Industrial Robotics in Manufacturing

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Technological advancements within Industrial manufacturing have stimulated an immense amount of precision within subjected functions of expected operations. Untouched capacities have resurfaced and enriched application options within the utilization of program enhancement. Robotics have played a large part in the application of approachable control among these stimulated successes. Effortless control, integrated with customizable vision systems, have automated the 'standard way' into a work cell challenge that enables an almost instant reaction to task-worthy applications. The designed execution of automatic tasks assembled within the function of robotics, disintegrate faulty production, and increase the precision of performance.

Keywords: industrial robots, automation, technology, advances

INTRODUCTION

Reduced controls from human perception have standardized components that reduce design requirements and automate scenario reconstruction. Mundane tasks are engineered through robotic features to manage and obtain equipment maintenance for improving product quality within the precision resources developed to significantly intensify the production line timeframe. High endurance, speed, and precision assemble product inspection and testing to dispense pressured handling within a range of processing features. Dangerous tasks consistently make up the applications of various industrial robotics within a manufacturing production line.

Suitable features widely decrease the mass assembly for human interaction, diminishing dangerous outcomes for manufacture workers. The manufacturing sector has been a top contender for robotics and automation within production lines, harvesting high-end technological research for mass production of products and services. "Industrial robots automated functionality allows them to operate around the clock and on weekends—as well as with hazardous materials and in challenging environments—freeing personnel to perform other tasks," (MHI, 2020, p. 1). Processes are adapted and manipulated to perform specific capacity research and control, causing profitable productivity, and eliminating potential labor-intensive injury for employees.

The primary focus of the research within general Industrial robotics stems from the impact of sensed performance within the set of tasks in exchange for regulated contracted stimulation of repetitive job functions and the opportunity of advancement through productivity application. The intelligence behind robotic machines largely manipulates the exploration in action, interaction, and engagement research. These cooperated values among understood functions establish a dynamic predictable system that stimulates the demonstration of internal and external information commands. "The vision is that, at some point in the near future, robots will be ubiquitously among us and help us to fulfill tasks in an increasingly complex society, a society that is more and more confronted by an aging population, educational problems, disasters, diseases, etc," (Schaal, 2007, p. 115). While most action-orientated perception are achieved through human methods, the mechanical industry is stimulating growth in robotic technology to increase supply and demand functions, while emphasizing complex information collaboration.

TECHNOLOGICAL DEVELOPMENT

Automation has evolved with basic systems of manufacturing robotics, improving high-efficiency and labor productivity within operations. The significance of these inceptions has allotted for the reduction of cost among labor markets. The evolution of industrial machinery predated to Medieval times, where the simple automotive function tools utilized engineering and mathematics to build a foundation of analytical technique. "The earliest known industrial robot was completed by Griffith P. Taylor in 1937, a crane-like device powered by a single electric motor," (Boisset, 2018). The desired movement of this mechanical device facilitated a "grab rotation" that allowed human control through levers and drove an intense breakthrough for pre-programmed patterns. "Unimation was the first company to produce manufactured robots, also called programmable transfer machines, their main use was to transfer objects from one point to another, less than a dozen feet or so apart," (*Thomasnet,* 2020). Research achievement fundamentally launched improvement technology and assisted in the impossible features' humans could achieve.

Licensing among Unimation creativity advanced the systematic response to competing permits for industrial robotic inventions. "They used hydraulic actuators and were programmed in joint coordinates, i.e. the angles of the various joints were stored during a teaching phase and replayed in operation; evaluating an accuracy within 1/1,000 of an inch through conglomerate measurements," (Boisset, 2018). The potential for widening industrial robotic technology was ultimately tested within European and Asian markets.

Factory automation measured robot's responsibility as sophisticated applications were being assembled and designed. Angles of various production and appealing framework were crucial in diversifying coding motor tasks, combining the ability to control multi-coordinated principles. "For more than 20 years, roboticists have tried to add imitation learning, or learning from demonstration as it was called initially, to the repertoire of robot learning," (Schaal, 2007, p. 115). Cognitive functions are continuously analyzed in the traditional manufacturing to increase associated trends and recognize common issues subjective towards the shortage of adequate focus within mechanical design.

