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Multi-Agent System and Events Plan Construction Using PDDL

ABDELLAH REDJAIMIA

Lobachevsky State University of Nizhni Novgorod, Department of Applied Mathematics, Cybernetics and Informatics – Russia

Abstract: **Life is the main interesting thing in this existence and we are always searching to make it better and easy answering our duties as simple as it can , the purpose is easy to understand it cause we are looking for a comfortable life which handles all our routine tasks, for that today we introduce a system which can be plugged on our terminals and which it can make tasks automatically basing on the environment events.**

We present a dissertation project details and its application on both sides the web corner and terminal assistant, Multi-Agent System collaborates with PDDL to determinate which functions and procedures the agent has to execute at the time basing on environments events which are playing the rules of parameters in each functions or procedures.

Keywords: **Multi-Agent, Agent, PDDL, Engine, Domain, Predicates, Robot.**

I. INTRODUCTION

Multi-Agent System or Smart Agent Group a system which divides rules between agents for fast execution and treatment of more tasks in one time (Parallelism).

An Agent is a smart process which gets all its existence from human be thoughts and it can react thousand times faster than him.

In our study we are focusing **on Multi-Agent System** as an **engine** which creates a specific **agent** for a specific mission basing on parameters (Environment Events) sent from user (via voice or keyboard) or taken via sensors (Case Robot).

II. PDDL

PDDL = **P**lanning **D**omain **D**efinition **L**anguage.

The Planning Domain Definition Language **(PDDL)** is an attempt to standardize by Drew McDermott and his colleagues in Artificial Intelligence (AI) 1998 (inspired by STRIPS and ADL among others) mainly to make the planning languages. It was first developed 1998/2000 International Planning Competition (IPC) possible, and then evolved with each competition. "The adoption of a common formalism for describing planning domains fosters far greater reuse of research and allows more direct comparison of systems and approaches, and therefore supports faster progress in the field. A common formalism is a compromise between expressive power (in which development is strongly driven by potential applications) and the progress of basic research (which encourages development from well-understood foundations). The role of a common formalism as a communication medium for exchange demands that it is provided with a clear semantics.

PDDL a specific language to create plans for each agent basing on predicates that we are interested in our study we are going to change a little in **PDDL** structure matching our goals. we are focusing on : **PDDL** Domain, **PDDL** predicates (Environment Events) and Actions which match every predicate's state (**True or False**).

NB:

The number of predicates determines automatically the number of agents which have to participate.
for example if we take our Domain : **Car** and predicates for example **Rain and Snow** then the agent's engine will create 02 agents equal to the number of predicates which is 02 (Rain and Snow).

The **Action Clause** studies every predicate in 02 states :

Case TRUE : then the agent has some instructions to execute.

Case FALSE : then the agent has some instructions to execute.

The max number of cases which the system can handle equal to $\mathbf{2^{number\ of\ predicates}}$

below an example of PDDL which has got those proprieties :

1- **Domain: Car**

2- **Predicates** got from the environment.

3- **Init objects** inherent from Car's features.

4- **Actions** basing on the plan definition according to each predicate received from the assistant which in our case a Car Robot.

PDDL - Car-Robot-Assistant Domain (define (domain Car-Robot-Assistant)

;; **Predicates in our case represented by
the car physical things such as :
windows, doors, lamps, post-radio,
glasses, wheels, air conditioner...etc.**

;; in our PDDL we will just show an example
how to write our plan basing on some of
those predicates which are : the car's
windows, the car's air conditioner, the
car's glass cleaner, the car's lamps.

;; Physical Predicates.

**(: predicates
(car-windows ?cw)
(car-air-conditioner ?cac)
(car-windows-cleaner ?cwc)
(car-windows-lamps ?cwl)
(car-doors ?cd)
(car-speed ?csp)**

