SIMULATING A CAR CRASH WITH A CAR SIMULATOR FOR THE PEOPLE WITH MOBILITY IMPAIRMENTS

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Abstract: Selection of drive parameters was one of the last works in building a car simulator. Engines used in the simulator are the latest generation they are designed for high-precision work. Each of them has a separate controller operated by industrial computer. Industrial computer also checks the position of the steering wheel, and the status of switches and pedals, and lights the lamp. The computer is connected to a master computer. Virtual routes for driving lessons are saved on the master computer. This computer displays the image on the four screens.
The biggest challenge was to ensure the safety of the driver. Was performed several simulations of a collision with other virtual cars. The first the collision was so dynamic that we were afraid of the simulator. Nothing happened because there was no one inside. These parameters were not safety.
So it was necessary to reduce the acceleration during impact.
Key words: Stewart platform, car simulator, mechatronics, crash, drive parameters.

1. INTRODUCTION

People with physical disabilities if they do not have a driving license, and when I want to go somewhere they have to use the special bus or rely on help from others. Some of them could drive a car but they rarely go to a car driving school.
When a disabled person decides to learn to drive a car at the beginning he should buy a car with special equipment matched to him. The equipment is different for each disability and expensive and require modifications to the car so much driving schools do not have such cars.
We want to help them to learn driving. We have built a prototype of a car driving simulator, where people with disabilities can learn to drive a car and choose the special equipment.
The next task in the construction of a driving simulator for the disabled to validate hardware and programmable control of the mechanical part. Included in the "Virtual World" module calculates the physical parameters of the motion of the vehicle model [3] [4] [5]. In an iterative process are determined the vehicle velocity. Line velocity is determined along each axis, and the angular velocity around each axis. These values cannot be directly used in the platform, because even small numerical errors after differentiating transformed into large differences in acceleration which causes the dynamic response on the platform. Additionally, events such as a collision or crossing the curb are modelled by control program as a very stiff (cars who do not have crash area and elastic tires), so they have a very sharp characteristics, causing high vehicle accelerations and high overload. The use of such acceleration would be dangerous for the driver and could cause faults of the mechanical and electrical system. Also note that the role of the platform is to feel the driver driven in tight spaces were almost the same as in infinite world. This effect is obtained by "modification" of the vehicle behaviour, and thus impacts the inertia at the driver. Reduced are longitudinal and cross acceleration and their action is replaced by tilting the vehicle. Feeling the effects of car is individual for each person. Can be only set the parameters that match the majority of the tested drivers.
Because collision with other virtual cars has never been the same, we have built a virtual test square with a wall. We tested several collisions and obtained the same time diagrams. Driver safety is the most important, so the motion parameters during collisions must be changed. It is important that the driver feels the collision, but he is safe.
When it was safe, many drivers tested the simulator. Everyone who tested the collision said it is very similar to the real.

2. SIMULATOR PARAMETERS

During installation, there have been many test drives and measurements. Each driving was repeated at least three drivers in similar conditions and trying to behave similarly. As a result of the first test it was

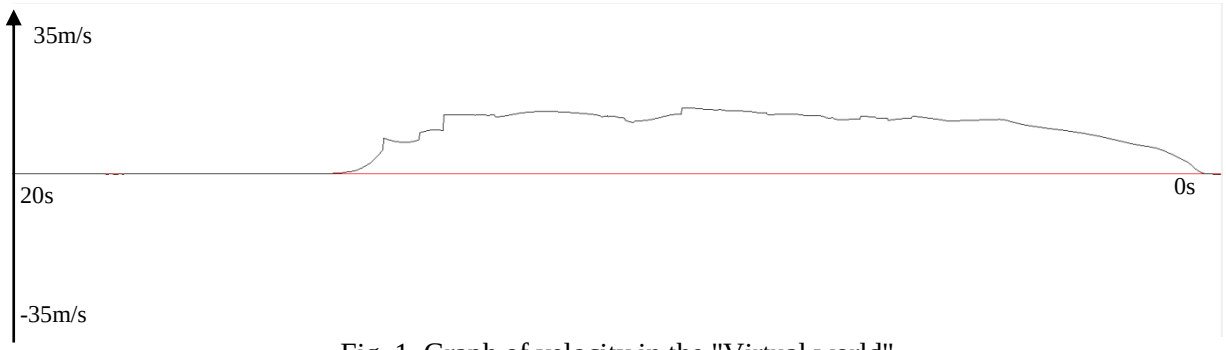

Fig. 1. Graph of velocity in the "Virtual world"