"As technology advanced, Victor Scheinman invented the Stanford arm, an all-electric, 6-axis articulated robot designed to permit an arm solution, widening assembly and welding," (*Thomasnet,* 2020). The sophisticated design marketed radical change within industrial production, installing electromechanically driven measurements in programmed technology. "Industrial robotics took off quite quickly in Europe, with both ABB Robotics (Swedish corporation) and KUKA Robotics (German corporation) in the 1970's," (Schaal, 2007, p. 115). Optimization of stable control within robotics research illustrated adaptive criteria for developing circuit systems within the motor command transformation.

Along with European companies developing general industrial advancements, U.S. corporations adopted controlled processors that furthered the venture of automotive mechanics. "US companies entered the industrial robotics manufacturing in the late 1970's, including large firms like General Electric and General Motors," (Schaal, 2007, p. 115). Joints and axels were compounded in the engineering of motion orientation within the robotics parallel. Maximum speed measured the robot calibration within compliance of quantified matrix. Carrying capacity speed, accuracy, and repeatability were all important criteria for method concepts in signifying robotic dimensions.

Applications of motion control limited the number of pre-taught positioning and intensified the placement of motor-ability in controlled orientations. Gear functions and free movement in connection of electric measures require high drive-in unit connections. "Compliance is the measure of amount in angle or distance that a robot axis will move when a force is applied to it," (Shea, 2017, p. 1). The collaborative thresholds within the performance accuracy of compliance control requires adaptive additions for a differentiation of techniques within multiple application variations. Challenges may be faced when parameters test safety standards and limit insufficient scanners for accurate specifications. "Because of compliance, when a robot goes to a position carrying its maximum payload, it will be at a position slightly lower than when it is carrying no payload," (Shea, 2017, p. 1).

Advances in technology have enabled industrial robotics to program motion sequences through laptop and desktop internal networks. This software installed with corresponding interface generators, specializes in robot control and system design. "Teaching a robot positions may be achieved a number of ways: positional commands, teach pendant, lead-by-the-nose, offline programming, simulation measures, and effector units," (*RTI,* 2020). From handheld controls to embedded applications, configurations of technique have enabled complex paths and routines in the development of industrial robotics.

INDUSTRIAL DEVELOPMENT

Facilitated manufacturing evolved from basic systems of formulation to modern robotic stimulation, deferring manual activity. Within the industry, teams of skilled and unskilled workers built every piece of product in order to obtain production line format. For example, within the automotive industrial manufacturing, robotics improved Ford production rates and increased the profit of assembly line effectiveness and increased the mass car production. The significant improvements in research and development optimized assembly line production and distribution systems.

Robotic technology in manufacturing has come to the forefront of markets. Greater emphasis has been placed on implementing procedures to ensure safety, as well as the maintenance of creating a wide variety of settings, manipulating current task dependency. As technology becomes more intuitive, complex tasks will become more routine and potentially increase the cost-effectiveness of industrial related functions.

Manufacturing industries surfaced when technological and socio-economic transformations forged a path throughout worldwide research and development. Many innovative creations throughout the robotics research were engineered within the Industrial Revolution. "Manufacturing industries are the chief wealth producing sectors of an economy," (*EconomyWatch,* 2010). The robotics technique enabled a generating labor force that produced materials required by strategic information systems, building an infrastructure of flourished benefits within manufacturing controls.

Emerging techniques favored the concept of ensuring important safety among contributing technologies. The economic structure of the industry profited from the mass production of products and services. Performance in electronics, mechanics, energy sufficient, and physical transformation are a few components labeled as substantial industrial construction over the re-inventions of modern-day robotic technology. These profitable parts of the manufacturing bracket instill preparation of defining subdivided assembly.

