International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 180-186 www.ijaem.net ISSN: 2395-5252

Artificial Intelligence powered Dump Truck Smart Management System: Case Study by viAct

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Submitted: 01-08-2021 Revised: 07-08-2021 Accepted: 10-08-2021

ABSTRACT
Dump Trucks are essential vehicles in any construction site for carrying materials. These vehicles have always been tedious to be managed due to their multi utilitarian nature which seeks a lot of surveillance effort. However, manual surveillance from entry to exit of job sites for these dump trucks is not feasible and thus most of the construction sites lack proper management of these vehicles which in long run severely effects productivity of the construction projects.
Looking at the dire need to enhance productivity of construction sites, viAct's Smart Dump Truck Management System is a holistic one-in-all AI powered solution that gives full proof assistance to on-site mangers and even remote mangers to effectively en-route dump trucks in the most effective manner. The system is a plug and play facility for any construction site with IP cameras with a resolution of 2MP or more, internet facility and power supply. The viAct's AI processor empowers the already installed cameras in the job-site with various smart modules to recognize, detect and record various dump truck related insights like dump truck count, open dump truck detection etc. viAct's cloud facility helps in sending instant alerts to both on-site as well as remote managers helping them to keep a constant check on dump truck from entry to exit. Moreover, the user friendly dashboard of viAct is easy to use even by someone who has no expertise in AI to have a regular track on dump truck count, operational hours and non-compliances for better planning for higher safety and productivity.
Keywords: viAct.ai, viAct, Dump truck management, Artificial Intelligence, Computer vision, ConTech, AI in Construction, Construction Safety, Construction Productivity

I. INTRODUCTION

The dump truck is generally used for transporting materials and demolition wastes such as gravel and sand, for the construction sites. A dump truck has several other names such as dumper truck, dump trailer, dumper trailer, dump lorry, dumper lorry, or even dumper in short. Typically, a dump truck consists of an open-box bed, hinged at the rear and equipped with hydraulic arms to lift the front, enabling the material in the open-box bed to be dumped on the ground behind the truck, at the place of delivery (1,2).

It has generally been thought that, the dump truck was used for the first time in the late 19th century in the farms of Western Europe. In 1896, a steam dust-cart with a tripper mechanism was developed by Thornycroft. Around 1910, small equipment companies, such as Galion Buggy Co., the Fruehauf Trailer Corporation, Lauth-Juergens and others, developed the motorized dump trucks for the first time, in United States (2). It was shortly after this, that Wood Hoist Co. introduced the hydraulic dump-beds. These companies were the ones that flourished well during World War I, due to huge wartime demands. August Fruehauf invented the semi-trailer in 1914, followed by the semi-truck. He received huge military contracts for his semi-trailer and semi-truck, during the World War I (2). Fruehauf further introduced hydraulics in his trailers after World War. In early 1920s, the company offered hydraulic lift gates, hydraulic winches and a dump trailer for sales. Eventually, Fruehauf emerged as the main supplier of dump trailers. Their "bathtub dump" was considered to be the best by the heavy haulers, road and mining construction firms.

After the war, companies like Galion Buggy Company, continued to grow by manufacturing a number of express bodies and smaller dump bodies that could be easily installed on either stock or converted (heavy-duty suspension and drivetrain) Model T chassis prior to 1920. During 1930s, Galion and Wood Mfg. Co. built all the dump truck bodies, offered by Ford, on their heavy-duty AA and BB chassis. Galion Company, now known as Galion Godwin Truck

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Body Co., continues to be the oldest known truck body manufacturer yet in operation (4).In 1920, the first known Canadian dump truck was developed in Saint John, New Brunswick; when Robert T. Mawhinney attached a dump box to a flat-bed truck. A winch was attached to a cable that fed over pulley, mounted on a mast behind the cab, to enable lifting (3). A cable was connected to the lower front end of the wooden dump box, attached by a pivot at the back of the truck frame. To raise and lower the box, a crank was turned by the operator (5).

