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Artificial Intelligence: The Impact Of A.I on Transportation and Road Management in Ghana

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Abstract — The purpose of artificial intelligence is to improve upon basic human life. In the most basic understanding, it is to augment the process of everyday living by making decisions that will be in the best interest of people at all times. The fast developmental space at which Artificial Intelligence (AI) is advancing, gives an endless opportunity to upgrade the capabilities of different business sector which includes the transport sector. The technique adopted by AI includes highly advanced computational methods that work like the way the brain of humans works. For AI to be applied successfully, it needs an in-depth knowledge on AI and Data, with the characteristics of transport systems in mind. It important for the transport Sector to associate with the use of these Technologies to improve the transport Sector whiles making travelling secure and safe and reliable for people. This will improve productivity in the economy of the country. This paper provides an overview of the AI techniques that will be applied handle the transportation and management in Ghana.

Keywords - AI, kinetic mobility, open corridor system, satellite, internet, road networks, advanced traffic management system

1. INTRODUCTION

1.1. Artificial Intelligence

In computer science, the term artificial intelligence (AI) refers to any human-like intelligence exhibited by a computer, robot, or other machine. Artificial intelligence refers to the mimicking ability of a computer to emulate the capabilities of the human brain by learning from examples and experience, recognizing objects, understanding and responding to language, making decisions, solving problems and combining these and other capabilities to perform functions a human might perform, such as greeting a hotel guest or driving a car.

After decades of being relegated to science fiction, today, AI is part of our everyday lives. The surge in AI development is made possible by the sudden availability of large amounts of data and the corresponding development and wide availability of computer systems

that can process all that data faster and more accurately than humans can. AI is completing our words as we type them, providing driving directions when we ask, vacuuming our floors, and recommending what we should buy or binge-watch next [1]. And its driving applications such as medical image analysis that help skilled professionals do important work faster and with greater success.

1.2. Problem statement

The purpose of artificial intelligence is to improve upon basic human life. In the most basic understanding, it is to augment the process of everyday living by making decisions that will be in the best interest of people at all times. The subjecting of computerized tools and systems to the benefit of human living however ought to take place at the behest of society as a whole. The state of mind of the people and the infrastructure that exist at that point in time must support instead of being an impediment to the success of artificial intelligence. Perhaps this could explain the reasons behind some countries adopting artificial intelligence at a faster pace than others. Whatever the actual reason may be, it can be observed that the major contributions that artificial intelligence is to do are to help society live its life better. The systems of transport and traffic control are sensitive to basic life. Commuting has to be safe because it is basically a matter of life and death when machines and speed are involved.

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The mechanisms that inform governments to adopt one transport system above the other have not been fully explained. The citizenry is left to move along with what is available at that point in time. In the construction of road networks and how traffic systems operate, the mechanisms that are behind it have not been fully investigated. In the Ghanaian context, artificial intelligence has not been seen implemented extensively. The Ministry of Roads and Transport, Driver and Vehicle License Authority, Ghana Highways Authority and the National Road Safety Commission are the major bodies responsible for managing road activities in Ghana. From an academic perspective, very little has been researched on how any of these bodies have implemented artificial intelligence in the management of Ghanaian roads. According to Ofori-Dwumfuor and Danquah (2011), transport inefficiencies in Ghana can be blamed in poor road infrastructure. Shapiro et al (2011) also indicated that driver and pedestrian indiscipline can be stated as the major causes of transport and traffic challenges in Ghanaian urban areas. This means there is a glaring problem of road and transport challenge that has not seen a sustainable solution from the angle of technology. The state of Ghanaian roads and the corresponding challenges that come with its usage may be subjected to exploration by artificial intelligence. The basis of this research will be to determine if artificial intelligence can help improve the existing transport and traffic systems in Ghana. This study has become necessary because there is inadequate academic exploration in this specific area in Ghana.

1.3. Overview of The System/Project

The project relies on the usage of live data from road usage. In the performance of its basic function as a system, there must be synchronization of multiple setups many of which will be based on the field of data collection and data administration. The field of data collection is mainly the transport systems which are the various streets in the Greater Accra region of Ghana. On this field, visual and sensory data will be fed into the system. The visual aspect of data which will be collected will focused majorly on the current state of roads, traffic monitoring and accident-related evidences which are to assist the police in their investigation should any form accident occur. The sensory data collected for the system will be based on traffic and bad road networks. The state of the road networks will be further monitored by the system in order to advise regulators on maintenance approach on how to keep the roads from defacing.