Manufacturing industries are essential for economic employment and share a huge part in labor force development, as well as important material sectors for producing goods and services. "With the current euro zone deepening, U.S. factory outputs grow, bucking global trend, UK factories sluggish, political glitches from China the manufacturing outcome on account of dependency of the above countries has ever seen to be declining," (*Market Research Reports,* 2020). Trends have generated external frequencies on capitalizing the earning profit of mass production. Considerable variations attract the focus on Industry development, subjecting the research on differentiating importance, whether it be technological advances in equipment management or computer information systems.

"Although solid growth led by developing-countries is the most likely outcome going forward, possible lingering post-crisis difficulties in high-income countries pose downside risks," (*Market Research Reports,* 2020). Due to ongoing improvements, industrial robots market further into new territories, penetrating small to large manufacturing companies, even putting emphasis on specific service functions such as everyday assistant tasks within office environments.

Key trends are emerging within these new operations, innovating program services. "The emergence of robotic technology has transformed the way businesses are carrying out their operations; Fully automated solutions are providing huge opportunities for warehouse purposes," (Mordor Intelligence, 2020).

Within the industry summary, multiple processing and design improvements have advanced the action and interaction of robotics breaking barriers of manufacturing operations. Accomplishing objectives that were once unbelievable, applied technology systems have engaged in new platforms previously dependent on traditional motor skills. Complex spectrums have extracted strategic advantages for countries willing to research technology. As our current generation expands technological knowledge, the increase rate of robotic functions within manufacture firms will significantly change the task essentials for production "end goals."

USE OF INDUSTRIAL TECHNOLOGY

The functionality of operating software among combination programs enables a distinct verification on process performance for extensive robotic activity. Equipped technology facilitates great usage within the variety technique of robots. Some references include the loading of production goods for potential transportation, diminishing the intensive work for manual labor. Performing and assembling work-in-process functions, such as placing specific features on goods created within the assembly line. Robotic systems are deployed for testing and inspection of hazardous work functions. Industrial robots are used in countless production creations, a few being aerospace dynamics, automotive creations, electronic and consumer good development, as well as, medical, produce, and hardware distribution.

Robotics construct performance tasks traditionally done by manual labor employees. "Dynamic system modeling and analysis, mathematics, physics, biology, mechanical engineering, electrical and electronic engineering, computer science and engineering, and automation (sensors, control, and actuators) technology develop disciplines in the construction of usage within the industry's technology," (*ScienceDirect,* 2020). The impact of robotic systems not only significantly competes within the market value of the company but establishes a broader area of effect when indicated among consumer knowledge.

The range of models in tool performance access powerful applications to potential variations of feasible solutions. For example, many manufacturing firms utilize robotics within welding purposes due to the ability of them producing a precise weld, while controlling power wire feed and gas flow, triggers usually incorporated with human contact issues." Applications include pick and place from conveyor line to packaging, and machine tending, where raw materials are fed by the robot into processing equipment such as with injection molding machines, CNC mills and lathes and presses," (MHI, 2020).

The utilization of these techniques, master significant sectors in experimental recognition, while enabling companies to discipline the simulation of outcome results within dynamic metric analysis. The processes formed from physically adapting products to ever-changing high-speed technology, allows the assembly of worldwide robotic articulation. New concepts will generate the awareness of software applications that resolve time extensive development and increase defined products in faster time. Intention will stem from consumer wants and solidify futuristic accomplishments if research is invested in and concepts are adapted. The configuration of intention-based control, detecting calculations of futuristic assumptions and plan for static change. "Among the methods of testing developed for maintenance and inspection purposes, non-destructive testing (NDT) techniques present the advantages of leaving the components undamaged after inspection," (*ScienceDirect,* 2020). It is imperative, as new technology changes manufacturing markets, that quality improves, and structured integrity remains at the forefront of facilitating improvements.

