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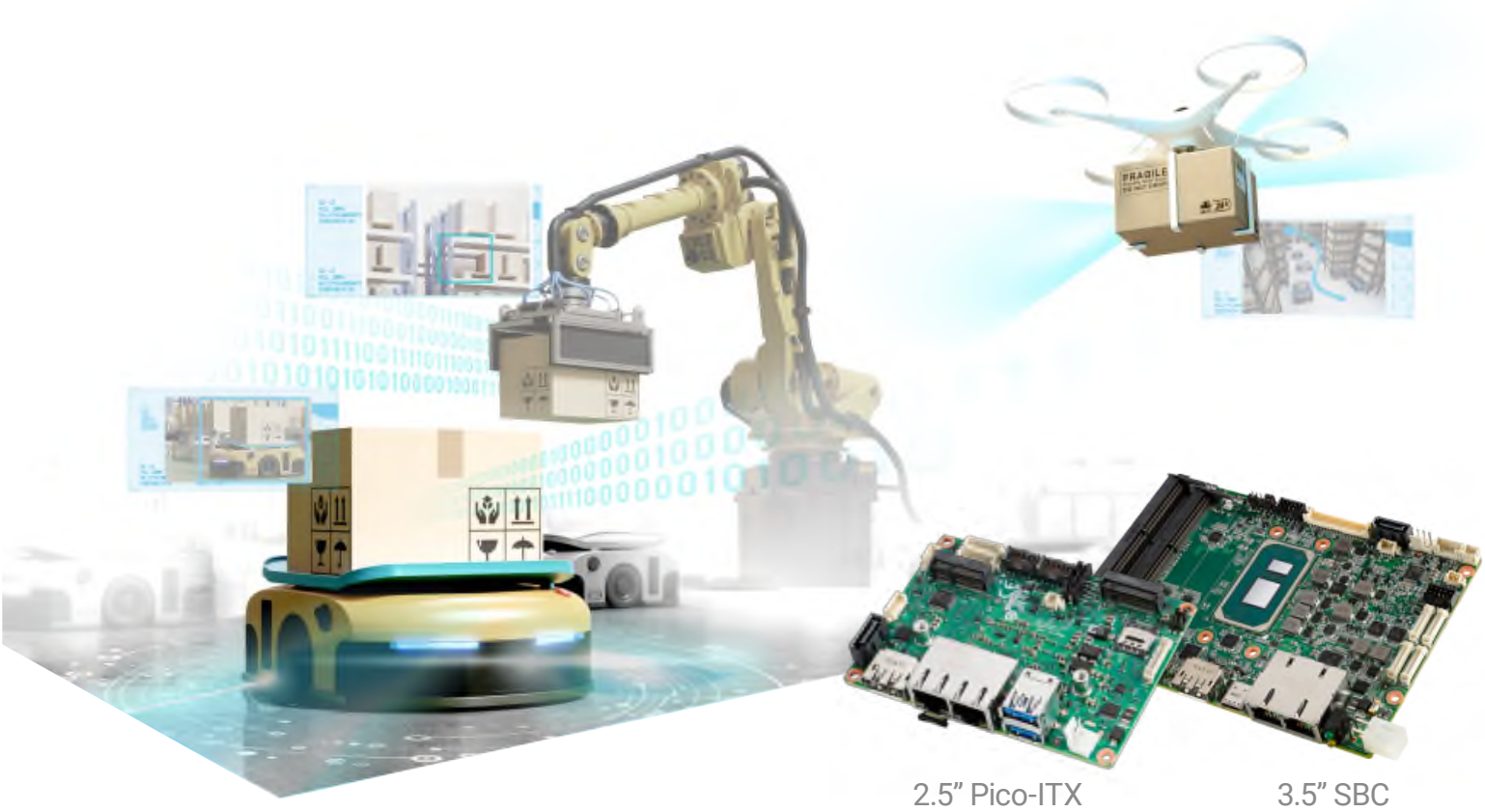

Enabling Smart Robotics with Single-Board Computing

By Advantech

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Introduction

Nearly 100 years have passed since the word "robot" was used for the first time in a play called R.U.R., short for Rossum's Universal Robots. R.U.R. was about mechanical men that are built to work on factory assembly lines. Tired of poor treatment at the hands of humans, they eventually revolt. Countless Hollywood movies have adapted this same script, portraying evil robots and artificial beings.