1.4. Tools and equipment required for the A.I. to function effectively

- Advanced traffic management system
- Kinetic mobility
- Open corridor system
- Advanced traffic controllers

In the performance of the artificial intelligence, the system must work in conjunction with the above equipment/tools which are to be procured by the National Road Safety Commission. The function and effectiveness of the system will depend heavily on the augmented prowess of the above stated systems.

1.5. On-site and off-site management of the intended system

The system will be feeding directly into the off-site and on-site mechanisms. There will be live feed correspondence sent from the off-site to the on-site policing unit. In the event of traffic jump and bad or damage road the system must be able to alert the back office at the off-site and prompt the authorities to take immediate action. When accidents occur, there should also be swift communication of this to all stakeholders. The system must be in the position to capture live feed (pictures) of all road incidents. This is to be fed directly into the stakeholder system or database and also inform all parties about the immediate actions that are to be taken.

Outlook of road accidents which the system is to improve

Table 1. Data Table on months

Month	Persons Killed		Persons Injured	
	No	%	No	%
January	127	6.1	753	7.2
February	188	9	688	6.6
March	153	7.3	827	7.9
April	177	8.5	816	7.8
May	153	7.3	899	8.6
June	140	6.7	846	8.1
July	199	9.5	815	7.8
August	177	8.5	916	8.8
September	155	7.4	895	8.6
October	167	8	1013	9.7
November	205	9.8	952	9.1
December	243	11.7	1018	9.8
Total	2084	100	10438	100

Table 2. Data table on Days

Day	Persons Killed		Persons Injured	
	No	%	No	%
Monday	278	13.3	1457	14
Tuesday	238	11.4	1345	12.9
Wednesday	320	15.4	1065	10.2
Thursday	260	12.5	1450	13.9
Friday	300	14.4	1750	16.8
Saturday	365	17.5	1805	17.3
Sunday	323	15.5	1566	15
Total	2084	100	10438	100

Table 3. Data on time

Hour of Day	Persons Killed		Persons Injured	
	No	%	No	%
00-02am	47	2.3	247	2.4
02-04am	60	2.9	225	2.2
04-06am	119	5.7	537	5.1
06-08am	109	5.2	644	6.2
08-10am	145	7	817	7.8
10-12noon	173	8.3	985	9.4
12-2pm	174	8.3	1199	11.5
2-4pm	199	9.5	1420	13.6
4-6pm	253	12.1	1463	14
6-8pm	456	21.9	1459	14
8-10pm	251	12	965	9.2
10-12midnight	98	4.7	477	4.6
Total	2084	100	10438	100

Table 4. Data on type of Vehicle

Vehicle Type	Vehicle Type in Fatal Crashes	%	Vehicle Type in Non-Fatal Crashes	%
Car	690	28.6	5463	47
Goods Vehicle	379	15.7	1446	12.4
Bus/Mini Bus	471	19.5	2154	18.5
Motor-cycle	547	22.7	1429	12.3
Pick-Up	130	5.4	803	6.9
Bicycle	77	3.2	148	1.3
Other	120	5	185	1.6
Total	2414	100	100	100

1.6. Significance/relevance of the research

At the end of the study, the following are the ways through which the research will be beneficial.

Ghana Highways Authority: this is the authority responsible for managing road construction and its related activities. The research will be beneficial to them by way of providing them with empirical data on daily road usage. Through artificial intelligence, the institution will be able to detect traffic usage, congestion, nature and condition of roads for the purposes of enhancing pedestrian usage. The research will also inform the institution on ways through which road usage can be improved by way of recommendation.

National Road Safety Commission: the purpose of this body is to provide the environment through which road users will be safe. They also ensure that education will be given to the general public on safe road usage. At the end of the study, the findings will inform the road safety commission on road user habits, factors that result in accident on the roads as well as impact of artificial intelligence when it comes to improving road use. In effect, the research will provide a basis upon which the general public can be educated. The artificial intelligence embedded in road usage in Ghana can provide predictive assessment of pedestrian and motorist actions for the purposes of improving safety on Ghanaian roads.

