current, thermal behaviour). When a problem is detected, the system is going to the security state with selective electric power cuts.

  The leds mode are off, with oled screen alerte message and buzzer activated.

Today the HMI feedbacks are mainly based on visual feedback.

The objective of the audio feedback project is to replace or overide the visual feedback in order to have better « sensitive » control of the machine in the general objective « hand free » and « mind free ».

Audio feedback link with logical transitions

A first class of audio feedback can be linked with logicial transitions.

HMI Cde Number	*Transition description*	*Transition start*	*Transition end*	*Transition abort*
1	Machine switch on	Audio 1		
2	Machine switch off	Audio 2		
3	Remote controller connected	Audio 3		
4	Remote controller deconnected	Audio 4		
5	Motor power connected	Audio 5		
6	Motor power deconnected	Audio 6		
7	"idle mode" enter	Audio 7		
8	"Idle mode" to "working mode"	Audio 8		
9	"Idle mode" to "manoeuvre mode"	Audio 9		
10	"Idle mode" to "autonomous mode"	Audio 10		
11	"working mode" to "Idle mode"	Audio 11		
12	"manoeuvre mode" to "Idle mode"	Audio 12		
13	"autonomous mode" to "Idle mode"	Audio 13		
14	"working mode" to "autonomous mode"	Audio 14		
18	Usage scenario activated	Audio 18		

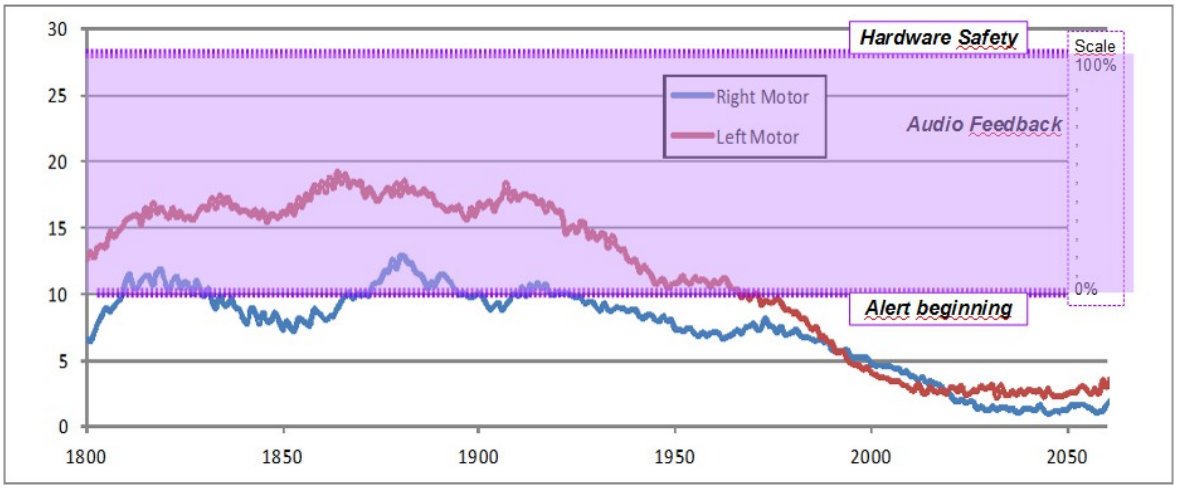
Transtions are events also the audio feed back is only active during a short time after the transition event.

Variable audio feedback linked with security watch

This second class can be a very interesting feed back in order to understand the machine behaviour not only when safety is activated but before to prevent safety activation.

Feedback as the noise of a thermal engine wich is information on the engine torque.

The following drawing give the motor electrical current example.



Electrical current is an torque image

Two levels are defined :

- alert beginning (10 Amps) ,
- hardware safety action (28 Amps).

It is possible to define a variable feedback from 0% of alert to 100 %

For instance, for the right motor there are 2 audio alerts (< 10 %) and 1 bigger for the left motor (~ 50 %).

IHM Cde Number	*Safety watch description*	*watch refresh*	*watch end*	*watch abort*
51	idle mode duration (more than xx hours)	Audio 51		
52	Battery State of charge	Audio 52		
53	Battery current	Audio 53		
54	Right Motor current	Audio 54		
55	Left Motor current	Audio 55		
56	Leveling motor current	Audio 56		
57	Tool motor current	Audio 57		
58	Battery temperature	Audio 58		
59	Right Motor temperature	Audio 59		
60	Left Motor temperature	Audio 60		
61	Leveling motor temperature	Audio 61		
62	Tool motor temperature	Audio 62		

Usage scenario instruction and audio feedback

A third class link audio feedback to usage scenario execution.

A set of usage instructions define a usage scenario.

There are four families of usage instructions :

- machine instructions in order to define speed, odometric, and up - down displacements
- tool instructions in order to activate optional tools
- cobot instructions in order to activate cobotic features.
- structure instructions for the scenario execution control (waiting time , go to …) .

