The System

An ecosystem of fully autonomous self-charging cars running on electricity which are connected over a network enabling communication.

DESIRED STATE
The Goal
The goal is to have enough charge in the car battery at all times to be able to reach the nearest charging station after completing the ride.

COMPARES
The Comparator
The comparator compares the current state (i.e. the current amount of charge in the car battery to the desired state (i.e. the amount of charge needed to achieve the goal).

MEASURES
The Sensor
The sensor measure the amount of charge in the car battery.

IF NOT ENOUGH CHARGE

ACTS
The Actuator
The car acts by self-driving itself to the nearest charging station and charging itself.

IF ENOUGH CHARGE

The car accepts the next incoming ride which it can complete in the current state.

VARIES
Significant Variable
The amount of charge in the car battery.

The feedback loop

AUTONOMOUS CAR

Boundaries of the System

- It is a closed ecosystem of fully autonomous cars *(level 5 and beyond).*
- The ecosystem operates within a set x mile radius.
- Only autonomous cars run in this space.

Rules of the System

- The cars run on electricity and self-charge themselves.
- The amount of cars in the ecosystem is always surplus of the demand.
  (At a point some cars are always charging).
- The car is a passenger car (upto 4 people) not a cargo/autonomous bus etc.
  (The self charging flow in such cases will be different since the route is set).

Setting the Goal

The goal depends on

- The distance between the destination and the nearest charging station
- The distance of the pick up location from the current location of the car.
- The distance between pick up and drop locations.

AFFECT
Disturbances
- Inaccuracy in calculating the capacity of the battery *(battery capacity decreases over time due to temperature conditions. It also depends on the driving speed and passenger load).*
- Roadblock (due to accidents/ construction/ natural calamities) causing detours. *(changes the time taken to reach the final destination)*

Main components of an electrical autonomous car

BATTERY

Electric cars run on a lithium-ion/ lead-acid or a nickel metal hydride battery.

The amount of charge in the battery is measured in kWh.

MOTOR CONTROLLER

Regulates the car's operation, motor, battery, and accelerator pedal with the help of a microprocessor

ELECTRIC ENGINE

It is a motor which actually propels the car by transmitting mechanical power to the wheels.

ONBOARD CHARGER

It inputs current into the battery to charge it.

THE ALGORITHM

Keeps a track of charging stations, distance to pick up and drop locations as well as the current state of the battery,

Computes whether the goal is achievable at all times.

Communicates with all other cars in the network for ride allocation.

An Example of the System in Action

Lets assume a future scenario where external cars are not allowed into San Francisco. **The city has its own fleet of autonomous passenger cars** which can communicate with each other.

- **If the current state of the car battery reaches a critical level,** where it is just slightly over the capacity for the car to drive to the nearest charging-station from the current location of the car, the car stops accepting further rides and self-drives to the charging station.
- **The ultimate aim of the system is to gain profit.** A car will accept a ride even if it is not fully charged if it crosses a certain level of charge (lets assume 90%) and there are no other available cars in the vicinity.

DESIRED STATE
The Goal
The goal feeds in to the algorithm.

CUSTOMER
Requests a ride
By choosing the pick-up location and the destination.

ALGORITHM
Matches the customer to the ride
The rider is matched to the nearest available ride which meets the goal.

CAR — ACT
Completes the ride
Drives to the pick-up location and picks the passenger up

Drives to the destination and drops the passenger.

IF ENOUGH CHARGE

CAR — MEASURE
Receives request

IF NOT ENOUGH CHARGE

CAR — ACT
Charges Itself

The request is automatically sent to the next nearest car which meets the goal.

IF CURRENT STATE IS CRITICAL

INPUT
External power source

Response to Disturbances

ERROR STATE 1 : Roadblock

In case of a roadblock, the car may have to take a detour which increases the distance and in turn affects the amount of charge left in the battery to complete the trip.
In such a scenario, the car may stop at a charging station before completing the trip in order to meet the goal.

ERROR STATE 2 : Inaccuracy in calculating the battery capacity

In case the algorithm is not able to calculate the battery capacity with precision, the car may die before it is able to reach a charging station.
To account for such situations, the minimum current charge requirement is always set slightly higher than the actual requirement to reach the charging station.

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