In current times, in countries such as South Africa, UK, India and Australia, dump truck is generally referred to the off-road vehicle used in the construction sites. Similarly it is known as tip trailer, tipper trailer, tip truck, tipper truck or tipper in Australia, New Zealand and South Africa; and tip lorry or tipper lorry in UK and India (1). Due to its widespread popularity in construction, management of dumping trucks is extremely crucial in enhancing productivity of the construction operations. However a lot of key challenges are still prevailing in dump truck management system which ultimately decreases the productivity by increasing project completion timeline, accidents and much such non-compliance. Thus, the current paper covers multiple aspects of dump truck monitoring and management using artificial intelligence through a case study of Hong Kong's renowned ConTech startup viz. viAct and its smart dump truck management system.

KEY CHALLENGES RELATED TO DUMP TRUCK MANAGEMENT IN CONSTRUCTION SITES

The role and importance of dump trucks in the construction sites can never be ignored. However, the management of dump trucks and its performance is directly associated with the productivity of the construction project. There are several key challenges related to the dump truck management in the construction sites.The very first challenge associated with dump truck management is related to 'safety'. Ensuring the safety in the premises of the construction sites is very important. In order to ensure this, keeping a round-the-clock check on every incoming and outgoing vehicle becomes necessary. This ensures that no intruder comes in and goes out of the construction site. Further, manual monitoring of every incoming and outgoing vehicle is time-consuming, inefficient and imprecise and thus this remains a prevailing issue in construction sites.

Secondly,the dump trucks are generally used in the construction sites to carry different types of materials like sand, gravel, waste materials, soil, slurry etc. Keeping an eye on what each dump truck is carrying is a challenging task. Thus it remains a necessity that trucks are identified and segregated at entry point itself on the basis of the material and en-routed to required destination in the construction site.

Furthermore, cleanliness is another attribute that cannot and should not be compromised in terms of construction material transportation through dump trucks. One of the many problems associated with the dump trucks is related to 'cleanliness'. As dump truck generally carries loose materials such as sand, gravel, soil, tar, asphalt etc., these trucks need to be covered while in operation to ensure both safety as well as environmental protection. Materials falling out of an open dump truck can cause fatal accidents on the road as well as degrade the environment. Thus, it is essential to keep a check on whether the dump trucks are covered or not before they leave the site. Apart from this, wheels of dump truck carry mud and soil on their wheels from construction sites which make the roads filthy. Therefore, keeping a check on the dump trucks' wheels cleanness is the next key challenge related to dump truck management.

Moreover in terms of environmental considerations materials, on proper sites is another problem associated with dump truck management. On-site segregation of materials has been suggested extensively in the literature but a full-proof system to manage this has yet not achieved efficiently.

Finally, keeping a record of the dump trucks is very critical. Aconstruction site makes use of large number of dump trucks that keeps coming and going throughout the day. Keeping a record of all the incoming and outgoing dump trucks in a construction site is very important to ensure productivity with regards to both time and money. However, manual monitoring and record keeping of such a large number of dump trucks is error prone and seeks for time, manpower and hard work.

viAct's DUMP TRUCK MANAGEMENT SYSTEM: CASE STUDY

Organization Details:

viAct is the leading artificial intelligence enabled automated construction monitoring startup. viAct's proprietary vision technologies and extensive deployment experience can detect, anticipate the potential risks in construction site 24*7 and trigger 5G enabled instant, real-time alerts for any non-compliance in construction sites including non-compliances related to improper

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onsite waste classification. viAct's well-trained AI modules can cope-up with any kind of environment and operate even under extreme weather by connecting within 5 minutes to any type of online cameras, drones and mobile phones to capture video and image without AI and coding knowledge. viAct has used the power of AI to introduce an all-in-one solution for dump truck management in construction sites.