Yet modern-day robots are vastly different from Hollywood portrayals. They play instrumental and increasingly important roles in improving the productivity and efficiency of both organizations and individuals. Both organizational and individual needs are constantly evolving. This creates significant obstacles for robotics manufacturers to continue to innovate and ensure that modern technologies are capable of serving more and more functions.

Robots are no longer just the workhouses of factory floors. Rather, their roles have expanded to those of personal assistants, autonomous vehicles, delivery vehicles, drones, and pocket-sized electronics. They play an integral role in organizations' pursuit of digital transformation initiatives, which have only accelerated following the COVID-19 outbreak.

As McKinsey noted in a recent report, "the COVID-19 crisis has brought about years of change in the way companies in all sectors and regions do business."

In this whitepaper, we will explore the booming robotics market in more detail. In addition to the general robotics market, we will look at industry-specific trends and use cases. We will then discuss some key robotics manufacturing challenges and conclude with a look at single board computers and how they can be used to overcome these obstacles.

The robotics market is growing rapidly largely because of the widespread need and demand for automation technologies. Automation allows both organizations and individuals to eliminate time-consuming manual tasks. For businesses, this means boosting employee productivity while reducing costs and increasing compliance. For individuals, robotics allows them to automate mundane household chores like vacuuming so that they can also be more productive and find greater satisfaction in doing the things that they enjoy.

The Booming and Evolving Robotics Market

As a whole, the global robotics technology market size was valued at some $62.75 billion in 2019. The market is projected to grow to an astounding $189.36 billion by 2027. Many factors are contributing to the widespread adoption of robotics. These include:

Technological innovations have made robotics more appealing and expanded their use cases

For example, according to McKinsey, industrial robots "have not only become larger and can handle heavier loads…but they also feature more axes and require fewer controllers, as in some cases, more than 30 axes can be synchronized by one controller."

Rising operational costs and increased competition

Robotics help organizations reduce their operational costs and remain competitive. For example, the same McKinsey study found that manufacturing labor costs have risen by 24% in the U.S. since 1990. By automating repetitive manual tasks, organizations empower their workers to get more done with less.

Advancements in integration

A high level of integration between technologies is required for automation solutions to run efficiently. Advancements in computing power, software, and networking technologies have made assembling, installing, and maintaining robotics technology easier and more scalable than ever before.

Lower costs

There is a high demand for affordable and efficient robotics technologies. Lower production costs and technological innovations have led to significant decreases in prices. For instance, the cost of robot work cells has decreased by 5 to 10% per year over the past decade while the speed and throughput has increased significantly.

Another important factor fueling the rapid growth of the global robotics market is that the technologies intersect with nearly every major industry. For example, consider the following industry-specific statistics:

The global autonomous car market is projected to grow to $3,195 billion in 2030.

According to a McKinsey report, China will be the world's largest market for autonomous vehicles, accounting for as much as 66% of passenger traveled kilometers in 2040.

As of January 2021, there were 1,782,479 drones registered in the U.S. with sales exceeding $1.25 billion in 2020. For industries such as agriculture, drones play a key role in eliminating labor-intensive processes such as harvesting, weed control, picking, sorting, seeding, and packing. The agricultural drones market is expected to reach $6.2 billion in 2024.

According to an International Federation of Robotics report, unit sales of household robots are expected to increase by 46% on average per year, with more than 55 million units being sold in 2022.

