The Issues and the Possible Solutions for Implementing Self-Driving Cars in Bangladesh

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***Abstract* - The main purpose of this study is to find the issues and suggest possible solutions regarding the implementation of Self-driving cars on Bangladeshi roads. A Self-driving car is fairly in its infancy today, but once implemented this can revolutionize our traffic management and transport system. This paper addresses some of the hurdles the technology might face in the country and offers a few measures that can be taken to overcome the downsides.**

Index Terms - Driverless car, Self-driving car, Autonomous car, Bangladesh, Developing country.

I. Introduction

As we are moving towards a driverless future, the technology is getting increasingly mature over time. What was once considered science-fiction, is now a reality. In the last couple of years, self-driving car technology has seen tremendous advancement. Many companies have already deployed their own version of driverless cars on the road.

Bangladeshi cities, especially the capital and other major cities, are renowned for their traffic jam. Not only traffic congestion is an everyday scenario in the country, traffic rules are seldom enforced properly. With non-standard roads, lack of proper parking facilities and broken traffic system, Bangladeshi cities are a nightmare for self-driving car's progress.

Despite these major concerns, it would be foolish to write off the benefits of this inevitable technology in a country like Bangladesh. While the authorities are taking measures like building flyovers, more roads, the issue is still likely to be persistent in the future given the increasing number of human and car population. An autonomous car system is probably the only solution to the traffic issues in Bangladesh.

In this research, there will be some proposals that can be implemented to mitigate the gap between Bangladeshi roads and the roads of the countries where self-driving cars are already implemented. While some of the proposals are purely theoretical at this point, with proper implementation, these can be proven effective.

II. Literature review

Some of the issues of Bangladeshi roads are highlighted in a paper published by World Health Organization in 2004 [1]. According to the document, Bangladeshi roads are filled with the non-motorized vehicle that often slows down the steady flow of traffic on major roads. Pedestrian jay-walking and over-involvement of large vehicles are among the other issues the paper mentioned. A more recent study shows that most of the traffic congestion is caused by mainly three issues: irregular car parking, street dwellers and pedestrian walking on the roads instead of footpaths that have been occupied [2]. Another issue that might become problematic for self- driving cars in Bangladesh is country's bad roads filled with pot-holes here and there [3]. While all these problems can be solved with proper infrastructure improvisation, traffic mismanagement and lack of enforcement of traffic rules remain to be the biggest problem in the country regarding transportation system [4].

Now have a look how far self-driving technology has come to get some ideas about the potential of the technology in Bangladesh and possible drawbacks country's troubled transportation system might bring forth.

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The breakthrough in the field of self-driving car system came with the inception of modern electric cars from makers like Tesla and the introduction of their Autopilot system [5]. Autopilot can substitute the role of a human driver and operate the car under various circumstances.

It is said that the autonomous car industry will only get bigger from here one. According to Zack Kanter, Uber - the US car-pooling giant's autonomous car is expected to replace at least 10 million jobs and have a major impact on the country's economy [6].

Perhaps the biggest achievement in driverless car technology is Google Car project [7]. The car is already in deployment, has travelled many miles on itself, and is learning and adjusting itself to new scenarios dynamically.

These were possible by the growth of Machine Learning and Artificial Intelligence in the last decades [8]. Computer hardware makers like Nvidia are now coming with their Ai powered supercomputer platform dedicated to self-driving cars. The Nvidia Drive PX can sense surroundings precisely in a friction of time [9].

Today's self-driving cars can detect other vehicles, pedestrian, traffic lights with great accuracy. The cars use a combination of sensor data and advance machine learning to replicate the driving prowess of a human driver. Google car among other things, can calculate the most efficient path, abide local traffic rules, park when necessary and change lane if required [10].

III. Issues

The issues regarding the implementation of a self-driving car in Bangladesh can be broken down into the following categories. The issues may alter in the future should the situation change for better or worse.

A. *Broken Roads*

As mentioned in the paper published 2004, many roads in Bangladeshi cities are the victim of waterlogging problem [3]. As result, the roads get broken after a few months of inception, leaving potholes and fractured spots everywhere. The drivers in the country often change their lanes, brake unexpectedly to avoid running over these spots. This is very problematic for current self- driving cars since they are not used to these types of roads. The cars might run over these spots and cause damage to it and its passenger in the process. Not to mention the unexpected lane changing and braking might confuse the cars that could lead to accidents.

B. *Congested Roads*

Due to Bangladeshi cities being one of the most densely populated in the world, the traffic jam situation in the country is alarming. Even when it's not a busy hour, the roads will be filled with vehicles [2]. The situation gets worse as the cars do not follow traffic regulations. The drivers try to cramp up space by putting their cars as close to others' as possible. So, when there's green light, it takes a car more time to get itself out of the cramped space and move forward, resulting in more traffic jam and congestion. This is also a foreign territory for today's self- driving cars. The system will need proper modification to adjust to such conditions.

C. *Lane Changing*

Most self-driving cars that are in deployment today can change lane efficiently if required. But their ability is untested in an adverse situation like Bangladesh's. Most cars in the country do not maintain lanes. The cars are all over the road despite there being laws against it [1]. This is particularly tricky for a self-driving car to comprehend. Current self-driving cars are designed to oblige the lane maintenance rules in the streets. But when almost every other car is breaking the rules, it becomes harder for the car to be the only one abiding.

D. *Parking*

Unlike most developed countries, Bangladesh lacks the proper amount of parking spots in the country [1]. Unsurprisingly, most drivers will try to park their cars in the streets, blocking the steady flow of traffic. As our self-driving car needs to park at its destination, it must have prior information about designated parking spots. Bangladeshi roads will become a hard nut to crack for self-driving cars in this regard.