BENEFITS & CHALLENGES OF ROBOTIC PROGRAMMING

Robotics interact within dynamic environments that distribute principles of coordinating construction and social advancement within controlling fast-changing environments. Robotic systems are utilized within many manufacturing firms, subjecting to the notion of managing predicting positioning for competitive advantages. For example, within mechanical engineering, robotics has maintained artificial programming in design functions. "Robots have precision, accuracy, speed, and dependability. Therefore, companies are trying their best to bring robots into action," (*TopTechyTips,* 2020). In the industrial atmosphere, painting, welding, building, handling material all consist of extract functions. These features enable robots to find growing demand of production instruction, while increasing the adaptability of changing controls.

Investments and advancements within research and trials of industrial robotics adhere to prominent trends and increase the architecture of integrating improved capability among current functionalities. Apart from precision function, efficient electrical sensors have adapted new navigation techniques for gathering information to aid in the manual research. "Today's automata often rely on sensors to the extent that they can be considered as robots; designed to be simplified because they work in a customized environment which humans are not allowed to access while the robot is working," (Ben-Ari & Mondada, 1970).

Basic characteristics recognize errors and optimize opportunities for high performance intel. The speed of industrial robotics ensures the sufficient movement of operations among production. Miscellaneous tactics done by the robotic technology enable humans to work on complex steps and increase various studies on intensity performance through robotic features. "Factory assembly lines can operate without the presence of humans, in a well-defined environment where the robot has to perform tasks in a specified order, acting on objects precisely placed in front of it," (Ben-Ari & Mondada, 1970).

Manufacturing robotics have developed diverse adaptabilities which allow them to impact industrial creations. "As industrial robots become faster, smarter, and cheaper, more and more companies are beginning to integrate this technology in conjunction with their workforce," (McKewen, 2020). Higher profits are greater within the use of industrial robotics due to the production speed increase. As manufacturing speed increases, initial cost will decrease as the reduction rate of time spent correcting errors will diminish.

Robotics enhance competitive advantage through performing lower cost tasks and providing quality results as employees focus on more complex skillsets. "Robots can work in lights-out conditions and do not require climate control, thus saving on utilities. Moreover, they contribute to green manufacturing by creating cleaner workspaces," (*Sam Solutions,* 2020).

Advancements in robotics increase opportunity attracting a new consumer base, and creating new perspectives, while itemizing new career and market directions. Economic gain is expected to occur as implemented value increases through the techniques of industrial robotics.

Though many speculate that robots take jobs away, numerous jobs are created within the change of manufacturing tactics. Individuals are needed to monitor and supervise handheld devices that control robotic systems. "In the near future, people will be freed up from demanding physical labor and can maximize their skills in business and creative areas to have a chance to obtain more desirable jobs," (*Sam Solutions,* 2020).

Training and advancements enable a new set of skills for unique employment opportunities. Innovative workplaces focus more on employee engagement, rather than repetitive motion work, that slowly decrease an employee's willingness to want to be in the workplace. Consistency advances as time-sensitive tasks are completed with little to no error.

With benefits of output technology comes challenges faced within the implementation of manufacturing. Knowledgeable skillsets through manual labor could potentially create a gap due to the viable structure of consistently changing dynamics. Robotic features, as well as technology to mandate these machines are extremely cost expensive. Though many industries function through robotic simulations, concern of malfunction could cause serious safety issues and potentially increase the threat of manual labor security. Implementation of new software into factories could impact the processing boost of robotic work and diminish the benefits of current performance machines. "In industrial settings, privacy concern centers around hacking, trade secrets, and performance data," (Staff, 2019).

Programming errors can be sustained through countless insufficiencies and miscommunication. Poor environmental conditions create unsafe work environments and increase the safety hazards of manual laborers. Engineering errors disconnect programming parts by possibly including bugs, faulty information systems, subjecting to electronical errors. "Power sources are main lifelines to production manufacturing and without the necessary resolutions and tools needed to sustain industrial machinery, robotic transactions will not be complete," (Dery, 2019). This also increases the cost value within maintenance requirements for internal costs. Overall, there are countless benefits and challenges when incorporating robotic technology within an industry, but efficient preparedness stimulates proactive responses to challenges set forth.