Global spending on military robotics will reach an estimated $16.5 billion in 2025.

Collaborative robots, those designed to work alongside humans, will constitute 34% of all robot sales by 2025 and have a market size that will exceed $24 billion by 2030. Amazon reportedly saves as much as $22 million with cobots for each new warehouse that they open.

Due to COVID-19, the life science and pharmaceutical industry had to transform its operations to accommodate social distancing and the need for rapid treatment and test results. As a result, the industry experienced a 70% year-on-year growth.

To fully appreciate these industry-specific robotics market trends, it is useful to explore several use cases in more detail.

A Closer Look at the Emerging Robotics Market

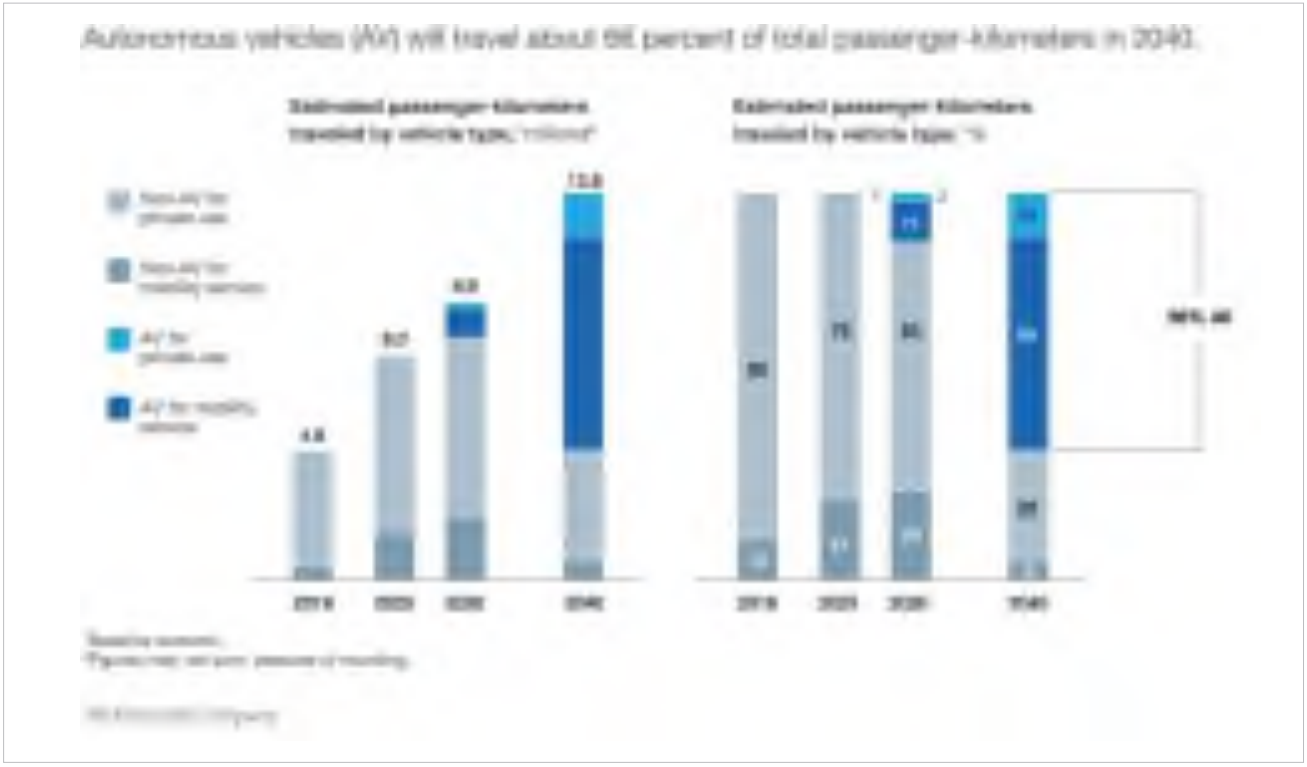
Autonomous Vehicles

Autonomous vehicles (AV) are vehicles in which some aspect of vehicle control is automated. AV technologies are not entirely new. Many modern vehicles already include some level of automation such as adaptive cruise control or parking assistance. The National Highway Traffic Safety Administration's (NHTSA) five-part classification system for AV technologies classify the automation of a single vehicle function as Level 1. The highest level of automation, Level 4, means that a car can drive itself without a human driver.

