Slot Car Demo

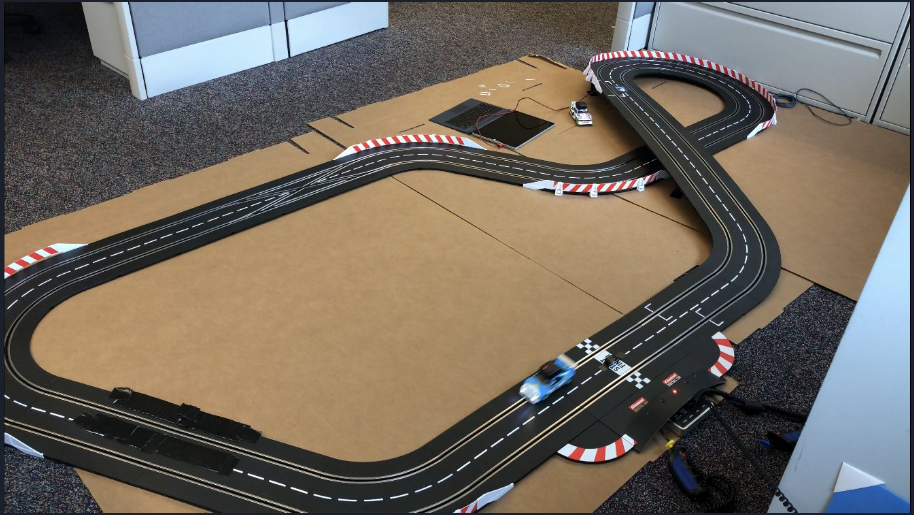
Kionix®

Setup

RaceTrack:

A slot car track was used to simulate cars driving

https://www.carreraslots.com/slot-car/30002.html?gclid=Cj0KCQjwl6LoBRDqARIsABlIMSbyotJAvisCU6hyYtwnWX0LHNGHKMvmEiTZspE-Ba65Uw5f9SPqpOEaAqbsEALw_wcB



Car Setup:
A sensor node was mounted on the top of each slot car. They should be mounted as parallel to the ground as possible

Video of data being collected

Roll-Over

Summary: This algorithm detects if the car has flipped over on its side, and then reports data to a black box recorder

Key Insight: Detection of device orientation relative to gravity.

Applications: Accident detection is important for safety features of cars and getting data about the car after the accident (e.g., temperature).

Other Applications: cameras, toys, level meter, screen rotation,

Implementation:
Accelerometers can be used to detect the force of gravity. The data shows the constant gravitational force shifting to a different axis when roll-over occurs. After the event, data is streamed to the black box recorder window to report the current conditions of the car.

Video: 

Recommended Sensors:

G-Force

Key Insight: Measurement of G forces acting on device

Summary: Dials display the G forces acting on the car in all three different axes .

Other Applications: motion detection, tap detection, shaking/mixing force, transportation

Implementation:
The acceleration data from all three axes are converted from digital counts to Gs. The data is filtered so it is not too jerky and then displayed on the dials.

Recommended Sensors:

Terrain

Summary: This algorithm detects what type of terrain the car is driving over by measuring vibrations.

Key Insight: Measurement and Analysis of Vibrations and frequencies

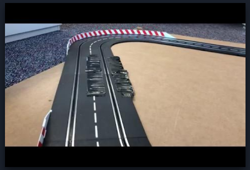
Applications: This is useful for cars to detect the environment and be able to adapt to difficult terrain.

Other Applications: Machine Health/Condition Monitoring, Road Noise Cancellation, Surface Classification, etc.

Implementation:

The acceleration data on the car is used. The algorithm looks for 3 peaks a certain threshold both above and below the average acceleration in the x, y and z directions in a short period of time. Specifically it stores the most recent 20 data points at 50Hz ODR and looks for peaks in that data set.

Video:



Recommended Sensors:

Lap Timing & Average Speed

Summary:
When the car passes the finish line its lap time and average speed can be calculated.

Key Insight: Detection of location via Magnetic Field Measurement

Applications:
Identify car location and track speeds.

