IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Human Journals
Review Article
May 2021 Vol.:21, Issue:2

Robotics in the Pharmaceutical Industry

IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Sudipto Nandi[1], Sattwik Das*[2]

[1,2]Department of Pharmacology, School of Pharmacy, Techno India University, Salt Lake City, Sector–V, EM–4, Kolkata–700091, West Bengal, India

Submitted: 25 April 2021
Accepted: 02 May 2021
Published: 30 May 2021

www.ijppr.humanjournals.com

Keywords: Digitalization, Automation, Robotics, Accuracy, Pharmaceutical field

ABSTRACT

In the pharmaceutical industry, there is rapid progress due to the advancement in digitalization and automation starting from the invention to the administration of the drug. Robotics plays an important role in the world of the pharmaceutical field. Robotics plays a vital role in complicated processes like research and development, production, and packaging. The safety of workers, accuracy, speed of delivering the drugs, the quality of the products has been improved now due to the development of robots. Robotics has been present in the pharmaceutical industry for more than twenty years. In the future, they will also be used for various other applications in the pharmaceutical industry.

1. INTRODUCTION:-

Robotics is the science and branch of technology of robots, it deals with the design, construction, operation, and application of robots, as well as computer-based systems. In laboratories, pharmaceutical manufacturing robots perform a huge role beyond human capability. It also speeds up pharmaceutical manufacturing work so faster and more consistently.

A robot is a mechanical artificial agent and practically it is an electromechanical system. The Robotics Institute of America defines a robot as a Reprogrammable multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks. (1)

Certain tasks which humans cannot do but robots can perform. Mainly robots are used where potential hazards happen (2). In the pharmacy manufacturing errors must be avoided by implementing a robotics system, the cost is coming down drastically. These robots are as fast as humans [at some times faster by 4 times] and are capable of working in 3 shifts (3). In the Pharmaceutical industry, they have to follow strict rules and regulations and standards. If they commit anything wrong, then the whole event will be affected. For this purpose, the manufactures slowly started to automate their industry. One such move is bringing robots into their industry for helping them and reduces human time. Today lots of pharma manufactures are using robots for manufacturing certain drugs. There are also few benefits with the involvement of automation in pharma company such as i) reduced amount of wastage, ii) better safety, and iii) less cost.

2. ROBOTICS IN THE PHARMACEUTICAL FIELD:-

Nowadays, robotics plays an important role in the pharmaceutical field and it works smoothly. Natural partnerships are robotic and manufacturing. Today robotics plays an important role in the pharmaceutical manufacturing landscape. Here the most important thing is that the automatic process should be a key part of any manufacturing that's for maximum, efficiency, safety, and competitive advantage in the market. Pharmaceutical field robotics helped to reduce margins of error to negligible rates and enable human workers to focus on a more productive area in the manufacturing field. Today a high volume of production robots is searching for more roles in small to medium-sized menus. Robotics in the pharmaceutical

field speeding up the process of manufacturing, so in a short time, various drugs are prepared. (4)

By screening the current robotics applications at more than a dozen pharmaceutical production sites the named palletizing application is the only known off-the-shelf solution. All other robotics applications within pharmaceutical production are custom-built. This results in high effort in engineering, development, qualification, and implementation. Especially in processes that are similar in all companies, the flexibility of modern robotics can enable standard solutions that are not only rewarding for suppliers due to their number of units but are also highly attractive for the applying industry in terms of implementation effort and costs. First, the pharmaceutical industry must identify the applications and their requirements. It is just a matter of time until the application targets are published. Second, robotics companies are needed which are engaged enough to envision the selling potential of such applications and willing to deliver the most flexible, most easy to qualify, most easy to install, and therefore most competitive robotics application.

The palletizer might not be the most typical pharmaceutical application, especially because it can be applied aside from regulative requirements. Anyhow it is flexible enough to serve the different clients, is already sold in hundreds, is set up in minutes instead of weeks, and therefore a good example where "industry" can get if "industry" really wants to. (5)

2.1 Research and Development (R & D):-

Robots now also play a vital role in the development of the latest drugs. In high throughput screening (H.T.S.) for example, various compounds are tested to see which could become new drugs. There's a desire for the utilization of robotics to check these ample compounds. The use of robotics can speed this process up significantly, even as they'll the other process where a robot replaces an individual completing any repetitive task. (6)

2.2 Quality control:-

In QC, many people perform routine tasks – if QC cannot be integrated into production inline. Complex analyses are often carried out by analytical equipment, but the complete material flow and the parts necessary for sample preparation are done by humans. Due to the variety of tasks and necessary steps, traditional laboratory automation is only suitable if its

use is worthwhile due to high throughput and low sample and process variance, e.g. preparation of microtiter plates.

Examples of such applications unmatched by classical automation are:

• Sampling from containers (drums, bags, barrels, buckets, Big Bags)

• Sample preparation in the microbiological laboratory

• Separation and dosing of samples for the different analysis needs. (7)

2.3 Filling and packaging:-

Slower speed applications being used in robotics are to fill the small vial. The company also has experience with handling plastic and glass prefilled syringes in pre-process, buffering, and initial and end-of-line packaging. In addition, productivity is increased because of the accuracy and efficiency of robots, which often perform at increased speeds and produce less scrap. Automatic inspection, as part of a robotic system, has the advantage of enabling 100% part inspection. Vision-sensing technology can be used in pharmaceutical packaging to verify serialization numbers for compliance with track-and-trace regulations.

An advance in vision sensors is color imaging, which, for example, allows systems to distinguish between bottle caps of different colors, noted the report. Vision sensors have also led to advances in end-of-arm tooling design that improve the ability of robots to accurately identify and place objects. (8)

Changeover, cleaning, and preparation of material are physical activities for people working in production in the process industry. These activities are characterized by high demands on flexibility, documentation, and/or the ability to master complexity. Automation that goes beyond the previous level must be particularly flexible here. Examples of such applications are: Depalletizing and re-palletizing. (9)

2.4 Robotic Automation of HPLC Laboratories:-

High-performance liquid action (HPLC) may be a technique ordinarily used during a sort of laboratory. owing to its inherent flexibility, HPLC is suited to a wider variety of analytical separation issues than the other single analytical technique HPLC has been a serious analytical technique within the pharmaceutical trade, in clinical laboratories, and industrial

environmental laboratories. Through the utilization of interchangeable hardware associated with an endless sort of separation media, virtually any variety of chromatographic separation is feasible, though HPLC is capable of quickly separating many various substances with the resolution, it suffers from being a labour-intensive technique. (10- 12)

2.5 Production and manufacturing:-

Manufacturing is a tool of the Pharmaceutical Industry wherein the production and manufacturing of the drug product are made out of materials using machines or robots. With the development of the Automation processes in the industry, the modern contemporary automation applied could be fixed or hard automation, flexible automation, and programmable automation. The computer integrated manufacturing (CIM) and computer-aided manufacturing (CAM) systems are applied to product development and manufacturing activities. These advanced manufacturing systems include three types of manufacturing:

1. Intelligent manufacturing

2. Virtual manufacturing

3. Internet controlled manufacturing (13)

3. ADVANTAGES OF INDUSTRIAL ROBOTS

3.1. Increase Efficiency:

Industrial robots will complete sure tasks quicker and additional with efficiently than humans as they're designed and designed to perform them with higher accuracy. AI will increase potency, which implies the worth of the drug itself can become additional competitive. Once it involves pharmaceutical production, individuals don't seem to be as economical as robots, particularly after they are sporting a protecting suit. individuals in protecting suits conjointly need an additional area to figure in. (14,15)

3.2. Quality:

Given their higher levels of accuracy, industrial robots are accustomed to turning out higher quality merchandise that leads to the reduction of your time needed for internal control and ensures that standards of quality are adhered to. This level of consistency is onerous to realize the other approach.

Improved operating atmosphere Another advantage within the laboratory is that robots are mothproof to several environments that will not be safe for humans. operating conditions, therefore, are immensely improved yet because of the safety among factories and production plants by introducing industrial robots. A mechanism will operate a unit of time every day, seven days every week while not a dip inaccuracy. (16)

3.3. Savings:

Bigger employee safety ends up in money savings. The results of introducing industrial robots will solely guarantee higher profitability levels with a lower value per product by increasing the potency of your method, reducing the resource and time needed to finish it while conjointly achieving higher quality merchandise, introducing industrial robots save cash within the end of the day. There are fewer tending and insurance issues for employers. Robots conjointly supply hardworking performance that saves valuable time. Their movements are continuously actual; therefore, less material is wasted. (17)

3.4 Longer operating hours:

As human breaks within the operating day are needed, distractions happen and a spotlight spans slow. Whereas robots will work 24/7 and keep functioning at 100% potency. on average a four-hundredth increase within the output of an assembly line happens once one key person is replaced by a mechanism UN agency operates identical operating hours, just because of stamina. Also, robots don't take holidays or have surprising absences.

3.5. Liquid Handling:

Innovative liquid handling of versatile pipetting platforms brings improved potency, safety, and outturn to laboratories around the world. It includes ascendable sample storage and retrieval systems with distinctive sample tube technology, with-it detection instruments, microplate washers, and microarray merchandise.

3.6. Reliability:

The Food and Drug Administration (FDA) needs all medication to be half-tracked and derived throughout the assembly method. Industrial robots build it easier for pharmaceutical firms to suit these needs. on similar lines, robots minimize accidents and wasted material.

3.7 Speed:

Robots work with efficiency, while not wasting movement or time while not breaks or hesitation, robots square measure able to alter productivity by increasing outturn. (18)

3.8. Safety Advantage:

Robots defend the integrity of pharmaceutical merchandise and also the health of workers and patients. With industrial robots, ototoxic chemicals are often mixed safely. These specific mechanism models square measure designed to figure in white room settings. Sealed arm construction and remotion with oxide Vapor (HPV) keep these models from ever contaminating merchandise. Low payload picks and places jobs that will prove tedious for human staff square measure currently the responsibility of tireless robots. (19)

3.9. Cost & Affordability:

Paybacks for the acquisition of robotic instrumentation within the pharmaceutical trade, given the fairly high hourly labour rates paid to workers, variety of production shifts, and also the low value of capital. A typical mechanism installation, complete with accessories, safety barriers, conveyors, and labour, may value around $200,000. If that mechanism were to exchange four manual staff every earning close to $30,000 annually, the mechanism would be acquired through earnings savings alone in an exceedingly very little over a year. (20,21)

3.10. Production:

With robots, outturn speeds increase, which directly impacts production. As a result of robots having the power to figure at a continuing speed while not pausing for breaks, sleep, vacations, they need the potential to provide over an individual's employment. (22,23)

4. DISADVANTAGES: -

4.1. Dangers and fears:

Although current robots don't seem to be believed to have developed to the stage where they pose any threat or danger to society, fears and concerns about robots are repeatedly expressed during a big selection of books and films. The principal theme is that the robots' intelligence and ability to act could exceed that of humans, that they might develop a conscience and a motivation to require over or destroy humankind. (24)

4.2. Expense:

The initial investment of robots is critical, especially when business owners are limiting their purchases to new robotic equipment. the price of automation should be calculated in light of a business' greater financial budget. Regular maintenance needs can have a financial toll similarly.