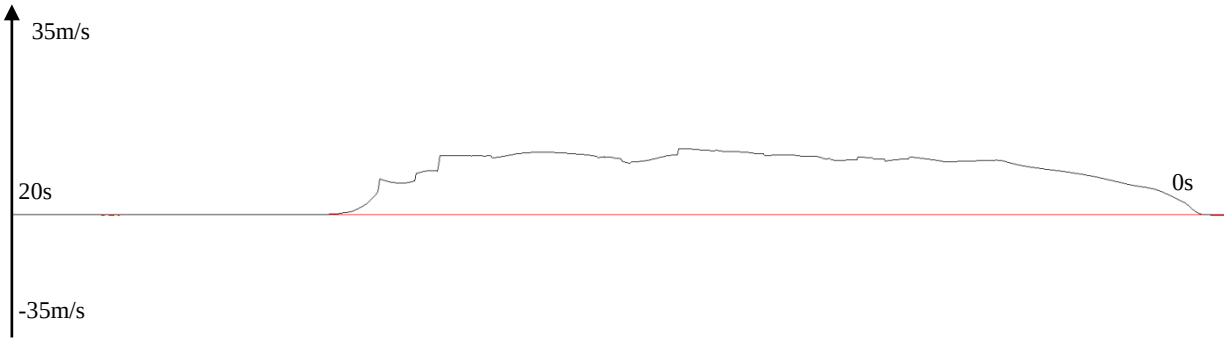

Fig. 2. Graph of velocity after filtering the dramatic changes

Fig. 3. Acceleration determined from velocity obtained in a "virtual world"

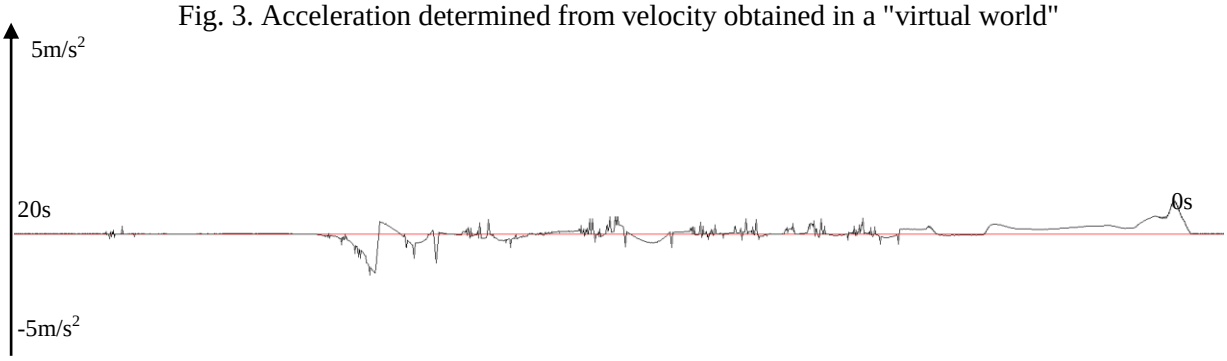

Fig. 4. Acceleration obtained from after filtration velocity

found that it is necessary to capture the transmitted data. Because feelings are very subjective prepared a program that displays the selected motion parameters. The graphs Fig. 2 and 4 shows the reduction of speed change applied to 3% of the previous value and changes in acceleration up to 5% of the previous value. Even the use of such modifications did not reduce the dynamics of movement. Due to health of the driver is not simulated collision with an obstacle [6].

The next step was to change velocity limit to 2% of the previous and a calculation based on the acceleration and reduce the change to 5% of the previous one. This processing enabled the simulation of collisions. Was performed a series of measurements.

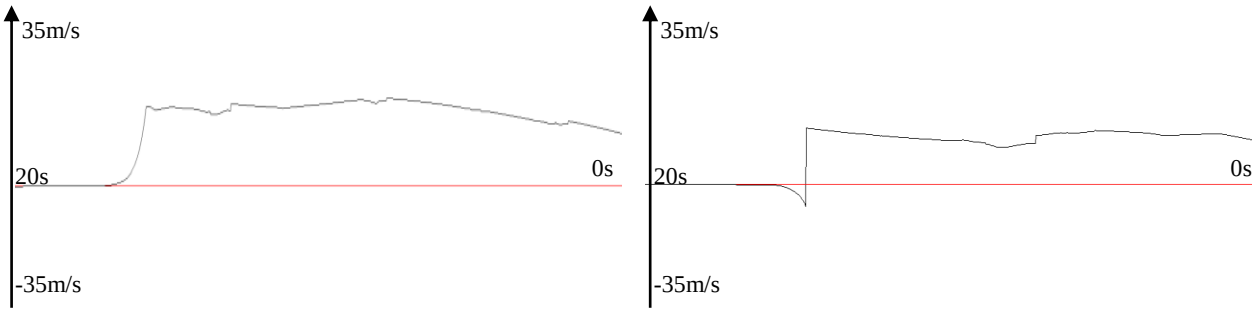

Fig. 5. Histogram velocity calculated in a "Virtual World" hard breaking and collision without filters

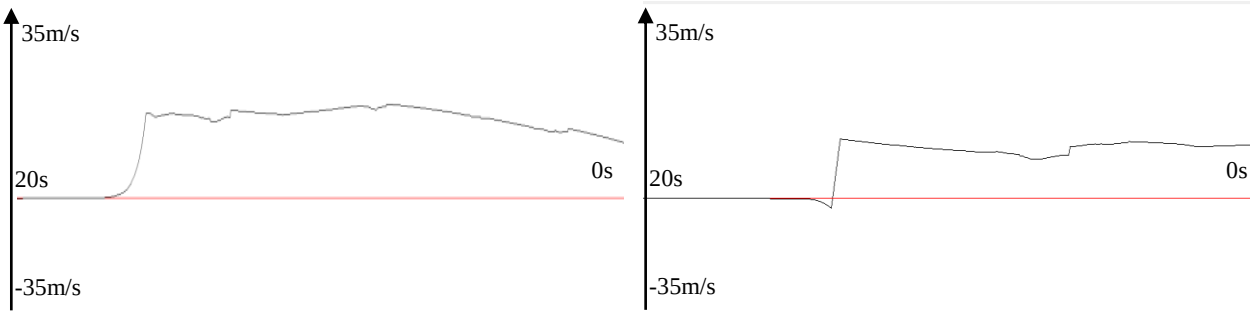

Fig. 6. Histogram velocity calculated in a "virtual world" hard braking and collision after filtering

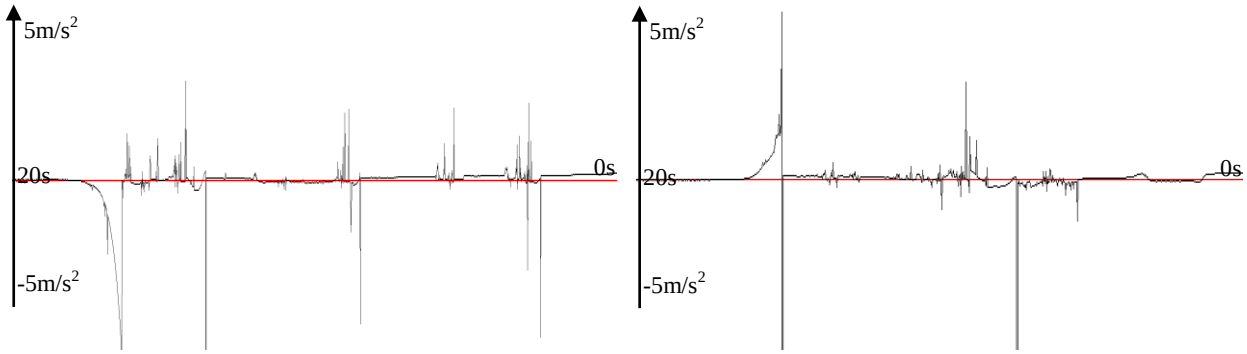

Fig. 7. Histogram of acceleration calculated in the "virtual world" hard braking and collision without filter

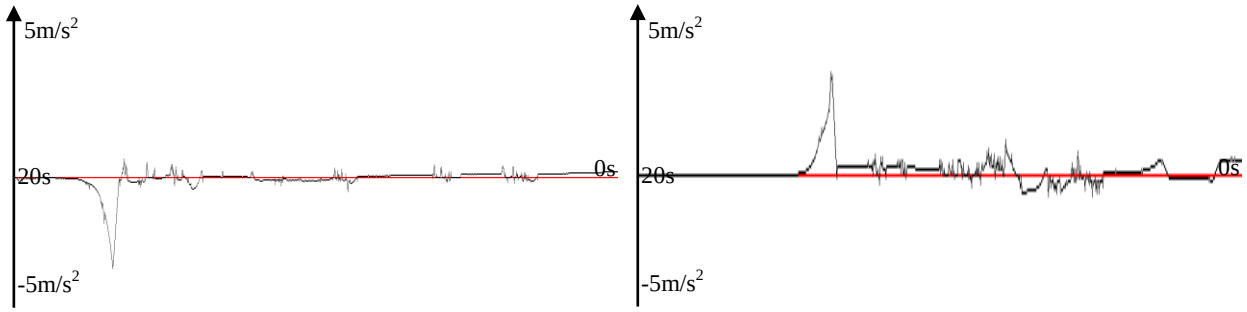

Fig. 8. Histogram of acceleration calculated in the "virtual world" hard braking and collision with the filtering velocity

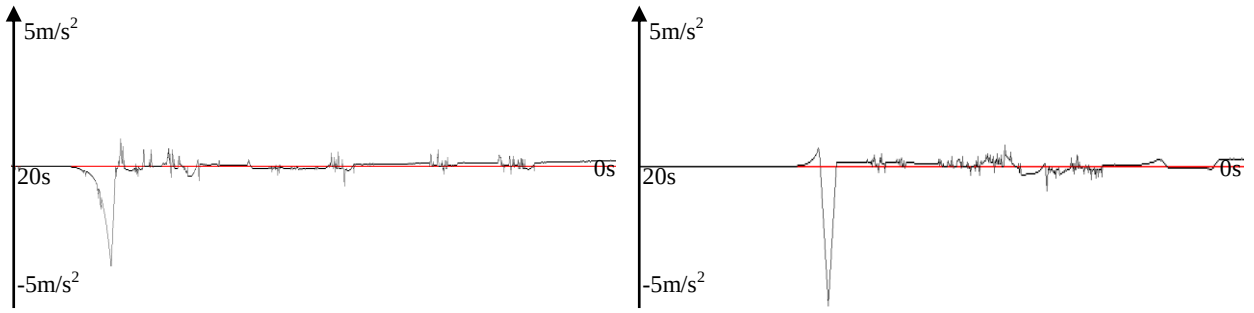

Fig. 9. Histogram of acceleration calculated in the "virtual world" hard braking and collision with a filtering acceleration and velocity

This processing eliminates the movements that threaten the health of the driver, but still could be felt vibrations while driving at a constant speed. In order to improve the ride comfort has introduced an additional filter. The new values of velocity and acceleration were calculated as 50% of the current, and 50% of the old value. In this way removed vibrations occurring during cruising figure 10 and 11 [1][2][7].

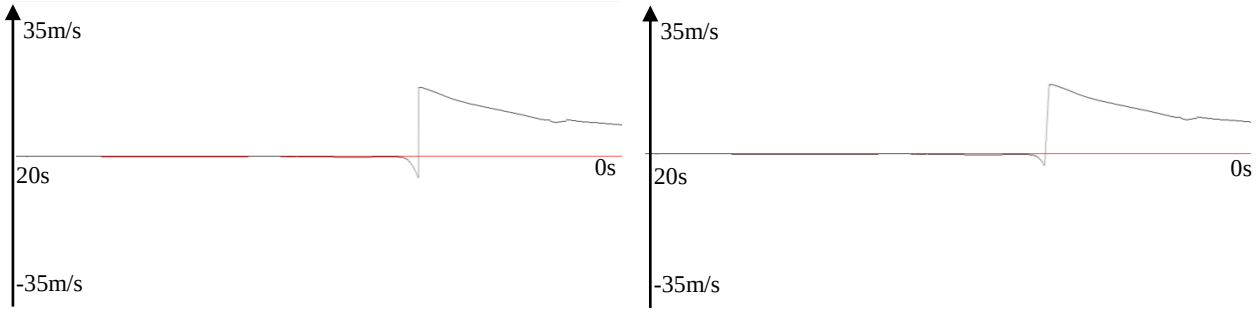

Fig. 10. Histogram velocity of its calculated in a "virtual world" without the filter and filter

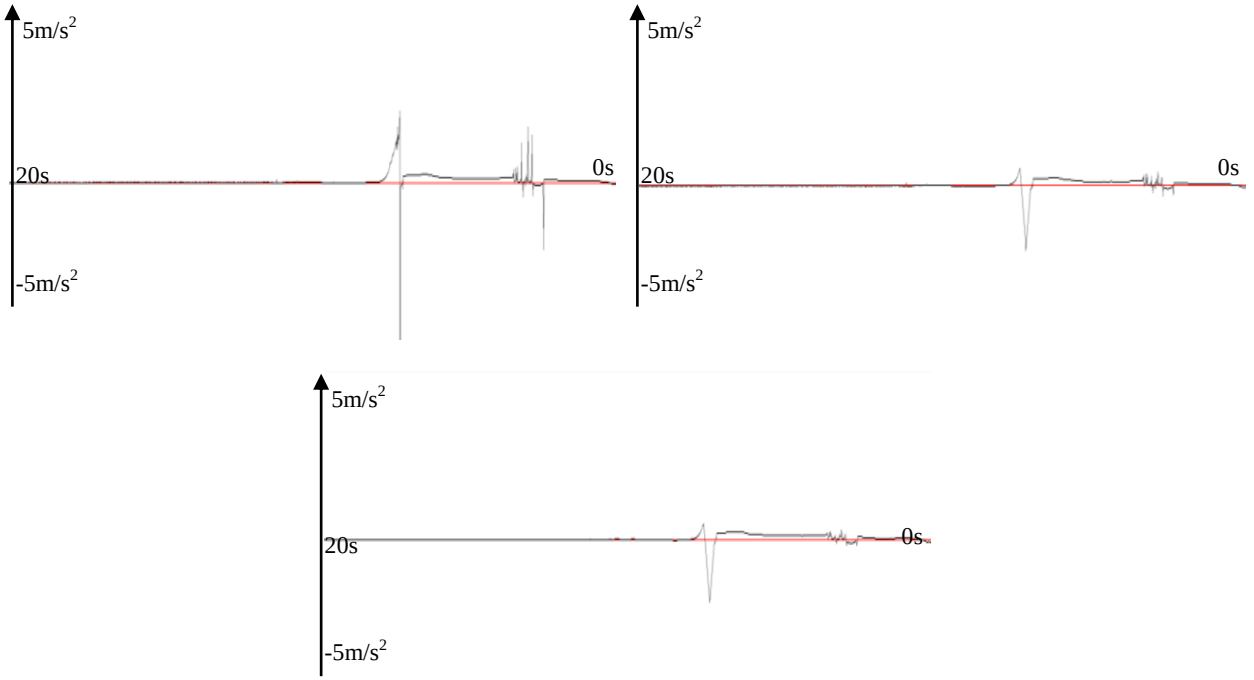

Fig. 11. Histogram of acceleration calculated in the "virtual world" - no filter - the filter velocity - the velocity and acceleration filter

According to the test drivers, these parameters influenced driving comfort. As a result, many hours of testing the filter parameters were determined at 75% of the current value and 25% of the new value.

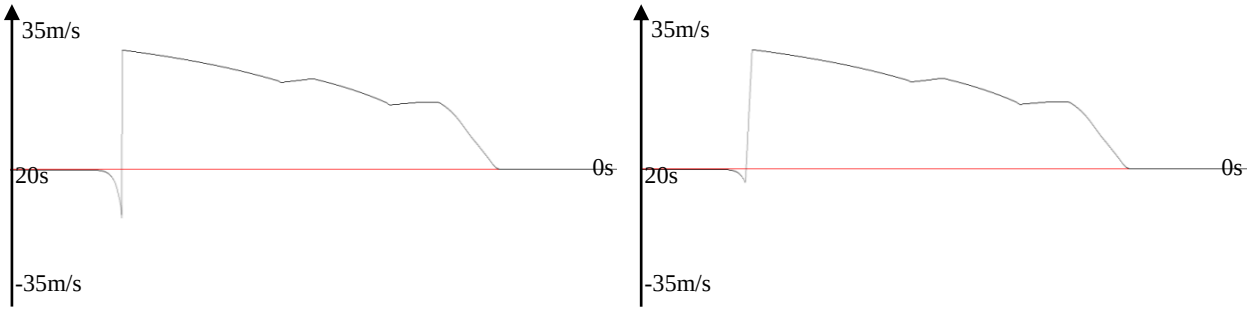

Fig.12. Histogram velocity calculated in the "virtual world" accelerate and hit the wall - no filter - the filter velocity

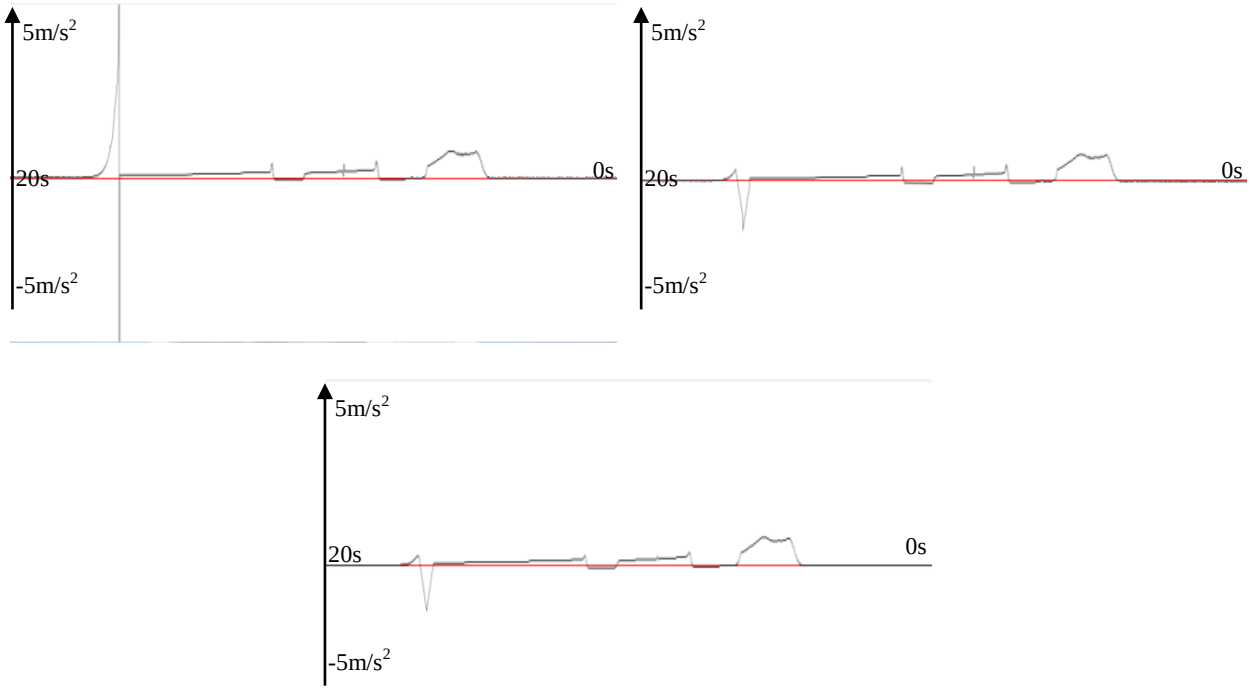

Fig. 13 Histogram of acceleration calculated in the "virtual world" accelerates and hit the wall-without a filter - the filter velocity - the velocity and acceleration filter

The used filters are not changed noticeably acceleration from a standstill but much reduced acceleration with a car collision with a wall Figure 12 and 13.

The next step was to test the behaviour of the vehicle during the accident-free driving and shifting.

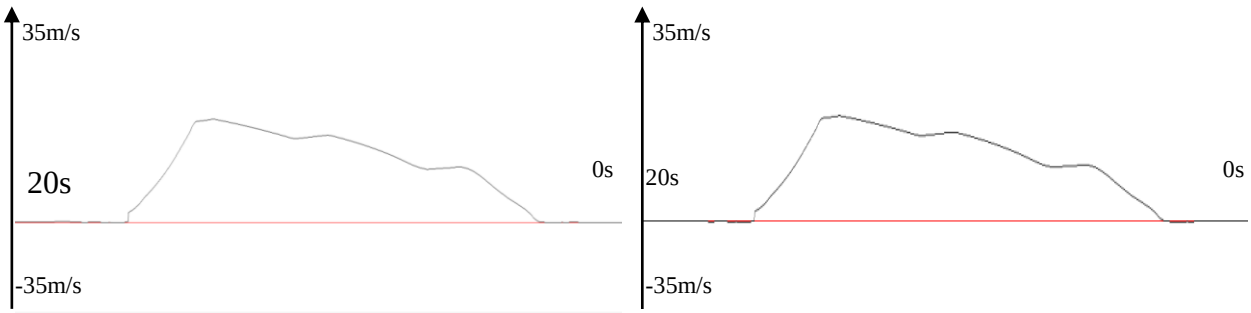

Fig.14 Histogram velocity calculated in the "virtual world" accelerate and hit the wall - no filter - the filter velocity