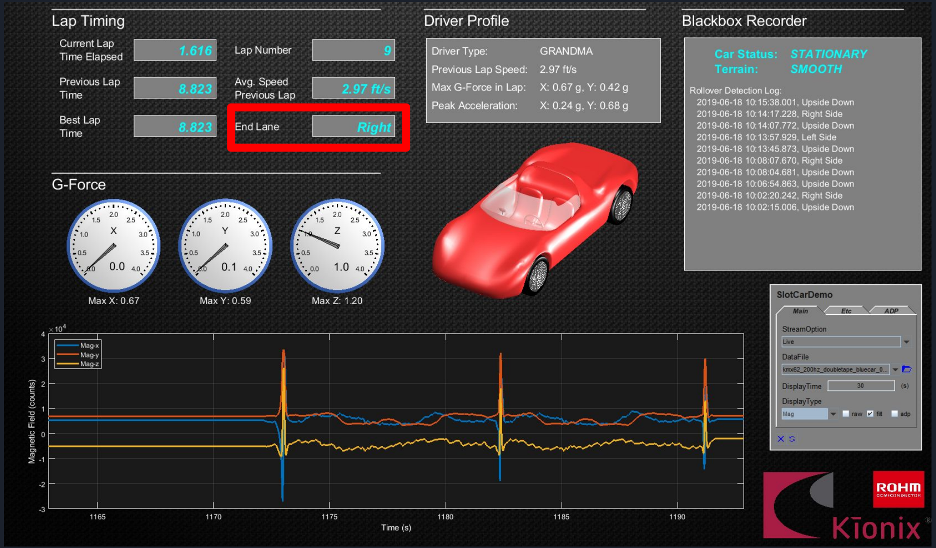
Other Applications: calibrate position, identify location, establish timing information

Implementation: A magnetic beacon is placed at the start/finish line. The magnetic data from the car's sensor is monitored for the signature of the beacon (a peak above a threshold), indicating the car has passed the finish line. The number of laps, current lap time, best lap time and average speed can be calculated.

Recommended Sensors:

Lane Detection

Summary: The lane that the car is in is detected when it crosses the start/finish line



Key Insight: Detection of location via Magnetic Field Measurement

Applications: This can be used for intelligent traffic, E-Z Pass and autonomous vehicles.

Other Applications: more specific location identification

Implementation:
The magnetic data of the sensor on the car is used. If the car drives past the start line and it has a positive peak it is in one lane and if there is a negative peak then it is in the other lane.

Recommended Sensors:

Peak Acceleration

Summary: Peak acceleration is defined as the largest acceleration within 0.5 second since the car starts to move, peak acceleration is reset once the car stops.

Key Insight: Measurement of acceleration in a short period of time

Applications: Peak acceleration can be useful for the users and insurance company. An aggressive driver will have larger peak accelerations

Other Applications: Machine Health/Condition Monitoring, Driving safety, Autopilot, Animal Health/Condition Monitoring, Surface Classification, etc..

Implementation:
To capture the largest acceleration within 0.5 second since the car starts to move, the movement algorithm is used. Once car motion is detected, the algorithm outputs the maximum acceleration among the most recent 0.5 second of data.

Recommended Sensors:

Maximum Acceleration

Summary: Maximum acceleration is defined as the largest acceleration within one lap, maximum acceleration will be reset once the car laps

Key Insight: Record of maximum G-forces acting on devices

Applications: Maximum acceleration over a time period is another way to detect how aggressive a driver is. It can be used by insurance companies or to teach drivers.

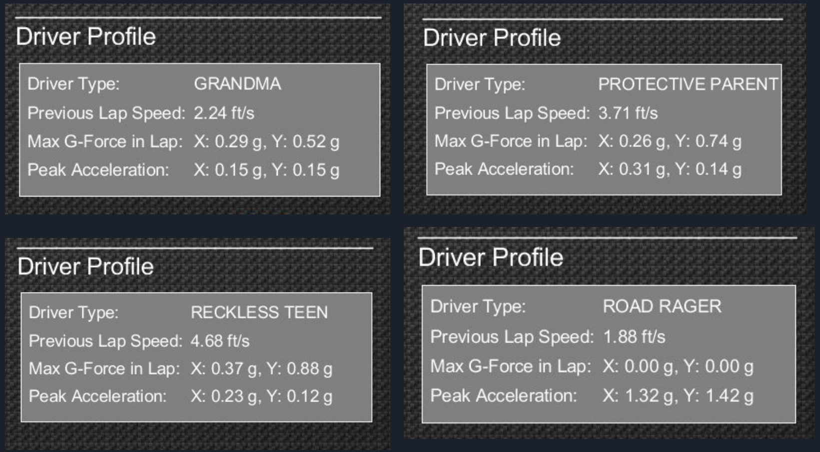
Other Applications: Autopilot, Machine Health, Motion Monitoring, etc.

Implementation:
To get the maximum acceleration of each lap, we take advantage of lap timing algorithm to know when the car laps and the algorithm will output the largest acceleration within the most recent lap.

Recommended Sensors:

Driver Profile

Summary: This algorithm classified the driver type based on data from the most recent lap.