Private contractors: this includes those parties that are into road construction, provision of security and monitoring equipment as well as provision of road user education upon the request of the road safety commission and highway authorities. The findings from this research will enable the private contractors understand which areas to concentrate their efforts. They will also learn from the recommendations suggested in this study how they can improve upon their current service provision and also assist road users more.

Further academic research: the findings from this research can serve as empirical input for further academic discussion by future researchers. In addition to this, there will also be a conceptual appreciation of road use and its improvement through artificial intelligence.

1.7. Sampling technique and justification

Sampling is a process of selecting a subset of individual or elements within a population for the study. Sampling is the selection of a number of respondents from a population to represent the entire population for decision making. In a research study, it is generally not necessary or possible to study all possible cases or elements to understand the phenomenon under investigation. The most important thing is drawing up a sample to make inferences or generalization from the sample to represent the entire population under consideration. The purpose of a sample is to help the researchers to undertake an analysis of a group people from the population so that the results of their study can be used to derive conclusions that would be representative to the entire population. The sample size must be representative of a good size of the population from which it was drawn to warrant statistical analysis. The sample size that will be used for the study will be sixty (60) respondents. This size was selected based on the discretion of the researcher.

Stratified sampling which will be used in this research is a probability sampling procedure in which the target population is divided into a number of strata, and the sample drawn from each stratum. The resulting sample makes up the final sample for the study. The probability sample will be adopted to select the sample from the respondents who made up the population for the study. Probability sampling is a sampling technique where the samples are gathered in a process that gives all the individuals in the population equal chances of being selected. Table 1 below contains the selected participants for this study:

Table 5. Respondents for this study

Category of Respondents	Number
National Road Safety Commission	5
Driver and Vehicle License Authority	25
Ghana Highways Authority	30
Total	60

1.8. Road Network

Roadways is known to be the most reliable modes of transport, which facilitates easy and fast movement of traffic with door-to-door services, also having comparatively lesser construction costs compare to that of than railways. Over the past two to three decades, road networks in Ghana have expanded more extensively than the respective maintenance budgets and institutional capacities. Eventually, the maintenance level of the roads network is low.

Road deterioration is a worldwide phenomenon. All new roads, whatever the method of construction or the materials used, deteriorate with time and use. The way and manner action is taken to contain and manage the situation makes the situation dangerous or helpful. The rate at which cracks and minor potholes are accessed when they start developing, and the quick approach at which they are these patched makes the significant difference because, if they are not patched and then water sieves into the base of the road then then it will develop into a serious pothole and with time deteriorate the entire road. The development of potholes on roads in Ghana is of a major concern, as newly constructed roads deteriorate over a short period of time. With is in mind the maintenance culture of the roads in Ghana is on low and are mostly left unattended to till the road disintegrates entirely making it more expensive to renovate.

Most of the good and safe roads in Ghana or anywhere else in the world, are turned into bad roads because of being left under construction or due to natural calamities like floods, landslides or even because of simple causes like heavy rains and accidents [5].

Poorly maintained roadways cause accidents in a variety of ways, mostly due to the fact that they create an enormous hazard to drivers. In many instances, a driver may attempt to avoid a certain situation, like a pothole or pooling water which could cause a serious accident. Bad road networks such as pothole causes slow vehicular movement causing heavy traffic and wastage of fuel. This in the nutshell causes financial loses on the economy.

2.0. Literature Review

2.1. Artificial intelligence

Human lives are increasingly becoming more complex and dynamic. The need for improvements in the way activities are performed on a daily basis has shifted from manual to advanced technologies that are to assist in decision making as well as task execution. The performance-based systems that are task driven has the central focus of achieving within the shortest possible time what it will take human capacity a longer period to achieve. All these are as a contribution of external data processed in a smart way with the intention of attaining desired objectives of safety and efficiency (Everitt and Hutter, 2018). For artificial intelligence, these areas are well covered in more ways than one.

Artificial intelligence is a concept that describes how a system is able to correctly interpret external data, learn from such data in conjunction with the environment within which the data was obtained in order to achieve specified goals through adaptations that are flexible (Miles and Walker, 2006). Artificial intelligence is based on the development of independent agents that can reason and plan towards their objectives without any inbuilt knowledge assessment of their environment. In other words, artificial intelligence is not built with all of its external environmental features known to it. It is therefore the adaptation of this system and using such adaptation to make smart decisions that make it intelligent in the first place (Knowles, 2006).