**;; Logical Predicates it means true or
false situations.**
(is-closed-windows ?bcw)
;; this predicate returns true if the car's
windows are closed - false otherwise -b-
means Boolean.
(is-switchedon-airC ?bsa)
;; this predicate returns true if the car's air
conditioner is on - false otherwise -b-
means Boolean.
(is-lightedon-lamps ?bll)
;; this predicate returns true if the car's

```
   lamps are on - false otherwise -b- means
   Boolean.
(is-closed-doors  ?bcd)
;; this predicate returns true if the car's
   doors are closed- false otherwise -b-
   means Boolean.
(is-speed-extreme ?bcs)
;; this predicate returns true if the car's
   speed is extremely high- false otherwise -
   b- means Boolean.
)
```

```
;; Domain's Actions.

;; CloseWindows
(
  : action CloseWindows
  : parameters (?cw)
  : precondition (and (car-windows ?cw))
  : effect (and (is-closed-windows ?cw))
)

;; OpenWindows
(
  : action OpenWindows
  : parameters (?cw)
  : precondition (and (car-windows ?cw))
  : effect (and (not (is-closed-windows
    ?cw)))
)

;; SwitchOnAirConditioner
(
  : action SwitchOnAirConditioner
  : parameters (?cac ?cw ?cd)
  : precondition (and (car-windows ?cw)
   (car-air-conditioner ?cac) (car-doors
    ?cd))
  : effect (and (is-switchedon-airC ?cac)
    (is-closed-windows ?cw) (is-closed-
     doors ?cd))
)

;; CloseDoors
(
  : action CloseDoors
  : parameters (?cd)
  : precondition (and (car-doors ?cd))
  : effect (and (is-closed-doors ?cd))
)

;; OpenDoors
(
  : action OpenDoors
  : parameters (?cd)
  : precondition (and (car-doors ?cd))
  : effect (and (not(is-closed-doors ?cd)))
)
;; SlowDown
(
  : action SlowDown
  : parameters (?csp)
  : precondition (and (car-speed ?csp))
  : effect (and (not(is-speed-extreme
    ?csp)))
)
```

NB :

The Action **SlowDown** depends on the speed limit which it can be discussed with professional road experts cause simply if it is a public road the speed limit has to be : less than 50 Km/h and it depends also on each country. below we can site some countries with their speed limits range basing on the road taken.

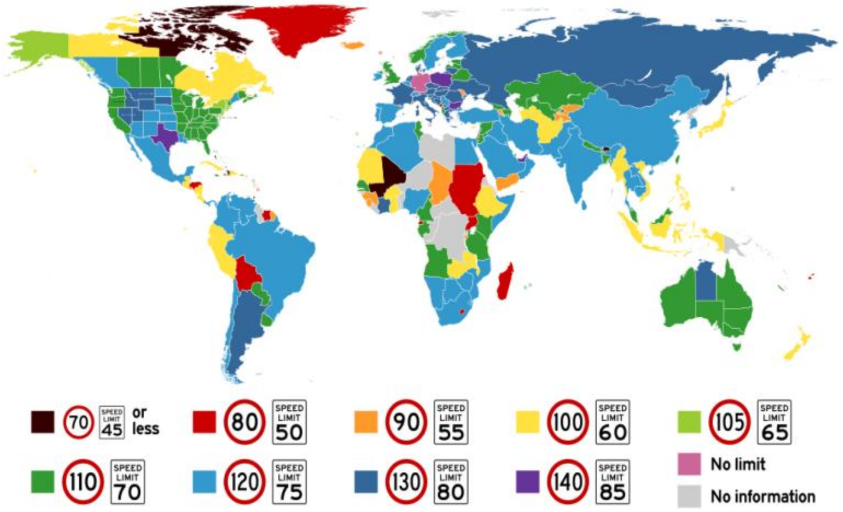


Figure 1.0

(Speed Limit Values depending on countries)

Basing on the map the assistant can create events which are matching with every country speed laws then the system and for sure has to be completed has some features in options view which allows every factory to initialize basic parameters depends on speed value.

Example of Speed limit control:

the speed limit in **Algeria** is **75 Km/h** on all roads types , the assistant has to make control with this value in all cases then if the user speeds up **75 Km/h** then the Assistant can inform him/her that the speed is extreme and for further features the assistant can allow for him/her to drive during a timer charged inside it or directly the assistant can slow down automatically and control the car instead the driver.

Speed limit Value: 75km/h.

III. OPTIONAL FEATURES

III-1 : Speech to Text engine :

This option frequently used in Terminals such as Computers, Credit Payment Terminals....etc.

The option translates the **voice** to a **text** and nowadays is not a stable cause the engine can't recognize many **voices** especially in case of **Dialects**.

In our view point the engine needs some **plug-in** inside to make it more efficiency those plug-in helps to give the right text to the right speech, **parsing** one of the helpful plug-in which allows to **Speech** to **Text** engine knows the phrase parts then it will give approximately the right Text basing to the voice sent.