One simple example : « Stop and Go » scenario

14 00 00	semi autonomous mod activation
06 00 1E	displacement order 30 cm
19 00 00	waiting position
13 00 00	stop order
15 00 14	waiting 20 secondes
18 00 00	restart motion
07 00 03	GoTo 3

An audio feedback is associated to the 3 possible instruction states :

- instruction start,
- instruction end,
- instruction abort (in case of security control or user control).

A same audio feedback can be used for different instructions if the waiting behaviour is the same (for instance abort control).

Note : it is possible to add structure instruction for switched on/off audio feedback. In order to avoid to much « speeches ».

The following table give an idea of the set of audio feed back.

HMI Cde Number	instruction description	instruction start	Instruction end	Instruction abort
101	Speed selection	Audio 101		
102	Blind translation	Audio 102	Audio 103	Audio 104
103	Blind rotation	Audio 105	Audio 103	Audio 104
104	Mobil feature absolute up – down	Audio 106	Audio 107	Audio 104
105	Mobil feature relative up – down	Audio 108	Audio 107	Audio 104
106	Odometric motion	Audio 109	Audio 110	Audio 104
107	sequence repeat	Audio 111		
108	Autonomous mode stop	Audio 112		
109	Autonomous mode start	Audio 113		
110	JSON structure update	Audio 114	Audio 115	Audio 104
111	Positioning motion	Audio 115	Audio 103	Audio 104
112	Guidance motion	Audio 116	Audio 103	Audio 104
113	Traject planning motion	Audio 117	Audio 103	Audio 104
114	Calibration procedure	Audio 118	Audio 103	Audio 104
115	Tool 1 motion start	Audio 119		
116	Tool 2 motion start	Audio 120		
117	Tool timer 1	Audio 121	Audio 122	Audio 104
118	Tool timer 2	Audio 123	Audio 123	Audio 104
119	Stop motion	Audio 124		
120	Semi autonomos mode start	Audio 125		
121	General timer activation	Audio 126	Audio 127	Audio 104
122	Tool 1 motion stop	Audio 127		
123	Tool 2 motion stop	Audio 128		
124	Start motion	Audio 129		
125	Odmetric motion type 2	Audio 109	Audio 110	Audio 104
126	ultrasonic feature mode 1 activation	Audio 131		
127	ultrasonic feature mode 2 activation	Audio 132		
128	ultrasonic feature mode 3 activation	Audio 133		
129	ultrasonic desactivation	Audio 134		
130	Waiting switch « ToutiRobo » « On »	Audio 135	Audio 136	Audio 104
131	Ask for GPS position	Audio 136		
132	Ask for GPS position push	Audio 137		
133	Waiting switch « toutidata » « On »	Audio 135	Audio 136	Audio 104
134	Ask for switch « toutidata » « On » Push	Audio 137		
135	Ask for GPS position periodic push	Audio 138		
136	Reset GPS position periodic push	Audio 139		

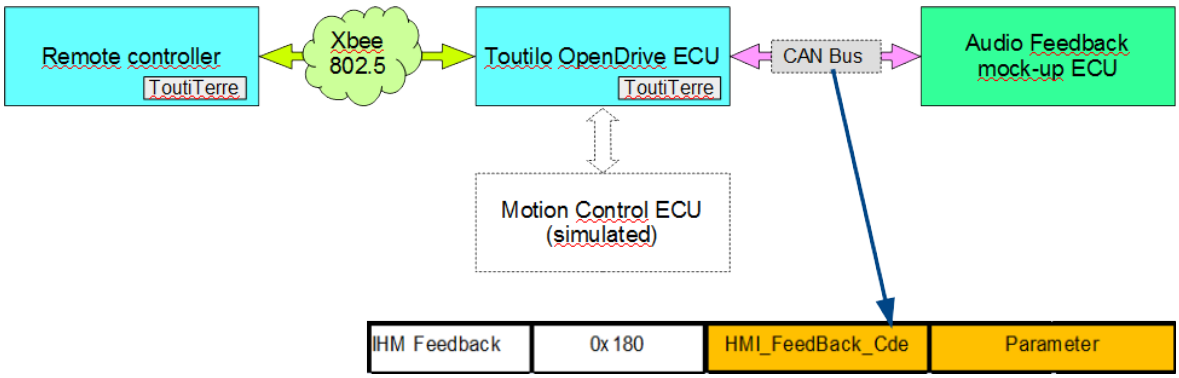
Open Audio feedback class

A fourth open class can be used for ToutiRobo feature or others (music for instance)

HMI Cde Number	*State description*	*state start*	*state end*	*state abort*
201	Music start	Audio 201	Audio 202	
202	Music stop	Audio 203		
203	GPS-RTK ready	Audio 204		
204	Voice recognition ready	Audio 205		
205	Optical guidance ready	Audio 206		
206				
207				
208				

Hardware for mock-up

At the beginning, the possible solution in order to support project is a Touti Terre delivery of two Toutilo hardware modules



- the remote controller and the OpenDrive ECU

- Any hardware with a CAN interface can be connected to the OpenDrive ECU with a specific message « 0x180 »

Parameter is used for Variable audio feedback class.

Then Toutilo test in INRIA Grenoble machine can be organized.