In general, there are many aspects of human life that artificial intelligence can improve. From health to transportation, space travel to financial transactions to say the least, artificial intelligence can improve upon the basic functions of human endeavours and also contribute to the efficient functioning of economies. Looking into the future, there are many unexplored areas of economies which have not adapted to or benefitted from the usage of artificial intelligence. One of such areas is transportation. Mobility is a basic human desire (Lyons, 2018). As the central theme of economic activities, humans have the innate inquest to move from one place to the other in a faster and safer fashion. This means that there must be inclusion of technological means which can ensure safety at all levels and for all people. In the contributions which are yet to be fully explored by artificial intelligence, transportation can get safer and more convenient when trusted systems are put at the helm of affairs (Papa and Ferreira, 2019). Artificial intelligence can be merged with daily human activities and transportation can be the fastest area where such goals can be easily achieved.

2.2. Automobility and vehicular usage

Daily lives of the planet have never been the same since the inception of cars. The coming into being machines that can transport people from one place to another in a very convenient fashion has shaped the external outlook of towns, cities, municipalities and countries. The outlay which is visible for all to see through the advent of cars mean that there have been significant improvements in the way and manner in which transportation is carried out in many aspects of daily lives (Lu et al, 2014). The invention of cars and vehicles in general did not come alone. They came with the invention of other geology defining aspects of societies such as roads and how they are constructed (Chehri and Mouftah, 2019).

Mobility has and always remains the backbone of economies. There is a constant desire to move from one place to another and this is the basic function which cars came to provide. Replacing the previous cart driven means of transportation, automobiles have come to work in sections that have created jobs and whole industries that provide income and jobs to governments. It is as a result of these provisions that automobiles have seen improvements over the years. In the course of time, manufacturing of automobiles has grown much more complex (Nikitas et al, 2019). The basic function of transporting passengers from one point to the other does not mean it is the stage at which automobiles are to stay forever. There have been growths to include areas of pleasure such as music, air conditioning, lighting, environmental learning and possibilities that affect the status quo of social settings. This implies that the invention of cars will continue to be an area of debate and speculation mainly because the needs of humans keep evolving. Such evolution ought to be matched with systems and machines that have the capability to perform multiple roles and still remain efficient in their usage (Milikas et al, 2019). This then becomes an indication that as the desires of humans increase, augmented systems must get smarter in order to catch up. Vehicular improvements can be best understood through the concept of cars at its basic level. The purpose is to ensure a faster movement from one point to another and for that matter the manner in which such transportation is achieved is very relevant to social and economic

The trends which have been set over the years concerning the expectation of cars means that there must be corresponding adjustments that must be made in humans' own adaptability to auto-mobility. This feature in the daily lives of people will also necessitate the involvement of advanced technologies that can provide the requisite support.

2.3. Anticipated benefits of artificial intelligence in transportation

In transportation and like many other sectors, artificial intelligence has not come full fleshed and for that reason, the benefits it stands to provide are only experienced in snippets. The inclusion of artificial intelligence in transportation can only be hypothesized in terms of how and areas where such improvements can be made (Thomopolous and Nikitas, 2019). The ability to have this assessment can be instrumental in determining whether it is worthy to have it fused into transport systems at all. At the basic level of commuting, there must be some predictions and functions that serve the purpose and interest of those using it. Eventually, such benefits can transition from anticipated to real benefits.

The benefits that artificial intelligence can bring to transport and traffic systems is the elimination of human errors. There can also be improvements in driver decision making as well as minimization of congestion on roads. Artificial intelligence in transportation can lead to time saving, vehicle platooning and cost minimization for logistics. Essentially, the coming into being as well as the inclusion of all these benefits into the modalities of artificial intelligence furthers the argument that progress ought to be made in order to bring its full force into usage (Nikitas et al, 2019). Apart from productivity being increased due to better routing and traffic management, artificial intelligence also has the tendency of preventing accidents by managing road usage. In the case of the latter, it has been the issue of contention especially in developing countries. Although developed countries also have their fair share of road accidents, the inclusion of artificial intelligence in their own fashion can contribute to the minimization of road accidents which is very critical to nation building.