III -2: The System Security :

System security one of the funny features in the system , some users would like launching the system at the same moment when the terminal starts.
The logic says that and we are agree, the system going to be under function in parallel with its holder (Computer-Robot....etc) .
but in this case also the system's owners wouldn't like seeing others using the system for their benefits, for example the system will not execute the instructions if the user is under 18 years old, in this case it is a useful feature if we root a security identifier such as : Finger Print - Eye Scan - Code Bar Scanner..................etc.

IV. IMPLEMENTATION

We will take our previous example which is considering the Nature as a Environment , Cars as the study Domain and events or predicates which are : Wind and Temperature.

basing on our data we can recognize :

- Number of Predicates : 2 (Wind + Temperature).

- The Number of Agents : 4 Agents.

basing on binary table :

Wind	Temperature
0	0
0	1
1	0
1	1

- PDDL Possible Actions : 4 Actions.

* **Act 1 : Wind** = False
Temperature = False.

* **Act 2 : Wind** = False
Temperature = True.

* **Act 3 : Wind** = True
Temperature = False.

* **Act 4 : Wind** = True
Temperature = True.

- Function creation basing on predicates :

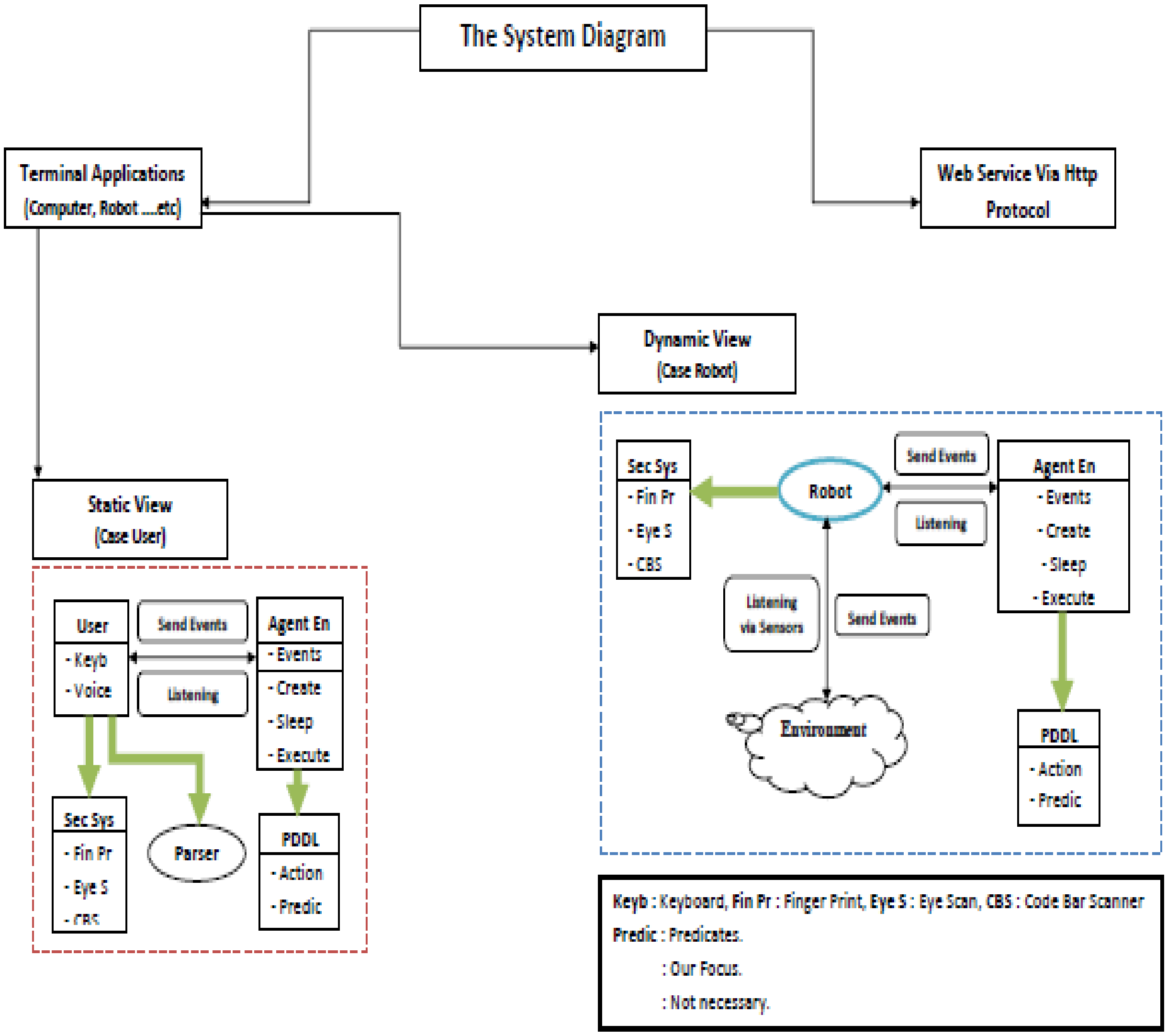
it is a choice between creation of one function which handles all the 4 situations or to give every situation a function which handles it separately. in our case we prefer to assign one functions to all situations and this function gets parameters which are predicates and every agent uses the same function just it has to prepare the right parameters (Predicates) for the function created .

```
Function  Action (Wind, Temperature)
{
   if (Wind == True)
   {
      if (Temperature == True)
      {
         Close cars windows;
         Switch on the Air conditioner;
      }else
          Close cars windows;
   }else
   {
      if (Temperature == True)
         Switch on the Air conditioner;
      else
          don't do anything;
 }}
```

