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Terminator-style robots? Artificial Intelligence (AI) overtaking humans? These are some concerns many people have when thinking of AI. However, the reality is the exact opposite, and AI has many benefits, particularly in autonomous systems. In fact, when thinking of autonomous systems, the first thing that comes to mind is NASA's rovers on Mars. Most recently, the Perseverance rover, along with its autonomous helicopter, Ingenuity, captivated the world's attention after its successful landing on Mars last February. Back home on Earth, news about autonomous vehicles, such as Google's self-driving cars and Tesla's automated driving system, constantly create headlines. However, unlike Mars rovers and self-driving cars, autonomous ships and submarines are often overlooked. From the Navy and Marine Corps, Aamir Qaiyumi's video on autonomy for unmanned systems captured my mind. I not only learned that autonomous systems have become increasingly useful, and will be even more important in the future, but I also gained critical insight into how Aamir and his colleagues have done incredible research, particularly on autonomous ships and submarines, which has benefited the world.

Like Aamir, I was a fan of space exploration when I was younger. The possibilities of space are endless. However, while our eyes seem to be fixed on the unknown in outer space, we often ignore the oceans on our own world. In fact, I was shocked when I first learned that 80% of our oceans have not been explored. The main reason that most of our own oceans are not explored is because it is difficult, dangerous, and expensive to send people into the ocean. As you delve deeper into the ocean, the pressure increases rapidly, and to counter this, expensive equipment must be made to withstand the immense ocean pressure. With these problems, the question arises: how can we make it less dangerous and easier to explore the depths of the ocean? After watching Aamir's video, the answer seems clear: autonomous maritime systems.

In his video, Aamir and his team in the Navy and Marine Corps briefly demonstrated his work on unmanned boats and submarines and the great benefits to the world. One large benefit is removing undersea mines safely. Over half a million sea mines were deployed in World War II, and many of these mines are still waiting to be set off. Because of how dangerous these mines are, it is difficult to safely remove them without putting human lives in serious danger. That is exactly where autonomous robots can provide significant benefits, as they don't require human involvement. Specifically, people can program unmanned underwater vehicles that can be trained to safely remove or detonate these mines, and no one will ever need to be close to the mine throughout the process.

In addition, unmanned boats and submarines can and have helped ocean exploration extensively. I was inspired by Aamir Qaiyumi's vision of sending a completely autonomous vehicle to the deepest parts of the Earth. While it sounds like science fiction, it is becoming a reality. Unlike humans, who are unfit for deep ocean conditions, robots can withstand extremely harsh environments. One particular area of ocean exploration that I believe might be helpful is mapping the seafloor. When going to places we are unfamiliar with, such as a tourist vacation, we use maps. In fact, mapping technology has become so advanced that we are able to view 3D models of cities. But, this is much more difficult with ocean floor maps. Through autonomous underwater vehicles, we can create ocean models to help in ship navigation, submarine explorations, analysis of shipwrecks, and discoveries of lost flights.

And not to mention, all these benefits are made the most of with the endurance and durability of autonomous underwater vehicles. Unlike humans, who require crucial needs like food, water, and rest, robots only need periodic maintenance checkups and can recharge from batteries.

It is truly stunning how many benefits autonomous underwater vehicles can provide. But, the benefits don't stop at the ocean. Because autonomy is a constantly changing field, this same technology can be applied in areas like space rovers, self-driving cars, robotic dogs, and even synthetic limbs. Motivated by Aamir Qaiyumi's video, I did a lot of thinking and research on what the future for autonomous systems might look like, and what I can do now, as a high school student. I believe that the advancements in machine learning will heavily impact the future of autonomous systems.

Autonomy of unmanned systems has come a long way. And while these systems use many technologies to help them make decisions, like using sensors to survey the surroundings and evaluate different situations, it can be argued that these systems don't really have the ability to make their own decisions yet because most of them make decisions that are pre-programmed. I believe that the future of autonomous systems is in intelligent robots that can make decisions on their own using AI and Machine Learning (ML). Realizing this, I have started to see what I can do now to help make future robots more intelligent.

As a high schooler, I have already taken courses in AI/ML. While these technologies might not be able to make these unmanned vehicles as intelligent as humans yet, it is already a critical aspect of autonomous robots, and will be even more so in the future. For example, one of the crucial aspects of autonomous vehicles is vision, the ability of automatic object recognition in real time. ML plays a big role in the vision of self-driving cars, guiding them to maneuver based on the feed from the environment and objects. Similarly, autonomous underwater vehicles need to evaluate their surroundings constantly and act accordingly, but they face the unique challenge of vision underwater, where light is refracted and reflected. Because of this, ML can help underwater vehicles adapt to lower quality images. And additionally, underwater vehicles rely heavily on acoustic based sensors to "see" objects due to the lack of light; however, sound in the ocean is very complicated – it is affected by factors such as temperature, salinity, and even other sound waves – which make traditional acoustic methods computationally expensive and slow. Just like computer vision, ML deep learning models, such as neural networks, can also be trained to quickly and accurately model sound in the ocean to help underwater vehicles. These benefits clearly show the impact that ML has on all autonomous vehicles, and they serve as a pathway for more intelligent robots in the future.

After watching Aamir's video and researching this field further, I am excited and motivated to work on autonomous systems and related research. It would be a dream to work on such exciting areas in the Navy and Marine Corps, which own world class research labs and perform state-of-the-art research in

those fields. Currently, both unmanned systems and machine learning are fast changing and developing STEM areas. While not perfect now, in the future, unmanned systems will likely evolve to operate in isolated environments and make decisions on their own. Although people may debate whether autonomous systems can make ethical decisions, it is clear that the benefits of autonomous vehicles are endless. With careful design, this technology can provide the world with a better tomorrow.