The advantages at this point in time far outweigh any potential risks. However, there is always the need to exercise caution in its application. The argument about the extent of inclusion of artificial intelligence in daily lives especially in a facet such as transportation can become an ethical one.

For example, the issue of what personal data is to be captured by traffic systems and artificial intelligence itself in the quest to provide safe transporting. At the same time to what other usage can this personal data be put in order to ensure commuting? Responsible usage appears to be the ethical consideration here but it still appears to be farfetched since the system itself has not been fully operationalized in any country at all. The inclusion of artificial intelligence still remains at the piloting level although the anticipated benefits are quite promising.

2.4. Anticipated challenges of artificial intelligence in transportation

One of the foremost challenges that are anticipated to be associated with artificial intelligence in transportation is internet connectivity and its related charges. Of course, this may be thought of as being a problem to be experienced in developing countries but that does not discount the fact that overall adoption can also be impeded when there is poor internet connection. The cyber nature of artificial intelligence means that at any given time there should be standby support services that can enable the transport system to function optimally (Nikitas et al, 2019). Any activity that serves as opposition to this may ultimately affect the perfect functioning of the system. It is not in the interest of the intelligent system to generate its own pathway of connectivity. This is an external infrastructure that must be made available by governments and agencies. Another challenge that is also to be expected with artificial intelligence in transportation has to do with the cost of setting up the infrastructure. It will mean that roads and their corresponding traffic signals must be more motorable and signs easily readable by the intelligent systems. In many developing countries, this can prove to be a strong challenge because even in the manual transportation system, there are some basic challenges which have not yet been fully fixed. The addition of artificial intelligence in transportation for some developing countries may come across as more of a luxury and the benefit of safety may not be in the picture at all. It is also important to make mention of cyber security which has been a matter of argument (Koutroukias et al, 2019). If artificial intelligent systems in transport can be centrally controlled for the purposes

of safety and speed, what happens when a more intelligent system is developed to overshadow and steal data from a less intelligent system? The

possibility of this occurring and consequently putting the lives of innocent people at risk raises issues of trust and the extent to which such smart systems should be included in the operational transport systems. These issues have affected the perception that people in general have (Kougias et al, 2019). It has also been argued that the significant threats that may be experienced by fully adopting artificial intelligence in transportation may be contributing factors to its slow pace when it comes to adoption.

2.5. Road transport and artificial intelligence

Artificial intelligence in road usage is not only driver focused. The general users of roads which include pedestrians are of equal importance. In the development of smart systems that are able to make decision on behalf of the driver and in some instances predict traffic routes on multiple road networks, the must be reliability in data fed into the system. One of the shortcomings of having a system that relies on human decision making in order to function effectively is the speed and priority with which humans attend to issues raised by the system. In the process of improving traffic congestion in developing countries such as Ghana, the notification of the system will only be relevant when there is a standby support system that attends to all or most of the issues raised (Nikitas et al, 2019). For the system to be thought of as intelligent, it must be supported by infrastructure that is also up to date. The artificially intelligent system will not solve all road problems when there are glaring issues that must be dealt with.

The inclusion of the system will have to be closely coordinated with existing vehicles. Alternatively, the collection of data from daily road usage may be carried out without involvement from active users (drivers, passengers and pedestrians). However, the performance of this task must be done in relation to the road user culture and the available network which the system is expected to improve. When the traffic system is terrible in a municipal due to poor road network, the inclusion of artificial intelligence in transportation for such a municipal will do little to no good (Nikitas et al, 2019). This is obviously because there is no efficiency in the manner in which such a system is to function. There are some countries given their current road infrastructure that will take decades before artificial intelligence can be well implemented there. This is because they are not prepared in terms of infrastructure. For the avoidance of road accidents, automated systems can play a vital role. This role can or may be limited to tracking and recording

data. The need to have support for systems that are to support human lives on roads is important (Firnorn and Muller, 2015). In the night when there are no street lights, it will be difficult for the system to capture road accidents as they occur. Unless night vision cameras are being used, the functioning of such a system will be near useless. Then again, the question to be raised will be what importance will night vision be if it is more expensive than fixing street lights. Eventually it comes down to policy and willingness to put into place support mechanisms that will not inhibit the proper functioning of artificial intelligence systems but rather support it.