AV technologies receive a lot of attention since they have the potential to improve the environment, improve mobility and quality of life, and increase safety.

According to the National Highway Safety Administration (NHTSA), the estimated total economic cost of crashes in the United States is approximately $242 billion or $784 for each of the 300 plus million people living in the U.S. These costs include medical expenses, lost productivity, legal fees, insurance administration costs, property damages, and emergency service costs.

The NHTSA also reports that 36,096 people died in vehicle traffic crashes in 2019. Over 90% of those fatal accidents were due to human error, such as speeding or not paying attention to surroundings. And despite people driving less during the pandemic, the NHTSA



found that the fatalities per 100 million vehicle miles traveled increased significantly during the second quarter of 2020. The NHTSA deputy administrator, James Owens, attributed the increase to drivers engaging in more reckless behaviors such as driving under the influence or not wearing seatbelts.

The widespread adoption of AV technology will significantly improve safety by reducing costly human errors. Moreover, autonomous vehicles will cut down on congestion, cutting back on the 111 hours of annual per-driver hours wasted in traffic congestion while helping to improve the environment.

Image Source: FedEx | Delivery robot Roxo tested in Kyoto, Japan

Inventory and Order Fulfillment

We already mentioned how human error contributes to car accidents. But human error is also a factor in other settings, particularly when manual tasks requiring precision are involved. For instance, human error is the most frequent cause of inventory and fulfillment issues. According to a survey of nearly 200 small and medium-sized businesses, 62% of respondents reported that human error from manual process management was the "#1 root cause of inventory fulfillment issues."

Robotic order fulfillment not only reduces these costly errors but yields many other benefits. One benefit is a drastic reduction of travel time through a facility. The less time that human operators spend moving from one end of the facility to another allows them to be more productive. They also help to eliminate physically demanding manual tasks such as transporting heavy loads or retrieving products from high shelves.

Collaborative robots are also easy to implement. They typically require no infrastructural changes to a facility and are easy to transfer between facilities. And like any automation technology, cobots provide flexibility and help organizations to meet staffing challenges by improving productivity and scaling up or down as needed.

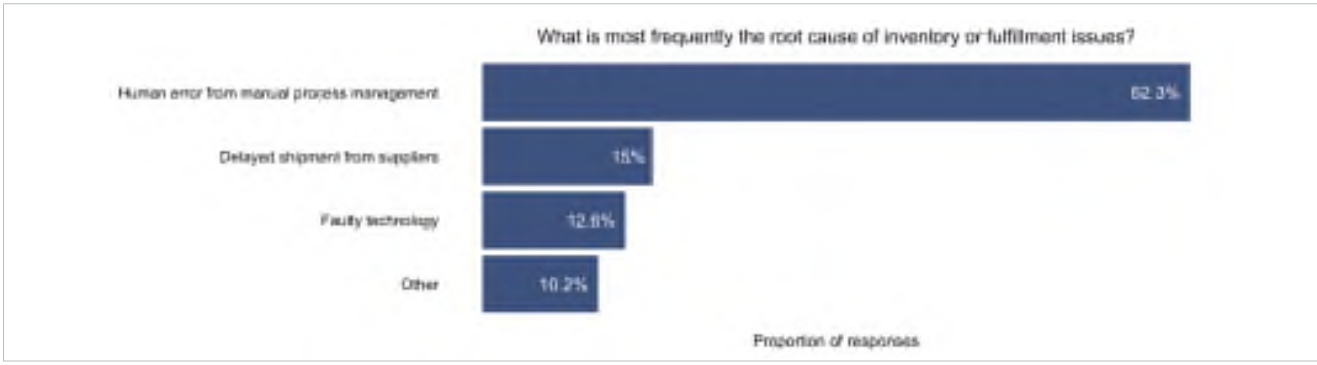


Image source: Advantech | AMR, service drone, and multi-axis robotics arm accelerating the intelligent manufacturing field