The robot will execute all those instructions at the right moments basing on the events (Predicates, Parameters) which he has got from behavior which is the nature in our study all those things the robot will make them via it is sensors.

Multi-Agent System and Events Plan Construction Using PDDL

The System's Diagram



V. CAR SENSORS

In this section we will try to focus on some of car's sensors which are plugged automatically in it and we will see their functions their contacts and acts (their proprieties).

As it is known our study is just to show the main functionality of the Multi-Agent System and nowadays there are plenty sensors which are represented inside the car engine such as: engine water temperature sensor, parking sensor, GPS sensor, speed sensor.....etc.

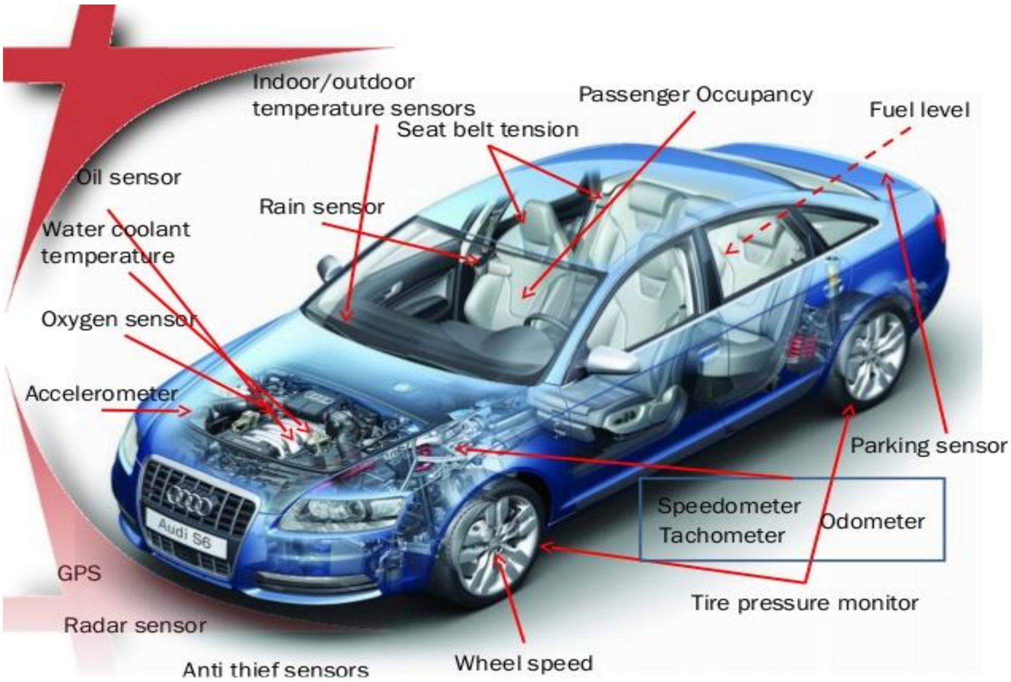


Figure 2.0

(Car Possible Sensors)

to cover all those sensors in our study is not our aim , our objective to choose some of those sensors to explain them basing on the user wishes , let's take some of those which are used on our PDDL file related to the Car Domain :

- **Weather Temperature Sensor (in and out).**
- **Speed Sensor.**
- **Weather Wind Sensor.**
- **Parking Sensor.**

V-1: Sensor

A sensor is a transducer whose purpose is to sense (that is, to detect) some characteristic of its environments. It detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal; for example, a thermo couple converts temperature to an output voltage. But a mercury-in-glass thermometer is also a sensor; it converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube.

Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micro machinery and easy-to-use micro controller platforms, the uses of sensors have expanded beyond the more traditional fields of temperature, pressure or flow measurement,[1] for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine and robotics.

V-2 : Weather Temperature Sensor

Figure 3.0

(Weather Sensor With Car Plug-in)

Description :
Temperature measurement range:
-10℃ to 50℃ (14°F to 122°F)
indoor:
-50℃ to +70℃ (-58°F to 158°F)
outdoor:
can be used in car
Cable length:
1m
Powered by 1 x 1.5V AG13 button cell
2.1" LCD display screen
Size: 5**.80 x 4.00 x 1.30cm**
included :

1 x Digital Thermometer
1 x AG13 1.5V Button Cells

the description shows us that the temperature range which the sensor can detect can offer us the whole control basing on our comfortable parameters in our sensor example the interval is fixed **[-50 ℃ + 70 ℃]**, then the assistant can fix by itself a control value depends on the user wishes this value has to be between the **Min** and **Max** value which the sensor can detect.

Control value € **[-50 ℃ + 70 ℃].**

V-3 : Speed Sensor :

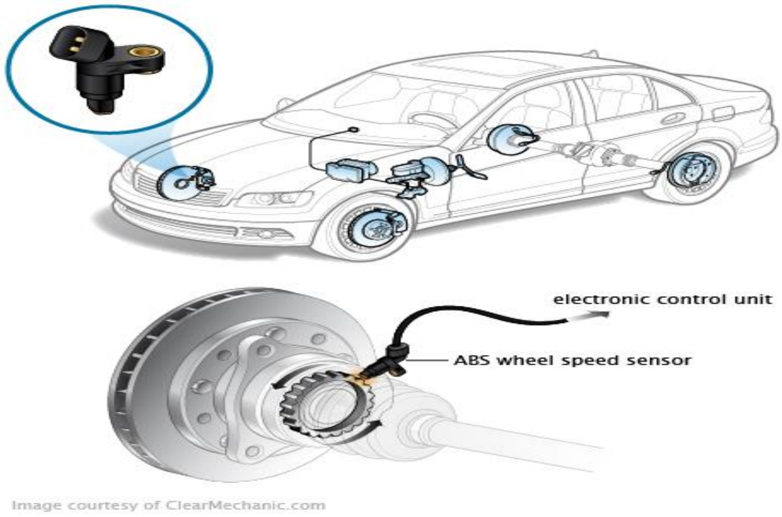


Figure 4.0

(Car Speed Sensor)

A **wheel speed sensor** or vehicle speed sensor (VSS) is a type of tachometer. It is a sender device used for reading the speed of a vehicle's wheel rotation. It usually consists of a toothed ring and pickup.

A **speedometer** or a speed meter is a gauge that measures and displays the instantaneous speed of a vehicle. Now universally fitted tomotor vehicles, they started to be available as options in the 1900s, and as standard equipment from about 1910 onwards. Speedometers for other vehicles have specific names and use other means of sensing speed. For a boat, this is a pit log. For an aircraft, this is an airspeed indicator Charles Babbage is credited with creating an early type of a speedometer, which were usually fitted to locomotives.

The electric speedoeter was invented by the Croatian Josip Belušić in 1888, and was originally called a velocimeter.