2.6. Policies and regulations that can assist artificial intelligence in transportation

Regulations must be in place to enforce the effectiveness of the artificial intelligence in developing countries to be specific. This is to raise issues of poor maintenance culture and partisan politics which can be associated with the requisite employment that will surround the implementation of artificial intelligence. In the rolling out of such a system, what is needed will be truthful and factual data which will be interpreted in the manner in which they are obtained. Eventually, data (images, videos and sounds) which will be obtained from the grounds will have to be used in the right respect. There should also be attention given to the personnel responsible for acting on such data for purposes of public safety (Firnorn and Muller, 2015).

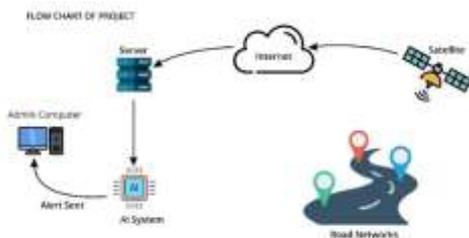
Transparency and effectiveness are critical to the functioning of artificial intelligence in transportation. Not to further stretch the argument, the reality that can be faced on the ground is that for political expediency, those at the helm of affairs can use personal data of political foes for their own benefits. This is not to become the ultimate use of the system. It is to be for public good and safety. This however, must not be left for subjective interpretation of those in charge of managing the system. There must be clear cut regulations that specify both the ethical and criminal misuse of the system. In the absence of penal systems there is room that will be created for these possibilities. It is not in the performing interest of any government that artificial intelligence becomes the new weapon for fighting those in opposition and also those who are in disagreement with the government on various issues. It is up to the government together with all stakeholders to ensure that total focus and

attention is given to the free and fair functioning of the system.

3.0. Conclusion

Looking at the facts available, there is an urgent need to improve the way and manner of approach needed when it comes to Transportation and Road Management in Ghana. Even though the research has covered a lot of areas that the AI can improve the Transportation system in Ghana, our proposal will however be on how to deal with the road management issues using an AI system. Our focus here is to solve the issues related to bad road network with ways to identifying them and eventually working on them to avoid traffic and accident. This Artificial Intelligence System that will be developed, will help identify bad Road from Good ones within our jurisdiction of study (Ghana). The AI System will be a Python based application that will incorporate image recognition to identify bad roads from good roads. The system will be linked to a server that will periodically collect images of the road network in Ghana. This will help the authority not to rely only on news items to know the state of the road networks. It will provide them with necessary report periodically and with location of the roads that needs attention. This AI system will be known as the Adasa Road Manager.

3.1. Process of the AI System on Road Maintenance (How it works)



Images of the roads networks within our jurisdiction of study (Ghana) is sampled periodically via images taking from satellites through google maps. These images are collected through the internet and stored in a server. The AI system is trained to identify bad road from good roads. The AI system is python base system that is programmed to identify images with specific attributes. The images of the road are categorized into three session, that is good road, bad road and fair road. The AI system has a set of algorithms that will let the system differentiate and group images acquired from the satellite into these three groups.

These three grouping are based on the attributes identified with the images gotten from the satellite.

When a road is identified as a fair road it means that it has minor issues like fresh small portholes that will need limited resource to address and fix. When a road is identified as good, then it has no issues and it does not need to be fixed. If the AI system identifies a road as a bad road, it means the road is damaged and can cause accident and traffic. This type of road will need immediate attention and reconstruction. In the first and third scenario an alert is sent to the authorities responsible for the management of the road network with report of the status of the road in question with geolocation and images attached to the alert.

Table 6. Table of A.I System Image Identification

Type of Road	Description of Road	AI System Action	Action Required
Fair road	Developing fresh portholes	Attention needed	Patch road
Good road	In good condition	No attention needed	No action required
Bad road	Portholes, damage road, no asphalt on road,	Attention needed	Reconstruction needed

This will make it easy for the authority to identify where and what to do with the road report from the AI system. A reminder will be sent regularly by the system to the authorities until the required attention need is fixed. This system is efficient and is not prone to errors since the AI is constantly trained with related images and the categories they are grouped. This system will element human interference and errors making data collect authentic. This system will also avoid the stress of Road Managers travelling across the length and breadth of the road networks in Ghana trying identify damaged roads. The System if implemented will also prevent the authorities responsible for the road management in Ghana hearing of bad or damaged road only from news items. It will give them first-hand information of the status of the road networks with related action to take.

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