Overview of the solution:

viAct has utilized its proprietary AI by training it in an efficient way to provide a holistic solution to mitigate above discussed issues. viAct's smart solution is a potential way for construction industries to manage dump truck operations to prevent non-compliances. The schematic diagram below depicts how viAct's smart dump truck management system helps in monitoring them from the point of entry till exit and even beyond (Fig 1)

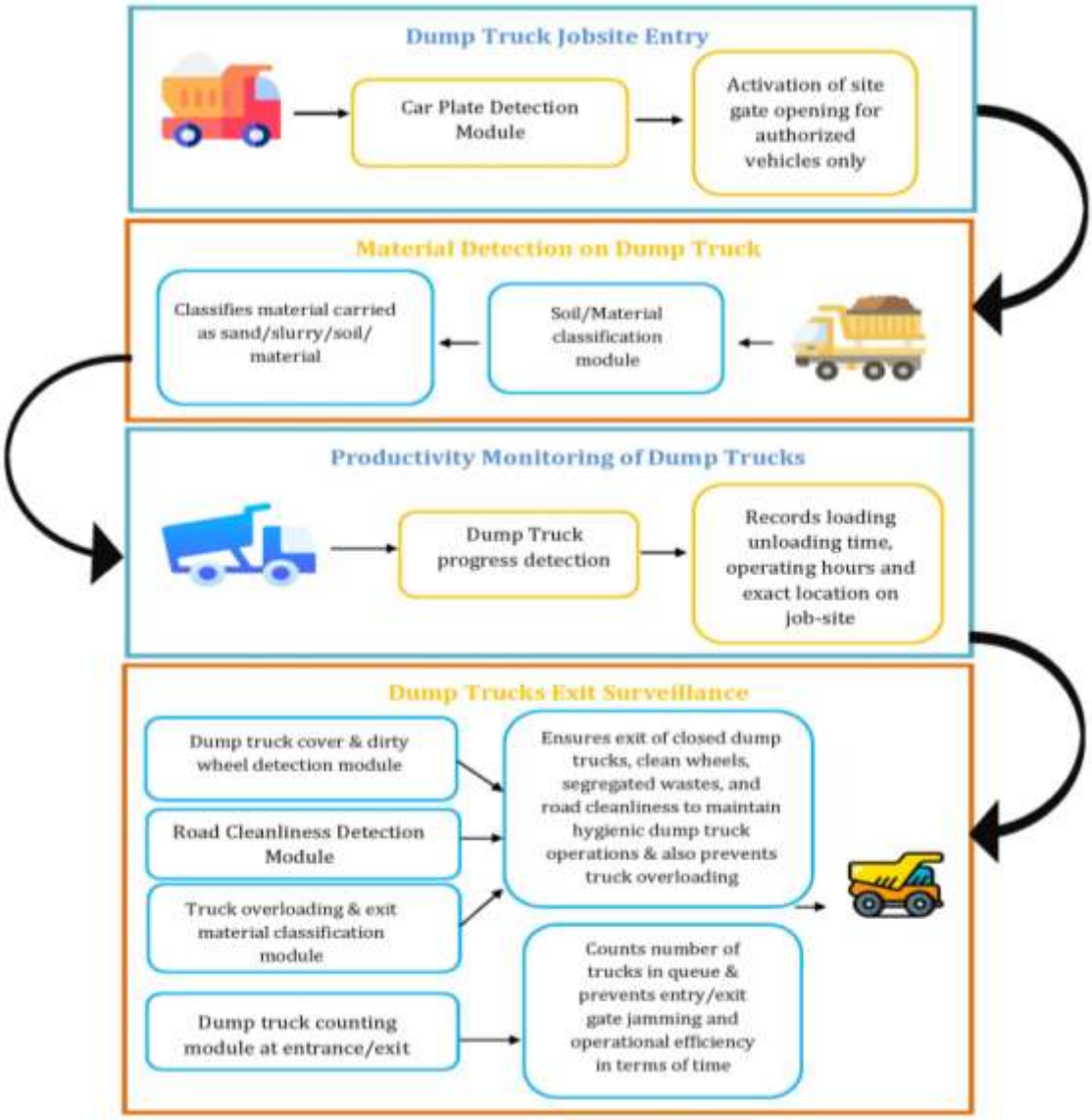

Fig 1: Schematic diagram for viAct's smart Dump Truck Management System: From Entry to Exit at a Glance

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Modules & Working:

Step 1: **Dump Truck Job Site Entry**

The first step in dump truck surveillance starts when the dump truck enters the construction site. viAct's powerful AI detects the license/number plate of the dump truck via. Smart car plate detection module which identifies authorized vehicles and open the gates of job site for their entry. The unauthorized dump truck is automatically prevented from entry at the gate. Thus, the AI powered cameras helps in keeping a strict surveillance while entry of dump trucks in construction sites.