FUTURE INNOVATION

Comprehensive knowledge regarding the future of the robotics industry in manufacturing firms is increasing every day. To remain competitive, industrial research and the implementation of robots, will create a competitive advantage for the manufacturing industry. Developing decision-making processes to diminish manual functions and increase productivity will enhance overall quality and mass production of current production value.

Replacing lower qualified employees with automated robots will maximize the manufacturing production measurements and revolutionize the potential for creativity.

"Robots will be ubiquitously among us and help us to fulfill tasks in an increasingly complex society," (Schaal, 2007, p. 115). Innovation will drive competition and expand into in-depth industrial options. Safer models will be created as research develops and enhanced products will continue to compete within the market. With the increase in customization of robotic technology, the variation of pricing among new technologies will become more diverse, enabling smaller industries to utilize these functions. Talent and job skills will shift from manual labor to installation, operating, and design techniques. "Advances in computing power, software-development techniques, and networking technologies have made assembling, installing, and maintaining robots faster and less costly than before," (Tilley, 2020).

Flexibility among commission standards and pricing will retract the cost of purchasing, enforcing a stimulated economic virtue in corporation funding. The advancing markets will stimulate proactive responses from consumers. Facilitated profitability will improve automated systems and plant framework stimulants within essential elements of technological processes. Increased security measures will invoke the identification of bugs and virus detection through high-speed functions, protecting the logistics and interface technology from exceeding problematic run-ins.

CONCLUSION

The intellectual exploration of robotic development in the manufacturing industry has enhanced the application for technology and productivity. Automation for stimulated design creation increases consumer growth, offering advancement through performance precision. Integrated controls execute internal and external functions that fundamentally improve the levels of programming. Emerging robotic technology will continue to advance the evolution for the manufacturing industry through the 21st Century.

REFERENCES

Ben-Ari, M., & Mondada, F. (1970, January 1). *Robots and Their Applications*. Retrieved from https://link.springer.com/chapter/10.1007/978-3-319-62533-1_1

Dery, M. (2019, February 7). *10 big robotics challenges that need to be solved in the next 10 years*. Retrieved from https://www.createdigital.org.au/robotics-challenges-next-10-years/

Industrial Robots. (2020). *MHI*. Retrieved from https://www.mhi.org/fundamentals/robots

Market Research Report. (2020). *Industry & Manufacturing*. Retrieved from https://www.marketresearchreports.com/industry-manufacturing

McKewen, E. (2020). *Uncovering the Benefits of Robots in Manufacturing* [Part 2 of 2]. Retrieved from https://www.cmtc.com/blog/benefits-of-robots-in-manufacturing

Robotic Technology Inc. (2020). *About Robotic Technology Inc*. Retrieved from https://www.robotictechnologyinc.com/

Robotics Market Size, Growth, Analysis: Growth, Trends, and Forecast (2020-2025). (2020). Retrieved from https://www.mordorintelligence.com/industry-reports/robotics-market

Robotics Tomorrow. (2020). *6 Disrupting Trends in Industrial Robotics Poised To Transform Manufacturing*. Retrieved from https://www.roboticstomorrow.com/article/2019/07/6-disrupting-trends-in-industrial-robotics-poised-to-transform-manufacturing/13926

Sam Solutions. (2020, March 25). *Why the Rise of Robotics in Manufacturing is Advantageous*. Retrieved from https://www.sam-solutions.com/blog/five-reasons-to-implement-robotics-in-manufacturing/.

Schaal, S. (2007, July). *The New Robotics-Towards Human-Centered Machines*. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2639844/

Shea, R.N. (2007, March 9). *Compliance for Robots in Collaborative and other Applications*. Retrieved from https://www.controldesign.com/vendornews/2017/compliance-for-robots-in-collaborative-and-other-applications/

Staff, M. (2019, April 24). *The Top Challenges Facing Robotics*. Retrieved from https://www.mistyrobotics.com/blog/the-top-challenges-facing-robotics/

Tilley, J. (2020). *Automation, robotics, and the factory of the future*. Retrieved from https://www.mckinsey.com/business-functions/operations/our-insights/automation-robotics-and-the-factory-of-the-future