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Toyota's Engine Control Module Firmware

The engine control module (ECM), also commonly referred to as the engine control unit, is one of the most important components in all modern vehicles. [1] Its main functionality is to manage the engine's performance and the driveability functions of the vehicle. It plays a vital role in modern vehicles where almost all the important functionalities of the car are controlled by the engine control module. Issues in the engine control module. Any issues within the engine control module of a car can cause serious problems within the vehicle and can sometimes make it undrivable. A failure of the ECM of a vehicle can be a cause of a serious and fatal accident. On October 24, 2013 one such incident took place in Oklahoma, USA, where a 2005 Toyota Camry suddenly accelerated that lead to the death of one of the occupants.[2.1] On investigation of the crashed vehicle, it was found that there were major flaws in the engine control module of that car which was the main cause of the accident.

The in-depth analysis conducted by Michael Barr, CTO and co-founder of Barr Group, an embedded systems consulting firm, and his colleagues suggested that the software program embedded in the ECM of the crashed Toyota was incorrectly designed and had a lot of potential bugs which caused the sudden acceleration of the car ultimately leading to an accident. [2.2] They claimed that Toyota's electronic throttle control system (ETCS) source code lacked quality. Toyota stated that the 2005 Camry's main CPU had error detecting and correcting RAM which it didn't. [2.3] The software embedded in the Camry's ECM was defective and contained a lot of bugs, including the bugs which caused unintended acceleration (UA). One of the potential bugs within the software was that two key items were not mirrored one being the RTOS critical interior data structure and the other was the target throttle angle global variable. [2.4] Barr analyzed that the unintentional RTOS task shutdown was the main source of the unintended acceleration of the vehicle. [2.5] Using the Cyclomatic Complexity metric, it was found that 67 functions within the software were untestable and throttle angle function within the software was unmaintainable. [2.6] The developers of that software violated the standard coding rules which resulted in poor quality of code. Such misbehaviors in Toyota's Electronic Throttle control system caused the unintended acceleration of the vehicle.

But, this was not just a technical issue. Bad engineering caused the lives of other people and this is clearly against the code of ethics. ACM code of ethics tells us that “We Must contribute to society and human well-being” and “We must not harm others”. [3.1] Also the IEEE code of ethics tells us “to avoid injuring others, their property, reputation, or employment by false or malicious action”. [4.1] Toyota’s ECM firmware clearly violated these codes of ethics and therefore these accidents were also a major ethical issue. The corrupted code approved by Toyota also violated other ACM code of ethics like “Strive to achieve the highest quality, effectiveness, and dignity in both the process and products of professional work.” [3.2] The software design used by Toyota was of an unreasonable quality which proved to be lethal as it caused the lives of other people. The IEEE code of ethics tells us “to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment” and also states that “we must be honest and realistic in stating claims or estimates based on available data”. [4.2] Toyota’s president “Akio Toyoda” violated these code of ethics by lying to the press in an interview saying that the rubber floor mat in the car was the actual cause of the unintended acceleration as the floor mat got stuck with the acceleration panel. [5.1] But, Toyota’s Camry accident in 2013 was not the only case, several other cases were reported that exemplified Toyota’s misconduct and their lack of interest towards public safety. What Akio Toyoda did not mention in his interview was something the engineers working in his company already knew.[5.2] The engineers knew that the software had problems still they passed it to be installed within the millions of vehicles thereby violating the IEEE code of ethics of “to improve the understanding of technology; its appropriate application, and potential consequences” And “to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others” and therefore risking people’s life. [4.3] The software was not properly tested and the engineers didn’t do their jobs which is against the ACM code of ethics “Honor contracts, agreements, and assigned responsibilities”. [3.3] All these misconducts from Toyota’s end proved their negligence towards ethics and moral responsibilities.

Engineers must strive to implement all possible best practices, and use all the tools at their disposal, to create code that is failure-resistant by design. These ethical and technical misconducts could have been avoided if Toyota would have been a little more concerned about their product before launching it in the market. The engineers could have been a little less overconfident and they could have tested the codes properly. They could have hired a good quality assurance engineer which would have increased the possibility of a good quality product. They could have followed the codes of programming while developing the software thereby building a better product with less serious bugs. Also for a company to maintain its reputation, it must be honest with its customers. The president of Toyota could have accepted their mistakes and could have assured their customers that some necessary actions would be taken and such failures won't occur in the future. This would have some

consequences but it would be the ethically correct thing to do.If only Toyota adopted these possible alternatives those accidents could have been avoided and people wouldn't have died.

Kerry Stokes, most widely known as the chairman of the Seven Network, one of the largest broadcast repeating corporations in Australia, said "Ethics or simple honesty is the building blocks upon which our whole society is based, and business is a part of our society, and it's integral to the practice of being able to conduct business, that you have a set of honest standards". [6] Toyota could have also followed these code of ethics and by doing so, they could have possibly avoided those accidents from taking place and saved people's life. Technology is good but it must go hand-in-hand with ethics especially if the technology is involved in safety-critical development.

CITATIONS

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