Household Robots

One reason that household robotics receive a lot of attention is that they are new and exciting. But another important factor is their widespread use cases. For example, in the past few years we have witnessed widespread user adoption of the following domestic robot technologies:

Robotic vacuums and floor-washing robots

These robots use sensors to navigate floors and clean with both sweeping and mopping functions.

Image Source: Pexel

Ironing robots

Ironing robots such as the Laundroid, use image analysis and artificial intelligence (AI) to fold and organize clothes.

Cat litter robots

Cat litter robots automatically filter out clumps into a built-in waste receptacle.

Lawnmowers

Robotic lawn mowers are programmed to memorize the correct route and mow lawns using control and steering units.

Window cleaning

Window cleaning robots contain a movement system that allows robots to navigate window surfaces in a defined direction. The robot's cleaning pad interacts with the window surface.

Social robots

Social robots will play an increasingly important role as the population ages. Variations include home-telepresence robots, network robots, and robots that can provide therapy.

Key Challenges in Robotics

The robotics industry is growing rapidly, and it is easy to see the potential. But that is not to say that the industry is without challenges. Rather, manufacturers must overcome numerous hurdles. The following are some of the key challenges that the industry must overcome.

Manufacturing Procedures

Many robotics solutions continue to rely on antiquated technologies. For example, large industrial and commercial robots are often still made from gears, motors, and actuators. While these parts are crucial for helping the robot to move and perform functions, they also result in rigidity and instability. And a large number of moving parts means that they are prone to breaking down.

One way that manufacturers can overcome this challenge is by building robots that are flexible and have fewer moving parts. For instance, soft robotics is an exciting field that may be able to overcome these limitations. These robots use systems that are built from materials with mechanical properties that are similar to those of living tissues. This often involves mimicking the behavior of biological muscles using pressurized fluid or air to contract or expand.

Human and Robot Collaboration

We are well into Industry 4.0. Innovative digital technologies offer an unprecedented level of connectivity. The Fifth Industrial Revolution will involve a higher level of collaboration between these technologies and humans. We have mentioned the increased adoption and benefits of cobots. Yet designing the perfect cobot can be a huge challenge.

The ideal cobot can understand human language, emotions, and behavior. Creating fully functional cobots that can understand human workers requires additional advancements in Natural Language Understanding (NLU), Natural Language Processing (NLP), Natural-Language Generation (NLG, and other behavior recognition technologies.

Environmental Limitations

Robots continue to be limited by their environments. Even a small deviation can require robots to re-learn to adapt to a new environment. This can lead to significant delays and bottlenecks in workflows. Manufacturers are turning to machine learning (ML) and computer vision technologies to overcome environmental mapping challenges.

But real-life situations are unpredictable. Even the most highly trained and adaptable of robots can encounter scenarios that they are not prepared for. For instance, while incredibly safe, there have been accidents involving AVs. The cause of the accident is typically human error by the

driver of the other vehicle but there are also cases where AVs failed to detect and respond to obstacles.

Multi-Functional Robots

Robots are incredibly efficient at performing a single task but typically cannot perform multiple functions with the same level of efficiency. To streamline operations and reduce costs, organizations will increasingly require robots that can carry out multiple tasks. This will require manufacturers to build robots with advanced levels of AI and ML as well as hardware capable of performing multiple tasks.

Creating More Reliable Power Sources

Many modern robots are not efficient when it comes to power consumption. These robots typically rely on older power generation and storage technologies. Batteries are unsafe and have short lives. Overcoming power source limitations will require manufacturers to develop energy sources that can safely power robots for long periods while also consuming less power.

Communicating in a "Robot Swarm"

Swarm robotics involves the coordination of multiple robots in an environment. Robots need to both sense the environment and communicate with other robots in the swarm. Creating autonomous robots that function in unstructured environments requires perception-action loops.

Communication ability must be embedded in this feedback loop. But manufacturers lack systematic approaches for achieving this across large groups. They require affordable and more efficient sensors, processors, storage devices, and hardware to overcome these limitations.

A single board computer (SBC) is a complete computer built on a single circuit board. SBCs include microprocessor(s), chipset(s), memory, input/output, power input built on the board, and other features included within a standard functional computer. There are two main categories of SBCs. The first is open-source SBCs, which give users access to the hardware design and layout as well as the source code. This allows users to customize the SBC to meet their unique requirements. The second category is proprietary SBCs. They are typically designed for and integrated into end-product designs.

SBCs offer robotics manufacturers many benefits.

Low Power

SBCs are highly efficient and offer longer operating times when running on a battery. This makes them ideal for many products ranging from household electronics to industrial manufacturing devices.

How Manufacturers are Overcoming Challenges with Single Board Computers

More Reliable Performance

The simplistic and unchangeable structure of an SBC results in fewer conflicts and performance issues can that contribute to downtime. They are also self-contained and more vibration resilient, making them an ideal choice for harsh environmental conditions.

Their superior performance is why SBCs are utilized for technologies requiring a high level of reliability, such as traffic light controllers and anti-lock braking systems.

Small and Flexible

SBCs are small. This allows them to be embedded in devices with limited space. With more and more consumers demanding smaller electronics, SBCs are an ideal and scalable solution. For example, consider a scenario where weight and size are of extreme importance, such as a drone. Lower power usage also allows for a lower thermal solution which contributes to a smaller overall solution size.

Easily Add a “Brain” to a System

SBCs simplify the process of adding a brain to a system. This allows manufacturers to focus on how a robot will perform its tasks. Specialized robots are often made in low qualities. Creating a new board for each iteration is often not cost-effective. With an SBC, manufacturers can use the same computer across multiple designs and can upgrade the brain of the system to accommodate more powerful hardware.

Cost Savings

SBCs are likely to be more cost-effective due to a smaller feature set that applies to a broad range of applications. The increased demand for SBCs has led to spikes in production. The increased supply has contributed to lower prices.

Easier Implementation

SBCs allow you to develop code directly on the board. This is due to the microprocessor, memory, built-in peripherals, and operating system being built on a single board.

Use an SBC as a Controller

Using a SBC allows you to eliminate the expense of designing, prototyping, testing, and producing an embedded controller. SBCs also have the added benefit of containing the required power regulation circuitry.

Image Source: Adobe Stock

Looking Ahead

The robotics industry is growing rapidly and constantly evolving. This is due to the natural progression of technology, changing consumer needs, and previously unimaginable external factors like a global health pandemic. Both organizations and individuals are turning to robotics to increase their productivity and make life easier.

Innovative technologies such as autonomous vehicles, collaborative and household robots, and delivery drones will fundamentally change the society in which we live. In the process, robotics technologies have the potential to help human civilization to overcome the most significant challenges of our time – such as global warming and public health crises.

Robotics manufacturers will continue to face significant challenges. These include manufacturing limitations such as antiquated technology, environmental limitations, and improving human and robot collaboration – a key tenet of the coming Fifth Industrial Revolution.

For more information about Advantech Robotics Solutions,
call 00-800-24-26-80-81 (Europe) or 1-888-576-9668 (USA)
or Visit Us Online: www.advantach.com/contact