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Automation in future prefabricated construction industry

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Robotic industrial applications are very well established in the manufacturing industry, while there is a very limited influence on the construction sector. A number of benefits are anticipated from these automated systems, including improved construction productivity, to eliminate the dependence on labor, and improved safety and quality. The impact of this integrated automation approach is expected to be significant due to its high level of management between resources and processes, and well defined environment for information transfer. As a follow-up to this effort, several research issues need to be considered, including the design of materials handling systems which will maintain the efficiency of the automated building construction approach. In Japan, the success of the automobile industry's automated assembly plants, combined with the construction industry's worker shortage, has helped encourage the development of Japan's automated and robotic construction operations. Although the trend toward automation itself has produced some gains in productivity, the primary goal is to do a specific task with fewer people in a safer environment [1].

The need for automation in construction is clear; as most construction activities are repetitious, labor-intensive, and dangerous so that it is perfectly suitable for robot automation.

T. Bock (2007) illustrated a robotic precast concrete panel factory that uses a multipurpose unit which allows flexible production of the concrete floor, wall and roof panels.

Here, according to certain CAD data, a multi-functional gantry type robotic unit with two vertical arms places magnetos on the steel production table. The unit also attaches shutters on top of the magneto and then places horizontal, vertical and triangular reinforcement bars, as per design. A CAD-CAM controlled concrete distributor spreads the right amount of concrete while controlled by a CAD layout plan, which takes into account installation, window or door opening [2].

Swedish company Randek has developed a number of high-performance position controlled systems for prefab house manufacturing. Those systems were developed similar to the manufacturing industry and were intended to perform routine task in on location. For instance, their latest wall, floor and roof production line system SF021 is developed to be a flexible system for effective production of insulated wall elements. Firstly, a framework is built with studs and top and bottom plates installed by using a CAD-CAM controlled nailing gun, and then wall sheet will be nailed in while the whole wall component is flipped over and ready for the next work station. Second step, the wall component will be insulated. The final stage, the insulated wall will be flipped upside down and another wall sheet to be nailed on to seal up the component. The wall component is completed and ready for site delivery. The whole process is computer controlled, and it is only require 3-4 operators to oversee the operation.

In Japan, there are more than 85 present of the houses are prefabricated, several leading construction firms have developed fully automated system for manufacturing building components, such as Sekisui chemical, robots has played active roles at the production line. Robotic manipulators were used as assistants to human. This approach allows the robot to be less autonomous and technically simpler, needing only limited sensing abilities. According to this approach, the human performs the vital parts of the task, and the robot is used to

expand the human physical limits. Such systems, of less autonomous performance, can be more easily adapted for assistance in a variety of building tasks [2].

Off-site production sequence may have successfully adopted automation concept, robots are capable of conduct many factory based roles such as handing heavy materials, and it has benefited construction industry greatly. On the other hand, robots still face many difficulties due to the dynamic nature of construction site and economical challenge. Construction industry has a variety combination of sectors and it has to cope with variety of circumstances on each project and site. In construction automation, the building also serves simultaneously as the work environment. Construction robots will face great challenges when cope with complexity of on-site tasks.

To tackle this, single-task robots need to be designed not only to assist human but also interact with human and enhance the overall performance; robots with specific function will be programmed to work independently, such as on-site single-task robots will perform most of the assembling and heavy lifting roles, as well as problem solving and data collection roles. Single-task robots been designed for a factory systematic environment free-standing robots will be moving along a production line on wheels to complete production roles. While suspended robots usually have lifting mechanisms to help it move up and down.

Mobile Robotic system also developed for material handing on-site. Personal interior finishing robot is developed to reduce human interaction. Engelbert westkämper et al (2000) developed a robotic system for the automatic laying of tiles within certain tolerances on prefabricated modules. The pilot work consisted of a tile laying system that consists of tile positioning equipment, a centering and measuring system and transport unit; a tile supply system consisting of a store and a

measuring unit; system for generating process parameters; and handing and positioning system having industrial robot and process control [3].

Moreover, Neelamkavil,J (2009) have illustrated that single-task robots technology will progresses quickly through the development of human-robot cooperative (HRC) system, key technologies development such as motion generation, remote control ,operation control, and mobility, there will be more interaction between humans and robots in workplace, human and robot will assist each other and exchange forces on site.

Pre-fabrication technology will be enhanced and expanded. New materials and building system will be developed to assist mass production. Building will be erected like a giant jigsaw.

Full automation is not economical right now but it will continue to improve work environment, reduce construction time waste, creating new jobs in construction industry.

Future success of construction industry is to obtain full automation; it is achievable, together with support of advanced technologies, appreciate system integration as well as a forward planning.

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