Applications: This could be used for insurance companies to rate drivers or as a learning tool to teach new drivers.

Implementation:
The Lap speed, Peak acceleration, maximum acceleration and rollover were all calculated from the previous lap. Then they were put in as weighted numbers to give the driver a score between 0-100 with 100 being the most reckless. A rollover resulted in an automatic 100. Then the profile was displayed as “Grandpa”, “Protective Parent”, “Reckless Teen” or “Road Rager”.

Recommended Sensors:
KMX-62

Car Movement

Summary: This algorithm detects if the car is moving or stationary. The GUI shows the status of the car in real time.

Key Insight: Vibration detection based on the variance of accel data

Applications: This can be used to detect if anything is in motion like if a car is being stolen. It can be applied to any sort of object motion detection.

Other Applications: Home Security, Anti-theft Animal Monitoring, object detection, wake up back to sleep

Implementation:

The most recent 10 acceleration data points are looked at. The variances of accel data in all three directions is computed, if the variance are really small then the car is stationary. If the variance is above a certain threshold then the car is moving.

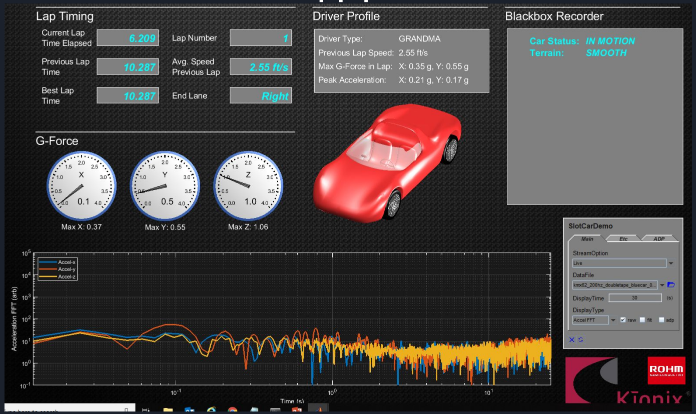
Recommended Sensors:

Data Transformation

The UI allows for the streaming of not only the raw and filtered magnetic/accelerometer data, it also can stream the FFT and ADP from the accelerometer. The box in the bottom right allows for control of the data stream. These data transformations could be used for even more applications.

ADP

FFT



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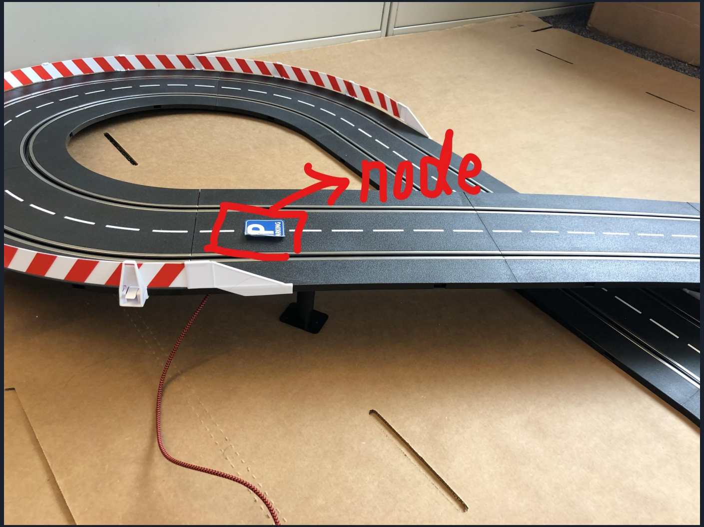
The sensor underneath the bridge is used to detect cars crossing the bridge using accel data, the number of cars crossed the bridge using magnetic data It is also used to detect parking availability and parking duration using magnetic data.



Bridge Crossing

Summary: This algorithm counts the number of cars crossed the bridge on the right track.

Key Insight: Detection objects via Magnetic Field Measurement

Applications: This can be applied on traffic monitoring or monitoring how much some infrastructure is used.

Other Applications: objects counting, objects detection, flow monitoring, etc.