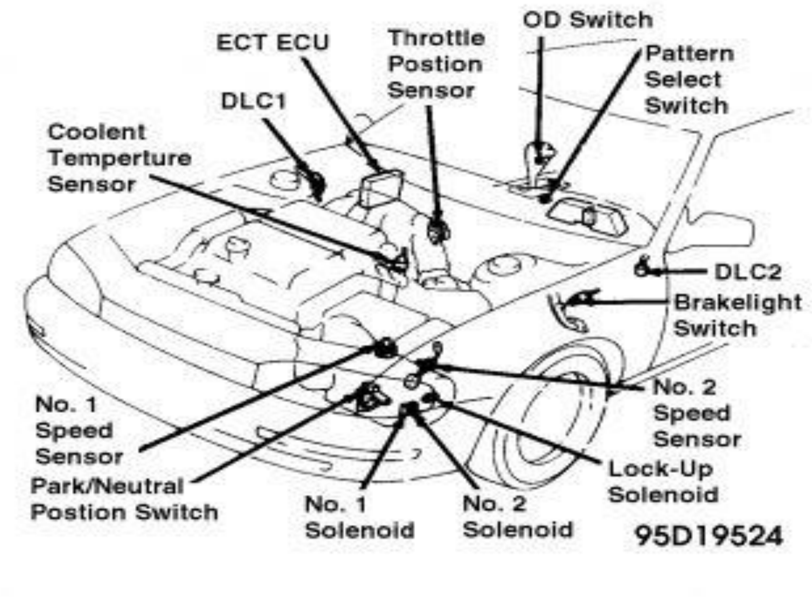


Figure 5.0

(Car Speed Sensor Locations)
As we figured out that the Speed control value depends on the country laws and speed interval allowed please check the section **Example of Speed limit control.**

V-3 : Weather Wind Sensor :

WIND SPEED SENSOR Wind speed, or wind velocity, is a fundamental atmospheric rate. Wind speed is caused by air moving from high pressure to low pressure. I Many aspects can be affected by wind speed such as weather forecasting, aircraft, mines, navigation and agriculture, so the observation of wind speed is necessary. An anemometer or wind meter is a device used for measuring wind speed, and is a common weather station instrument. The term is derived from the Greek word anemos, meaning wind, and is used to describe any air speed measurement instrument used in meteorology or aerodynamics. The first known description of an anemometer was given by Leon Battista Alberti around 1450. **Types of Wind Speed Sensor Nowadays the anemometers are usually divided into seven types:**

1. Cup Anemometers

2. Vane Anemometers

3. Hot-wire Anemometers

4. Laser Anemometers

5. Sonic Anemometers

6. Acoustic Resonance Anemometers

7. Ping-pong Ball Anemometers

Wind speed sensor kinds are 7 as it is listed in our demonstration, we would to give a definition of one of them and our interesting is focusing on the top list one which is **Cup Anemometers** cause is the most widely used between all the rest of kinds.

Cup Anemometers The cup anemometer is the most widely used type which consists of several metal cups (usually three) attached to the ends of horizontal arms mounted on a vertical shaft. Wind catching in the cups causes them to revolve. This action turns the shaft, which is connected to a device that can calculate the wind speed (miles per hour, kilometers per hour, or some other ways to present speed). Commonly, the shaft is connected to an electrical generator and the amount of current produced by the generator varies with the speed of the wind. This kind of anemometer was further developed to measure both velocity and direction by adding a tag to one cup, which makes the cup wheel speed change along with the tag moving alternately with and against the mind. The fluctuation of cup wheel speed can be calculated to show the wind direction.

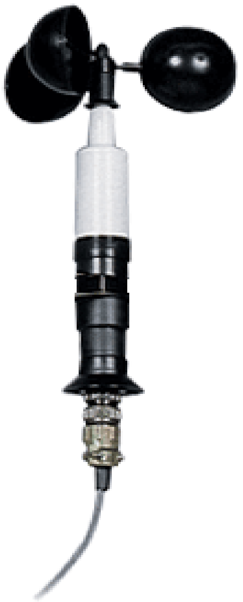


Figure 6.0

(Wind Sensor)

The Gill Anemometer is a traditional type, sensitive sensor for horizontal wind measurement.

The Cup assembly is constructed with lightweight and UV resistant plastic cups. Housings are precision machined aluminum. A sensitive DC generator outputs wind speed. The anemometer mounting bracket installs on standard 3/4 inch threaded pipe

Specifications
Wind Speed :
0-60 m/s (130 mph)
Threshold:
0.5 m/s (1.1 mph)
Wind Speed Signal:
DC voltage linearly proportional
to wind speed. 1800 RPM (2400 mV)=28.6 m/s (64.0 mph).
Dimensions:
32 cm (12.5 in) H x 17 cm (6.7 in) dia.
Mounting:
Standard 3/4 inch threaded pipe
Weight:
1.4 kg (3.1 lb)

Shipping Weight:

1.8 kg (4 lb)

V-4: Parking Sensor:

Parking sensors are proximity sensors for road vehicles designed to alert the driver to obstacles while parking. These systems, which use either electromagnetic or ultrasonic sensors, are marketed variously by vehicle manufacturers under proprietary brand names such as Park Distance Control, Park Assist, Parktronic or EPS.

Parking Sensors detect obstacles behind you and also infront of your car if you wish, to aid your parking and enable you to get into those tight spots without damaging your car. Using Ultrasonic technology they emit a cone of sound behind your car which bounces of obstacles behind and returns to the sensor.

The time taken for these sound waves to bounce and return off obstructions behind your car is how they calculate the remaining distance behind you.

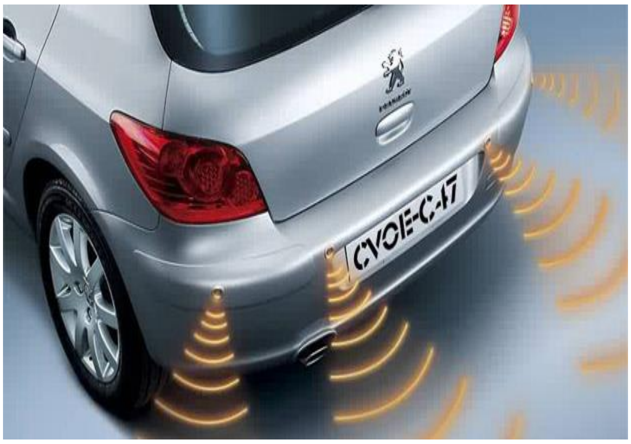
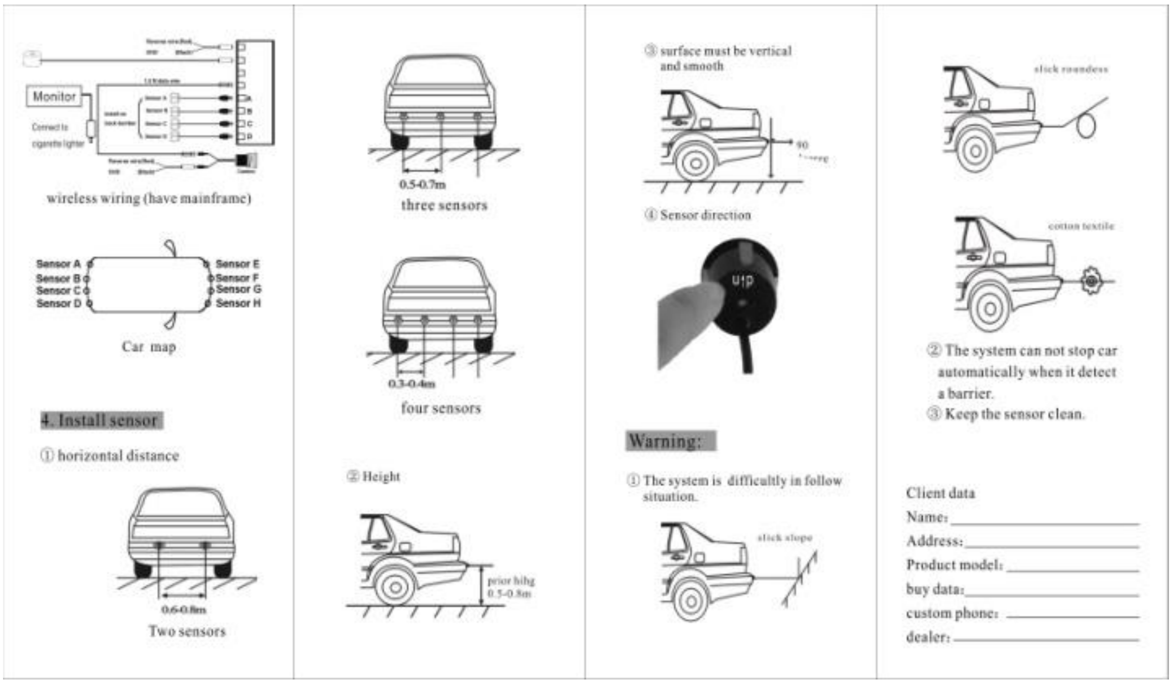


Figure 7.0

(Car Parking Sensor)

Installation:



wireless wiring (have mainframe)

Car map

4. Install sensor

① horizontal distance

Two sensors

three sensors

four sensors

② Height

③ surface must be vertical and smooth

④ Sensor direction

Warning:

① The system is difficaltly in follow situation.

② The system can not stop car automatically when it detect a barrier.

③ Keep the sensor clean.

Client data

Name: ____________

Address: ____________

Product model: ____________

buy data: ____________

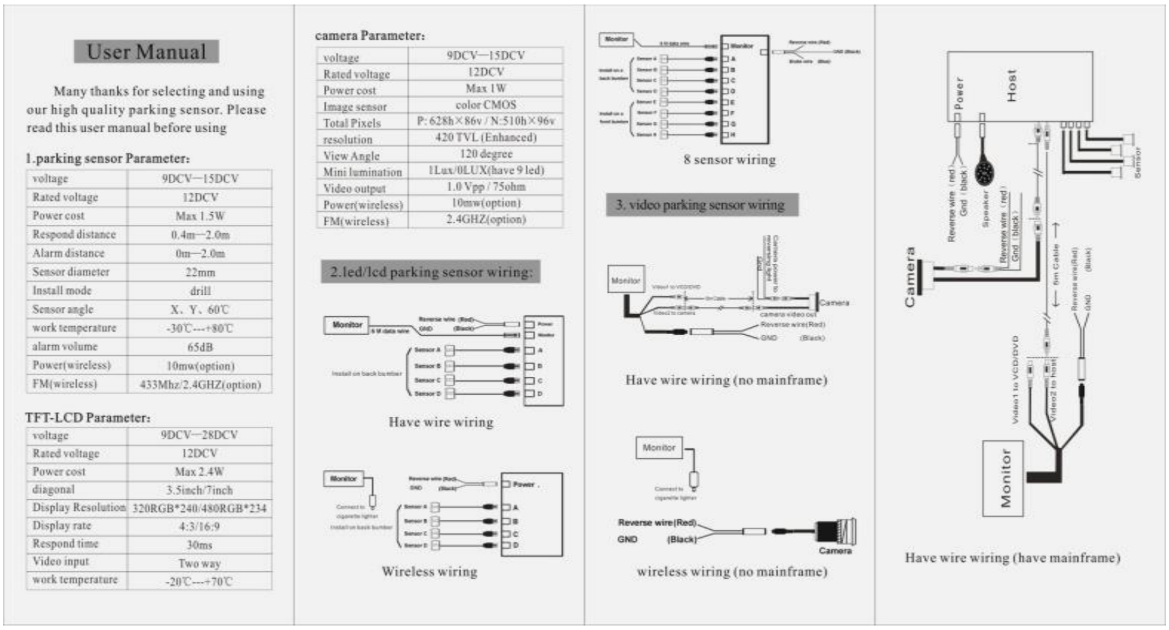
custom phone: ____________

dealer: ____________

Figure 8.0

(Parking Sensor Installation)

User Manual :



User Manual

Many thanks for selecting and using our high quality parking sensor. Please read this user manual before using

1.parking sensor Parameter:

voltage	9DCV—15DCV
Rated voltage	12DCV
Power cost	Max 1.5W
Respond distance	0.4m—2.0m
Alarm distance	0m—2.0m
Sensor diameter	22mm
Install mode	drill
Sensor angle	X、Y、60℃
work temperature	-30℃---+80℃
alarm volume	65dB
Power(wireless)	10mw(option)
FM(wireless)	433Mhz/2.4GHZ(option)

TFT-LCD Parameter:

voltage	9DCV—28DCV
Rated voltage	12DCV
Power cost	Max 2.4W
diagonal	3.5inch/7inch
Display Resolution	320RGB*240/480RGB*234
Display rate	4:3/16:9
Respond time	30ms
Video input	Two way
work temperature	-20℃---+70℃

camera Parameter:

voltage	9DCV—15DCV
Rated voltage	12DCV
Power cost	Max 1W
Image sensor	color CMOS
Total Pixels	P: 628h×86v / N:510h×96v
resolution	420 TVL (Enhanced)
View Angle	120 degree
Mini lumination	1Lux/0LUX(have 9 led)
Video output	1.0 Vpp / 75ohm
Power(wireless)	10mw(option)
FM(wireless)	2.4GHZ(option)

2.led/lcd parking sensor wiring:

Have wire wiring

Wireless wiring

8 sensor wiring

3. video parking sensor wiring

Have wire wiring (no mainframe)

wireless wiring (no mainframe)

Have wire wiring (have mainframe)

Figure 9.0

(Parking Sensor User Manual)

NB:

On both sides **(Weather Wind Sensor and Parking Sensor)** the assistant has just to inherent all the parameters from the plugged sensor and operate when something is going wrong with initial values for the second feature **Parking Sensor** the feature is prepared then the assistant will use just the information as parameters to execute it is tasks .

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