Assignment 3 – Daniel Lay

**Tools and Technologies**

Software

* NVDLA Deep Learning Inference Compiler (Open source)
* CAN (Controller Area Network) FD standard/protocol to allow multiplexing of electrical wiring and communication between the systems.
* Ethernet bus for image processing
* Elasticsearch analytics

Hardware

* Texas Instruments mmWave sensor (AWR1843)
* Blind spot monitoring (AWR1843)
* Camera (front/rear/side)

Continental MFL400 for front with incorporated use for Lane Keep Assist.

Surround View System SVS220 for front, rear and side view

* Electric brakes – Lexus ECB (electronically controlled brakes)
* Nvidia Deep Learning Accelerator, Jetson AGX Xavier SoC (System-on-chip) to provide the processing power for the AI driven bus
* Jetson AGX Xavier Developer Kit for developing the system via machine learning.
* NXP microcontroller-based device plugged into OBD-II port
* Electronic throttle (drive-by-wire)

**Plans and Progress**

The autonomous bus by TransForMation will be powered by Nvidia’s deep learning accelerator named Jetson AGX Xavier. It is a SoC (System-on-chip) with very high processing power at 32 TOPs (trillion operations per second) on a small package of 10 watts. (NVIDIA Developer, 2019a)

Development of the system will be done using the Jetson AGX Xavier development kit (NVIDIA Developer, 2019b), utilising the open source NVDLA deep learning compiler. (Mukund, Gaikwad and Harwell, 2019)

By utilising a specially designed SoC on a small form factor, it will be suitable in automotive use as it allows easy integration into the vehicles systems, provide a low power consumption solution while being very efficient at its job.

The hardware to provide the data for the Xavier SoC includes Texas Instruments’ mmWave sensors and Continental automotive cameras.

The Xavier SoC will be trained using machine learning to recognise obstacles and people using the camera’s situated at the front, rear and side of the bus. It can then apply the electronic controlled brakes as necessary. The Continental MFL400 automotive camera can also provide lane keep assist functions if the bus is drifting out of the lane which can be easily corrected via an electrical steering system. (Continental-automotive.com, 2019a)  
As for the side, rear view and additional front camera monitoring, the autonomous bus will utilise the Continental SVS220 Surround View System. (Continental-automotive.com, 2019b)

Texas Instruments makes a variety of millimetre wave sensors for different ranges of distances. These millimetre wave sensors are currently used in modern automotive vehicles today such as all-speed radar cruise, pre-crash safety systems, cross-traffic monitoring and blind-spot monitoring. (Lexus, 2014)  
For the autonomous bus application, TransForMation have identified that a short-medium millimetre wave sensor (AWR1843) would be appropriate for a bus as the development and trial will involve slow to medium speeds. Even at normal road speeds, a detection range of 150 metres is a sufficient amount of distance to allow the SoC to analyse the data and respond accordingly. (training.ti.com, 2019)

CAN-bus communication is currently used in automotive systems to interconnect the ECUs and allows multiplexing, reducing the amount of wiring. However, CAN bus doesn’t have great bandwidth capabilities, only at 1 Mbit/s. Due to the increased demand of bandwidth from the autonomous bus system, it would be wise to invest in newer CAN technology, known as CAN FD.   
CAN FD increases transmission speeds considerably, from 1 Mbit/s to 8 Mbit/s; it also increases the packet size from 8 bytes to 64 bytes so the efficiency of the protocol is further improved. (CSS Electronics, 2019)

During the development and testing cycle, security will be a main overarching goal blanketing the system. In the current society, cyber attacks are a real threat. With the proposal of TransForMation’s autonomous bus, there are various safety aspects to consider.   
An important aspect that TransForMation has identified is the potential for the system to be hacked or tampered with. It is a serious issue as there is no dedicated driver as a backup; to combat this issue, machine learning using hardware attached to the OBD-II port of the vehicle can “learn and protect” the integrity of the system. The anti-hacking device would be able to shut down systems if it detects any attacks/abnormalities, putting the bus into a “limp” mode. It is also possible to implement software analytics to carry out similar functions. (Causevic, 2019)

Furthermore, the GPS receiver in the bus will be able to pinpoint the location of the bus if any issues or attacks occur and the system can send out SOS messages to a central depot to deploy teams to rectify the issue.

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