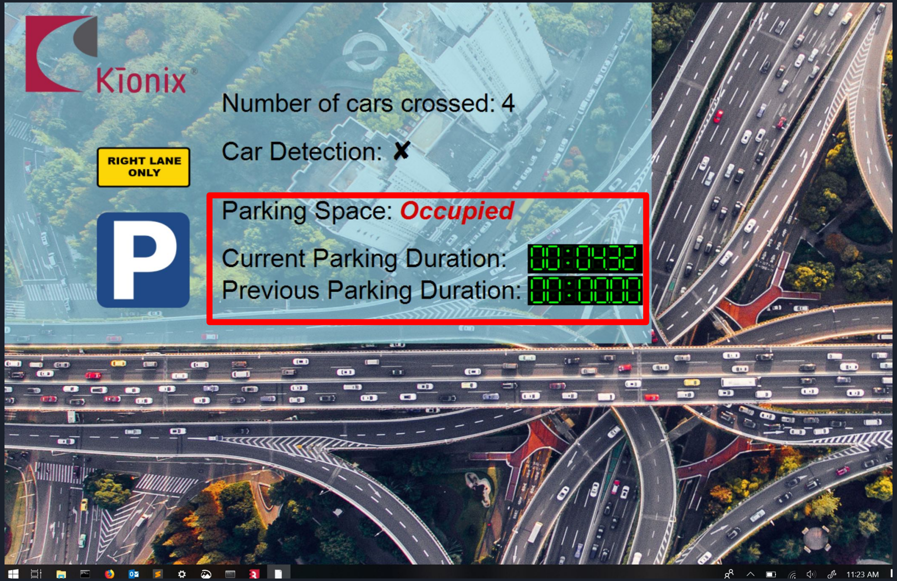
Implementation:
When the car crosses the bridge, the node underneath the bridge detects a peak of magnetic value. This algorithm sets the threshold of the magnetic value on the Z Axis. When the value goes beyond the threshold, and quickly falls back to the regular value within 3 seconds, the algorithm detects that one car has crossed the bridge.

Video:

Recommended Sensors:

Parking

Summary: This algorithm shows whether the parking space is available or not, records the current parking time and previous parking time on the parking spot.



Key Insight: Detection objects via Magnetic Field Measurement

Applications: This can be applied on a smart parking system. A parking lot can show how many parking spaces are left and calculates the parking fee automatically.

Other Applications: timing, object detection, etc.

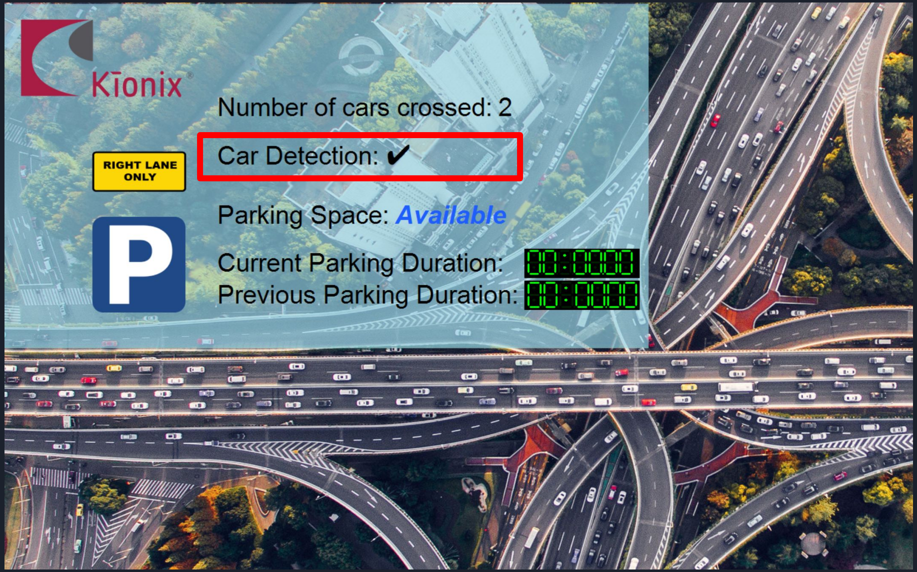
Implementation:
The magnetic value will be much higher than usual when any car is parking on the spot. The algorithm detects the higher value, and starts the timer when the value goes beyond the threshold. If the duration lasts longer than 3 seconds, the car is regarded as parking, and the space will show occupied.

Video:

Recommended Sensors:

Car Detection

Summary: This algorithm shows if there are cars moving on the bridge or not, and shows the status on the GUI in real time.



Key Insight: Vibration detection based on sensor mounted to the infrastructure/ground

Applications: Measuring how many cars pass over an area, detecting stress put on infrastructure

Other Applications: Detecting humans walking, Measuring stress on a system through vibrations, earthquake detection, detecting landing planes

Implementation:
We put the node under the bridge and it detects the vibrations of the bridge. If there is no car on the bridge, the bridge won't vibrate a lot and the variance of the recent z accel data will be small. When a car is crossing the bridge, the variance reaches the threshold and outputs ✔.

Video :

Recommended Sensors: