AIIoT based Autonomous Guided Vehicles for agile and lean manufacturing

Technology synopsis

Advancement in technologies to increase productivity thereby to achieve agile and lean manufacturing lead to frugal innovation in the automation. Today's industry makes rapid, and paradigm shift in manufacturing operations due to digital transformation of agile and smart technologies especially the autonomous systems like guided vehicles. Automation is fundamentally changing the way due to smart working operations. The industry requires smart workflows to matrix with smart production systems thereby making the process simpler and safer. The advent and addition of internet technologies such as Internet of Things (IoT) to form a manufacturing framework thereby achieve optimized automation systems, the manufacturing cycle can be made more robust, seamless, less dependency on human intervention, and enabling the systems to perform autonomous self-decision-making through artificial intelligence and machine learning. The integration of internet of things to human-machine interface pave the way to achieve less ROI (Return of Investment).

Industry needs dedicated autonomous systems basically to address the following challenges

- Optimized flow of logistics and supply chain
- Enhanced safety at industry location
- Minimize the painful tasks
- Utilized the resources intelligently
- Reducing carbon footprints

The industry is lookout for implementing disruptive technologies such as intelligence-based system with devices work on internet such as merging of artificial intelligence and Internet of Things so called AIIoT.

The outcomes of the technologies lead to the development of AIIoT based smart Autonomous Guided Vehicles named AIIoT-AGVs and AIIoT-Autonomous Mobile Robots (AMRs).

Smart operations

The present industrial setup requires devices and technology that can work based on smart technology forecasting and assessment. The concept of "Just in Time" makes complex things in a simpler fashion to achieve optimized inventory of works in progress and parts, and other goods before the assembly line in shop floor. Hence AIIoT based AMRs capitalize the potential of machine learning and Man-Machine interface (IoTs) to locate and move the goods to load and unload in the shortest time which can be achieved through intelligence algorithms such as SLAM (Simultaneous Localization and Mapping). The SLAM AI based navigation system enables safety and anti-collision with any object or human around in the factory environment.

The devices and technology such as AGVs and AMRs can be integrated with the Visual Positioning Systems (VPS) and laser positioning systems as well to achieve intelligent operations in manufacturing. The advancement in the disruptive innovations like 5G, ChatGPT (OpenAI) may also be utilized for the smooth operations of AIIoT-AGVS and AMRs.

The guidance or motion control of AGVs are achieved through Radio Frequency Technologies such as RFID.

AGVs and AMRs are intelligent devices which can use onboard semiconductor chips and OpenAI tools to perform path planning. AGVs and AMRs are capable to operate and function in dynamic manufacturing environments through intelligence decision making tools. The outcomes of the smart operations are optimizing the 05 Ms (Man, Material, Machine, Money and Methodology). AGVS and AMRs are capable of reconfiguring and reorienting the manufacturing process through AI and IoTs.

The key characteristics of intelligent reconfigurable manufacturing systems are:

- Convertibility
- Customization
- Diagnosability
- Reducibility
- Neutrality utilization
- Interconnectivity

In addition to the above the AIIoTs-AGVs and AMRs may be controlled centrally through intelligent systems controlled through various wireless technologies such as LoRaWAN, Light Fidelity (LiFi Technology). Moreover AGVs and AMRs can be controlled virtually through virtual software tools as well to ensure safe movements in the factory environment.

The above technological features lead to addressing the manufacturing systems in a qualitative manner and also help to optimize the inventory managements as well.

Case study of AGVs

Bhabha Atomic Research Centre (BARC) has designed, developed, and tested an Automated Guided Vehicle-based material transfer ecosystems for moving, the manufacturing goods from one location to another in the factory environment. It has developed a cost-effective system that is $1/6^{th}$ of the cost of the imported AGVs. The BARC has developed this system for the Bajaj Auto manufacturing plant.

ABOUT THE AUTHOR

Dr. T.Senthil Siva Subramanian

Head Institute Industry Interface Program,
Hindustan College of Science & Technology, Mathura

Dr. Senthil is an academic veteran, vivid researcher, industry 4.0 specialist and green energy expert (Hydrogen). He hold M.Sc. degree from Dayalbagh University, M.Tech and Doctoral Research from Indian Institute of Technology, IIT Delhi. He presently serves at Sharda Group of Institution as Head Institute Industry Interface having a professional experience of 22 years.

He has been awarded International Project on Research on manufacturing transformation of Industry 4.0 by Asian Productivity Organization, Japan as an International expert. He carried out case studies on implementation of cobots in Indian MSMEs. Dr Senthil has signed Memorandum of Understanding (MoU) with Foundation for Innovation and Technology Transfer, FITT, IIT Delhi for the technology transfer of his innovations. He is the lead inventor of multi-functional Smart hand tool and hydrogen fuelled e-bike which has been granted Industrial design patent. He has successfully transferred his technology on hydrogen fuelled e-bike to M/s Comuti Energy Ltd. Telangana.

Disclaimer: The information contained in the article represents the views and opinions belong solely to the author, and not necessarily to the author's employer, organization, committee or other group or individual.