4.3. Expertise:

The initial start of business robots needs loads of coaching and experience like the other form of technology, this is often as a result of their glorious for performing arts several tasks. Smart automation corporations give a support package of their experience that is an especially necessary issue. However, to minimize reliance on automation corporations, coaching is given to engineers to permit them to program the golems – tho' the help of fully-fledged automation corporations continues to be needed for the initial integration of the robot. staff would require coaching in programming and interact with the new robotic instrumentality. This commonly takes time and money output. (25)

4.4. Safety:

Robots may protect workers from some hazards, but in the meantime, their very presence can create other safety problems. These new dangers must be taken into consideration. (26)

5. SUMMARY

Robotics has emerged as a more modern and advanced field in drug companies has gained abundant nonquality within the pharma trade. Their relevance in several fields of the drug company trade is appreciated it's accepted that within the future. It would play a significant role in the event and growth of pharmaceutical sciences. Robotics has been present in the pharmaceutical industry for more than twenty years. The pharmaceutical industry is looking for automation due to high competition and to provide drugs to customers at a low-cost Robotics will play a significant role in the field of Pharmacy. Primarily they were used in only laboratories, but now they are not only used for packaging purposes but they are being used on the manufacturing side also. In the future, they will also be used for various other applications in the pharmaceutical industry.

Acknowledgments

The authors acknowledge the support and encouragement given by my guide Dr. Sattwik Das and also thankful to Dr. Beduin Mahanti, Director, School of Pharmacy, Techno India University towards this work.

REFERENCES:

1. Allendorf JD, Bessler M, Whelan RL, Postoperative immune function varies inversely with the degree of surgical trauma in a murine model, SurgEndosc, 11, 1997, 427–430.
2. Lakshmi Teja T, Keerthi P, Debarshi Datta, Niranjan Babu M, "Recent trends in the usage of robotics in pharmacy", Indian Journal of Research in Pharmacy and Biotechnology, **(2014)**, pp. 1038 – 1043
3. Gopal Nair, "Robots vs People – The Future of Pharmaceutical Engineering", **(2018)**. Available online: [https://fabtechnologies.com/robots-vs-people-the-future-ofpharmaceutical- engineering/]
4. Fuchs KH, Minimally invasive surgery, Endoscopy, 34, 2002, 154–159. Kim VB, Chapman WH, Albrecht RJ, Early experience with tele manipulative robot-assisted laparoscopic cholecystectomy using Da Vinci, Surg Laparosc Endosc Percutan Tech, 12, 2002, 34–40.
5. J. Harrison, K. Izzetoglu, H. Ayaz, B. Willems, S. Hah, U. Ahlstrom, et al., "Cognitive workload and learning assessment during the implementation of a next-generation air traffic control technology using functional near-infrared spectroscopy," IEEE Transactions on Human-Machine Systems, vol. 44, pp. 429-440, 2014
6. S. Ratschan and Z. She, "Safety verification of hybrid systems by constraint propagation based abstraction refinement," in International Workshop on Hybrid Systems: Computation and Control, 2005, pp. 573-589.
7. J. Andreu-Perez, D. R. Leff, K. Shetty, A. Darzi, and G.-Z. Yang, "Disparity in Frontal Lobe Connectivity on a Complex Bimanual Motor Task Aids in Classification of Operator Skill Level," Brain connectivity, vol. 6, pp. 375-388, 2016.
8. A. J. Gonzalez and V. Barr, "Validation and verification of intelligent systems-what are they and how are they different?," Journal of Experimental & Theoretical Artificial Intelligence, vol. 12, pp. 407-420, 2000.
9. D. Kirat, G. Vigna, and C. Kruegel, "Barecloud: bare-metal analysis-based evasive malware detection," in 23rd USENIX Security Symposium (USENIX Security 14), 2014, pp. 287- 301.
10. Ft. Schuster, W. Haecker, Application Note "Automated Precolumn Sample Preparation System", Hewlett-Packard, Waldbronn, GFR,
11. L. Zhang, M. Jiang, D. Farid, and M. A. Hossain, "Intelligent facial emotion recognition and semantic-based topic detection for a humanoid robot," Expert Systems with Applications, vol. 40, pp. 5160-5168, 2013
12. L. Zhang, M. Jiang, D. Farid, and M. A. Hossain, "Intelligent facial emotion recognition and semantic-based topic detection for a humanoid robot," Expert Systems with Applications, vol. 40, pp. 5160-5168, 2013
13. Popovic D. Automation and control in production processes, Control systems, robotics and automation. Industrial Appl Control System 2009;19:1-10.
14. Matsuoka, S.-I., Shimizu, K., Yamazaki, N., & Oki, Y. (1999). High-speed end milling of an articulated robot and its characteristics. Journal of Materials Processing Technology, 95(1–3), 83–89.
15. Zargarbashi, S. H. H., Khan, W., & Angeles, J. (2012b). Posture optimization in robot-assisted machining operations. Mechanism and Machine Theory, 51, 74–86.
16. Steven Keating, Neri Oxman, An open source multi DOF articulated robotic educational platform for autonomous object manipulation. Robotics and Computer-Integrated Manufacturing, 30(3), 3, 2014, 351-362.
17. Sarah Manzoor, Raza Ul Islam, Aayman Khalid, Abdul Samad, Jamshed Iqbal, Testbeds for ubiquitous robotics: A survey: Robotics and Autonomous Systems, 61(12), 2013, 1487-1501.
18. K. Mochizuki, S. Nishide, H. G. Okuno, and T. Ogata, "Developmental human-robot imitation learning of drawing with a neuro dynamical system," in Systems, Man, and Cybernetics (SMC), 2013 IEEE International Conference on, 2013, pp. 2336-2341

