CSP 587 - Software Quality Management

Homework #4

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1. **A set of relevant metrics for each threat type and automated collection mechanism for each**
   a. **Risk of an accident:**

      Metrics:

      Different metrics are used in the system to capture the state of driving and vehicle dynamics in assessing accident risk. It considers the distance to the surrounding nearby obstacles in finding the remaining time to react in order to avoid collision. Also, it calculates vehicle speed with respect to other surrounding vehicles so as to keep a sufficient driving distance from other vehicles. Furthermore, consideration must also be done to environmental elements such as rain, snow, and fog since these atmospheric conditions always affect visibility and traction directly. The system monitors lane adherence so as to make sure the car remains in its lane. It also detects the type of road on which the car is traveling, such as highway or local street, etc., since the density of traffic varies between types of roads greatly, so it is important to track the type of road and its surroundings in order to avoid an accident.

      Automated Collection Mechanism:

      To collect all these metrics, our vehicle is equipped with number of highly efficient sensors that work simultaneously. These self-driving cars are surrounded by cameras all around it, which covers each and every detail happening around the car. We use LIDAR to create a detailed 3D map of our surroundings. We use RADAR which helps us to track how fast the surrounding objects are moving even in bad weather. The cameras around the car work like vigilant observers which read road signs, lane markings and other important signals on the road. GPS helps us navigate the directions, while other sensors make use of the navigation to control the steering and car movement according to the navigations. There are many other sensors which work right from the start, collect data and send it to the system which makes a decision within milli seconds and sends it to the sensors which control the car's movement. Everything here is processed within fraction of seconds and executed in the blink of eye.

b. Risk of a system element failing:

Metrics:

It is very important to make sure that each and every element of the system is in good working condition because in a self-driving car each and every movement is relied on data which is collected from various sensors. If one sensors or element stops working or malfunctions there might be risk of accident. We will be constantly checking on the health of each and every sensor to make sure that the data they capture is legitimate. For electric vehicles, we need to keep an eye on the battery and make sure that there is enough to reach the destination safely. Also, we need to monitor how quickly and efficiently the sensors are talking to each other, because in self-driving environment everything must be done in the blink of an eye. Software must be up-to-date and in case of any security and other issues immediate action must be taken and software update must be sent to the cars which resolves the issue. We must also check that cars responds promptly whenever we steer, accelerate or brake. The car's electrical system should be monitored to make sure that everything is going well.

Automated Collection Mechanism:

For keeping track on all the metrics which we mentioned above, we should have a monitoring system which is basically automated and continuous process. We will be having a set of tools which diagnose the issues constantly by running various tests and look for any issues. If something is not working as it is intended to do so the in-built system immediately raises a red flag and tries to fix the issues by itself. If the system is not able to solve the issue on its own it will send the issue report to the remote monitoring centres. The system's software looks for any potential issues and alert the user if anything might happen in future. There are backup systems in case of emergency which might help the user to ride safely atleast for a certain amount of time to reach a nearby monitoring centre.

c. Risk that the human "passengers" lack awareness:

Metrics:

The passengers must be alert and ready to take over the car from the autonomous system in case of any malfunction. So, we need to pay more attention on the passenger activity. We should be monitoring the passenger and their eye activity whether they are focussed on the road or watching something else. We must also track their facial expression to make sure that the passenger is not sleepy or tired. Their sitting position is also important because that shows their attentiveness towards the road and traffic. For safety purposes, we must make sure that the passenger keeps his hands close to the steering, in case of any emergency it will be easier for the passenger to quickly take control. Some advanced can also track if the passenger is using phone or road and give an alert message so that he can say alert.

Automated Collection Mechanism:

Passenger safety is utmost priority of any car whether it is an autonomous car or human controlled car. As we are talking about autonomous cars here, it is much more crucial because everything here is controlled by system. We must make sure that the passenger is alerted in case of any failure in the system. We must collect passenger data automatically and alert the passenger if he is relaxed or not attentive. We can make use of special cameras which can track the eye ball movement even during the night time. We will also track the facial expressions and body language of the passenger. We can have microphones which listens to the passenger and detect the mood of the passenger. There are lot of sensors are imbibed in the car which can detect the passenger's sitting position, hand movements, mood of the passenger. Here our aim is to save the passenger from any potential accidents. These systems can help us safeguard the passenger in case of any failure.

2. Automated Analysis Process:

The automated analysis system operates as a vigilant co-pilot which constantly monitors the risk exposure to guarantee the passenger's safety. The system acquiring data which collect from sensors and other monitoring systems, analyses the received data in order to form one stream that will help the system determine an overall condition of the vehicle currently. That particular data is then fed as inputs into algorithms that analyse risks of an accident, system failure as well as passenger sensibilities.

The system divides the risk in view of the road type, weather condition, traffic flow or time of the day. In addition, it involves predictive analytical techniques of machine learning models and assesses historical and current data inputs checking for risks before they get worse. What we get from this analysis is for each type of threat a dynamic risk score that is computed they second. The more accurate risk scores will be compared with the fixed safety measures that will be changed online based on the driving situations.

In the first instance if the risk score it comes up with is over the threshold limit, the system displays the correct warning to the passengers. All the information is then used so that the system can construct an improvement in estimation to be applied in the future to make it smarter and more precise. In this way, the notifications would be given to the passengers in charitable time, thus reducing on the instances of false alarms.

3. Automated Warning Escalation Process:

It is crucial to understand the warning escalation process, which targets on enhancing the passenger's safety without causing high alarm. It begins with a first level warning

whenever a risk probability is noted. This might include an audible beep, or a light pulsing in the seat or on the dashboard. These alerts are not dangerous but rather visible so the passengers have an opportunity to respond without panicking. If there is still no response then after 3 to 5 seconds the system jumps to the first level of escalation and the alerts increase in severity. Audio messages are increased, visual signals on the Dashboard are intensified, and the vibration is advanced in intensity to alert the passenger.

In case the passenger does not respond for the next 7 to 10 seconds, then the system advances to the second layer of escalation. At this stage, it presents simple and precise voice instructions informing of the risk and what has to be done. These commands are supported by simpler and contrastive vision signals, as well as enhanced physical signals including pulsing of the steering wheel. If the situation remains unchanged for 12 to 15 seconds the system moves to the third degree of escalation. This includes excessively loud audio signals, bright Pop-up dashboard messages and messages that appear on the centre screen and default safety features to the effect that the vehicle will dangerously slow down if it is safe to do so.

Finally, if the car fails to get a response from the passenger, then the car starts an emergency process, which may take between 20 to 30 seconds. It slows down itself to a halt, turns on the hazard light and dials for an emergency. At the same time, the system actively assesses the context waiting for the level of threat to decrease or the passenger to respond adequately. The undertaking of each step may also take variable amount of time depending on the severity of risk and conditions of the drive. It is important that passengers are given a number of chances to reply, if the passenger does not respond to all those chances, then the car starts to slow down and then it calls the emergency services.