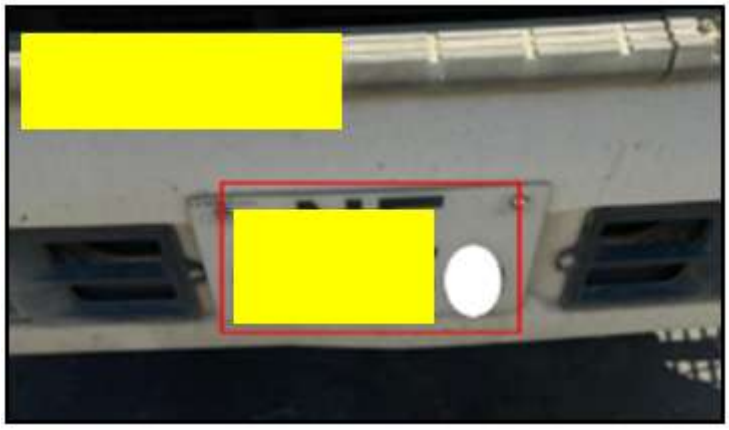

Fig 2: Result validation for authorized number plate detection for dump trucks (Number plate hidden for privacy purposes)

Step2: MaterialDetection On Dump Truck

Once the dump trucks enter the construction site, it is essential to know the material it is carrying to en-route it to exact location where the material is to be unloaded. viAct's smart AI powered cameras are trained well to identify the material it is carrying through soil classification module which efficiently bifurcates material carried by dump trucks into soil/slurry/sand slurry or other materials.

Fig 3: Result validation for classification material carried by dump trucks

Step 3: Productivity Monitoring of Dump Trucks

The most important aspect of dump truck management is its productive usage by monitoring, tracking and efficiently managing its loading and unloading cycle. The dump truck progress detection module records the loading-unloading time of dump trucks to ensure the entire operational timings and hours of each vehicle. viAct's smart dump truck monitoring system not only keeps an onsite surveillance but also with its cloud powered dashboard the remote stakeholders are also able to track the operational hours of each vehicle to plan more productive approach in dump truck operations, like dismissing drivers with more operation hours or removing defective dump trucks from operations.

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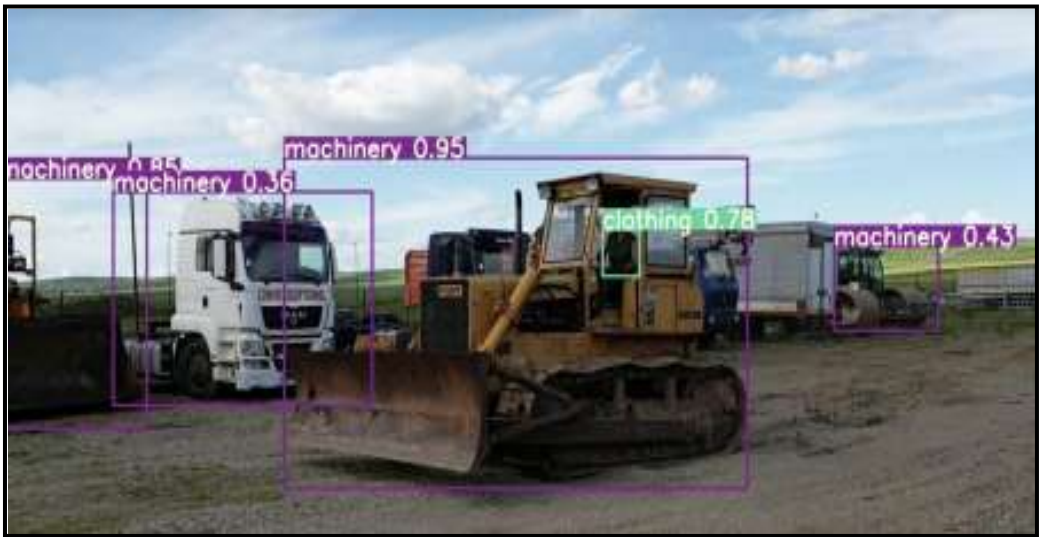

