**AT-PIC**

**Automated Testing of Integrated Photonics Chips**

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**Project Summary:**

Silicon photonics is a rapidly growing field in the world of microelectronics, especially in computing power. A main bottleneck in computing power is the limited bandwidth of the interconnects between various subsystems in a microprocessor. Silicon photonics inherently has a larger bandwidth due to its use of photons rather than electrons. In our project, we want to create a fully automated silicon photonics testing station that will allow for the testing of various issues within photonic circuits, i.e., thermal cross-talk, accuracy of bits, power dissipation, etc. The testing bench uses a 90-mm camera and servo motors to achieve optical fiber connections in 3D space. It also has a vacuum to hold the chip in place. The most extensive part of this project will be the coding that will run this machine. There does need to be a user interface that will allow one person to command the testing station fully and set various attributes for the specific test. All of the parts used in the project have been purchased and received by the ECSyD lab run by Professor Mahdi Nikdast.

**Why is it important?**

This project will provide the ECSyD lab with new hardware and software directly tailored to their needs, allowing the testing of silicon photonic chips to be done automatically. This is important because silicon photonics is a rapidly growing field with many use cases in telecommunications, optical computing, neural networks, etc. Silicon photonics could also lower the power use of various circuits, as general photonic circuits use less power than their traditional silicon counterparts.

Part One - Volkswagen's Emissions Scandal:

The Volkswagen Emission Scandal first set off in September 2015 when the United States Environmental Protection Agency (EPA) issued a notice that Volkswagen violated the Clean Air Act. It was alleged that Volkswagen had knowingly installed software in their 2.0 Liter diesel cars, which would allow them to deceive the EPA’s emission tests. Later that same year, it was alleged that this was not only in 2.0-liter cars but also in 3.0-liter cars. In total, this device was found to be placed in approximately 590,000 vehicles, with 16 different models from 2009-2016 (In-text Citation). This number also doesn’t include the other 8 million cars worldwide that Volkswagen was forced to recall in other countries. This raises the question, what is the critical ethical dilemma? In this case, it can be presumed that because Volkswagen purposefully tried to circumvent the emission standards, the critical ethical dilemma is hurting the environment to turn profits.

This gives way to the motivations of the various characters involved. To start, the CEO and upper management of Volkswagen were looking for a way to create diesel vehicles with higher gas mileage to compete in the market. Consumers, especially when it comes to diesel vehicles, generally buy because of the lower fuel price when compared to more traditional gasoline vehicles. That said, diesel vehicles are typically more expensive than gasoline vehicles. This gives way to the idea that consumers who are already choosing a diesel vehicle for its less expensive fueling cost will also consider the gas mileage of the car to make up the difference. That said, the consumers are not at fault, as it was Volkswagen's choice to violate this rule. Nonetheless, due to this pressure from the higher up’s engineers and other employees at Volkswagen chose to knowingly violate this rule and create software to undermine the testing procedures so that various governments and consumers would not know that Volkswagen's emissions were higher than that of the standard set by several different governments. As for the investigators, prosecutors, and judges, they proved that Volkswagen, in fact, did violate these rules and were responsible for punishing them in such a way that it would strongly deter Volkswagen and other car manufacturers from violating these rules in the future.

This leads to the next subject: what were the ramifications for Volkswagen, and what else could have been done? Volkswagen settled with the U.S. for $14.7 billion; included in the settlement was that Volkswagen would agree to buy back any U.S. consumer cars, and if the consumer did not want to sell back their car, they would be compensated and given a free modification so that the vehicle emissions fell within the U.S. standards. This was also needed for Volkswagen to get approval to make modifications in their future car models. At the same time, these actions have worked as Volkswagen is now considered a leader in lowering emissions, largely due to public pressure. The buyback program only allowed consumers deceived to sell back their car at market-price based on mileage, age, and trim. We argue that Volkswagen should have been forced to buy the vehicles back at the original cost to the owners, as when they purchased the vehicles, they were under the impression that they met all U.S. standards.

Part Two - Automated Photonic Testing Station

The prospect of ethical concerns for designing and implementing an automated photonic testing station could be more obscure. As discussed in the summarization section, silicon photonics use less power than their electronic counterparts, which means that silicon photonics is better for the environment than the alternative. This being said, silicon photonics still uses silicon and other rare earth materials, which are often extracted with unethical means such as pollution, underpaid workers, lack of safety equipment, and in the worst cases, even forced labor. This rare earth material is used not only in the chips being tested but also by the testing equipment itself. This raises the question of whether the world will use these materials for electronic devices, regardless of the means by which these materials are sourced. Is it unethical to design devices that use these materials? It is not as often the designers and manufacturers have little to no control over how the materials are sourced. The blame should be put on the mining corporations and governments that oversee them.

Another ethical concern of the automated photonic testing station might be automation, as this could theoretically limit the number of workers needed to conduct these tests. While this concern is generally pointed at the idea that by systems becoming more automated, there will be fewer job opportunities in those fields, it has been proven over history that other jobs replace the ones lost, such as technicians to maintain the testing station, or data scientist to help interpret the data from the station. Without automation, the hundreds of thousands of devices placed on a chip would be infeasible for this task to be done without an automated system.

As for existing standards that the team has had to comply with while implementing the test station, communication standards such as RS-232 and RS-485 have been considered for the project. These two communication standards were handled primarily using third-party devices that used these ports and adhered to the standards. These were some of the ethical standards focused on the group to ensure that this project follows engineering ethics.