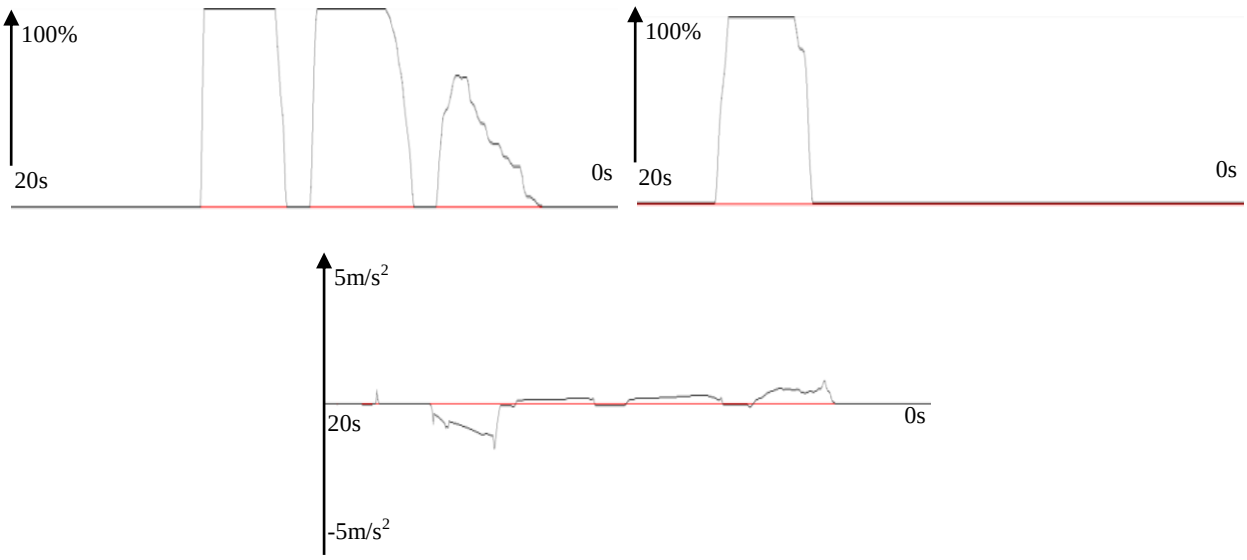

Fig. 15 Charts position gas and brake pedals while driving and acceleration, shifting and braking

Visible are the moments of acceleration and deceleration shift not only in the graphs showing the state of the gas and brake pedals as well as the histogram velocity and acceleration.
The histogram velocity, shifting and pushing the clutch associated with a modest reduction speed. The timing chart of acceleration, during the shift value falls below zero acceleration (deceleration). During heavy braking chart acceleration drops down.

3. CONCLUSIONS

The simulator is designed for people with disabilities who want to learn to drive a car. It is very important to keep them safe and not discourage them from learning.
It is also important that the forces acting on the driver in the simulator were similar to those in a real car. We had to find the right balance between safety vs. driving realism.
The car in the virtual world is a solid body, so dumb he crumple zones. During the collision the virtual car behaves like a billiard ball. This is shown in the graphs of acceleration as peaks. For drivers are very dangerous short and high peaks. It is so gentle strength and extension time of the collision.
The use of simple filters poorly decreased during the collision acceleration, and had a sharp change in the parameters of the basic movement.
Finding the appropriate filter and selection of relevant parameters was very time consuming. Even if the velocity and acceleration graphs were good, it was necessary to check the drivers' subjective feelings.
Use the filters reduced the impact of accidents, without changing the acceleration during normal driving. The simulator was safe because the force of impact increases with speed up to 40km / h above this speed changes are not much larger than the collision at this speed. Removed vibration resulting from calculation errors in the "virtual world".

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