Fig 4: Result validation for dump truck loading-unloading cycle at job-site

Step 4: Dump Trucks Exit Surveillance

After the dump trucks are loaded with material from construction site, it is essential to perform some mandatory surveillance steps to ensure proper operations of dump trucks. viAct's smart AI modules provide one-in-all solution for ensuring all exit compliances for a dump truck leaving a construction site. Primarily by applying dump truck cover detection and dirty wheel detection module, it is made sure that any dump truck is not let to leave without cover or dirty wheels. Apart from this to maintain hygienic dump truck operations the system also allows detection of the road cleanliness to prevent any construction trash sticking to wheels.

Fig 5: Result Validation for dirty wheel detection and open truck detection modules

Fig 6: Result Validation for exit material classification detection modules

Secondly, the AI powered cameras are also trained to detect any dump truck with overloading of material to prevent break failures and on-road accidents. Furthermore, it is also essential to make sure that the material that are leaving the site is segregated into waste and inert

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material so that they can be disposed at their destined locations. Thus viAct has also introduced the waste classification module to detect material carried in the dump trucks before their exit.

Fig 7: Validation Results for Dump truck overload detection module

Finally, the dump truck counting module counts dump trucks at entry and exit of the job site which is displayed over the monitor as well as the dashboard for a coordination of site mangers to manage entry-exit of these vehicles in a hassle free manner. This also helps in preventing unnecessary jamming of entry/exit which not only enhances safety but also productivity of dump truck operations in many aspects.

Implementation Results:

The effectively of viAct's smart dump truck monitoring system is known from the fact most of the construction sites after its installation successfully enhanced their productivity over 25%. Apart from this the powerful AI is sensitive enough to enhance efficacy of inspection which otherwise through manual efforts consumes a lot of time along with human resources. viAct's smart dump truck monitoring system has been reported to be far more accurate in comparison to manual monitoring. The smart system helps in curbing inaccurate human judgment which is the major reason of flaw and bias as reported by many construction site mangers. However, viAct's smart solution which facilities instant alerts in case of non-compliances for both on-site manger and remote manger has helped the construction companies to detect 40% more flaws than manual inspection. viAct's smart dashboardwith records of all alerts and activities related to dump trucks has been reported to help mangers to take proper planned decisions which ultimately accelerated productivity of the construction site.

II. CONCLUSION

Looking at the dire need to enhance productivity of construction sites, viAct's Smart Dump Truck Management System is a holistic one-in-all AI powered solution that gives full proof assistance to on-site mangers and even remote mangers to effectively en-route dump trucks in the most effective manner. The system is a plug and play facility for any construction site with IP cameras with a resolution of 2MP or more, internet facility and power supply. The viAct's AI processor empowers the already installed cameras in the job-site with various smart modules to recognize, detect and record various dump truck related insights like dump truck count, open dump truck detection etc. viAct's cloud facility helps in sending instant alerts to both on-site as well as remote managers helping them to keep a constant check on dump truck from entry to exit. Moreover, the user friendly dashboard of viAct is easy to use even by someone who has no expertise in AI to have a regular track on dump truck count, operational hours and non-compliances for better planning for higher safety and productivity.

Thus is could be stated that AI is creating a new methodology to replace inaccurate human based "practices'' in construction by helping construction workers and managers to do their task in far efficient manner.

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