19. Weidong Zhu, Biao Mei, Guorui Yan, YinglinKe, Measurement error analysis and accuracy enhancement of 2D vision system for robotic drilling, Robotics and Computer-Integrated Manufacturing, 30(2), 2014, 160-171
20. Weidong Zhu, Biao Mei, Guorui Yan, YinglinKe Compound fabrication: A multifunctional robotic platform for digital design and fabrication.Robotics and Computer-Integrated Manufacturing, 29(6), 439- 448.
21. M. T. Chan, R. Gorbet, P. Beesley, and D. Kulic, "CuriosityBased Learning Algorithm for Distributed Interactive Sculptural Systems," in Intelligent Robots and Systems (IROS), 2015 IEEE/RSJ International Conference on, 2015, pp. 3435-3441
22. Gebbers, R., &Adamchuk, V. I. (2010). Precision agriculture and food security. Science, 327(5967), 828-831. PMid:20150492. http://dx.doi. org/10.1126/science.1183899.
23. R. Fergus, P. Perona, and A. Zisserman, "Object class recognition by unsupervised scale-invariant learning," 2003 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, pp. 264-271, 2003.
24. T. Leung and J. Malik, "Representing and recognizing the visual appearance of materials using three-dimensional textons," International Journal of Computer Vision, vol. 43, pp. 29-44, 2001\
25. Lachman, L., Lieberman, H.A. and Kanig, J.L., In; The Theory and Practice of Pharmacy, 3rd edition, Varghese Publishing House, Bombay, 1991,660.
26. M. Colombo, "Why build a virtual brain? Large-scale neural simulations as jump start for cognitive computing," Journal of Experimental and Theoretical Artificial Intelligence, vol. 29, pp. 361-370, 2017.

	***Author Name –*** Sudipto Nandi *Student,B.Pharm 4th Year* *School of Pharmacy,Tehno India University,* Salt Lake City, Sector–V, EM–4, Kolkata–700091, West Bengal, India
	***Author Name-Dr.Sattwik Das*** *Associate Professor* *School of Pharmacy,Tehno India University,* Salt Lake City, Sector–V, EM–4, Kolkata–700091, West Bengal, India