E. *Manual Traffic Control*

Although the government has tried to enforce automatic traffic control several times in the past few years, the huge amount of traffic and the inconsistency made it harder to maintain an automated system. Almost every traffic section in the cities is controlled by traffic officials manually [4]. They use hand gestures and voice to control traffic. This is very hard for a self- driving car to comprehend unless a proper adjustment is made to the said area. If the car is deep in the queue, it becomes worse for the car to understand traffic signal.

IV. SOLUTIONS

To overcome the issues, we are proposing a few measures that might help a self-driving car operate as intended.

A. THE PROTOTYPE

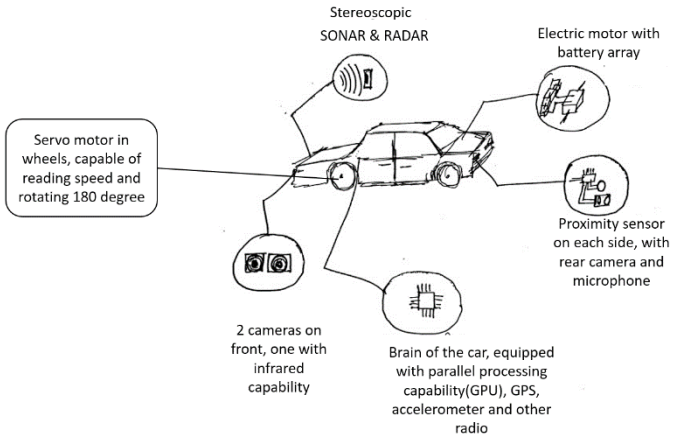

Fig. 1 The proposed prototype

Our proposed prototype has an array of sensors embedded in it. The brain of the system is an ARM CPU capable of exchanging data with the sensors and fast enough for calculate millions of data per second. Since our car will use machine learning, it will need heavy parallel computing power, for that reason, the CPU will be accompanied by a more powerful GPU. The cars will be controlled by Servo motor controller, capable of reading its rotational speed and rotate the wheel 180 degrees.

Instead of using rotating cameras on top, we will be using 2 cameras on the front and one on the rear. One of the front cameras is capable of infrared imaging, they will be placed in such a way that a stereoscopic 3D image of the environment can be produced.

Each side is equipped with a proximity sensor to detect other objects' distance. This along with the infrared sensor will make sure objects are identified no matter the situation.

The SONAR sensor is also stereoscopic. They can read the depth and dimensions of any surrounding objects.

There are other sensors like GPS and accelerometer; they will help determine the location and position of the vehicle.

The car is powered by an electric motor in the back with PWM capability. An array of battery is powering the motor and can be charged fast with home mains.

B. BROKEN ROAD PROBLEM

The car will deal with broken roads by using any combinations of total avoidance and/or slow run over in damaged streets. The car will first detect a damaged area by using its front camera(s) and its infrared and Sonar capabilities. Once detected, the car will make a virtual rectangle of the damaged part so that the rectangle contains the damaged portion in its vicinity. The car will then calculate the amount of space left in its current lane, if there's enough space for it to move through, the car will simply avoid the potholes. If it's not the case, there are two possible outcomes. The car will either change its lane or run over the area with causing as fewer damages possible by slowing down its speed.

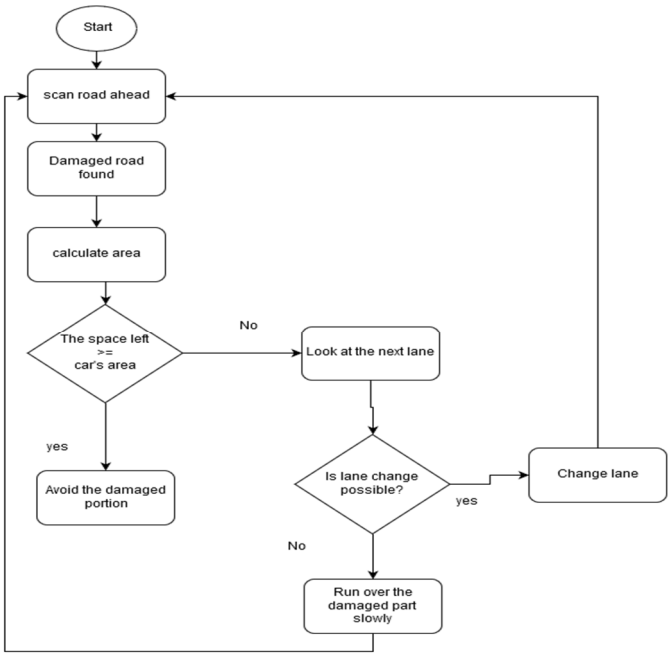

Fig. 2 Damaged road avoidance

C. CONGESTED ROAD PROBLEM

Once the Red light is on, the cars start cramping up as much as possible. Our car's goal is to keep its safe distance from other cars until the following triggers are executed. The triggers being: Cars in the back asking for space, people using voice or hand gestures to let their cars go. One of the ways our car will detect this is by judging the amount of space in front of it with the approaching of that car and/or rate of its honking. This is so-called "Loose mode" where the car will act against its regular will and cramp up space like other cars. In this scenario, the car will use its proximity sensors, cameras and sonar sensors to detect whether it's in a congested place. As for human gesture recognition and voice detection, the car will use its microphone, camera(s) with the natural language processing and image recognition system.

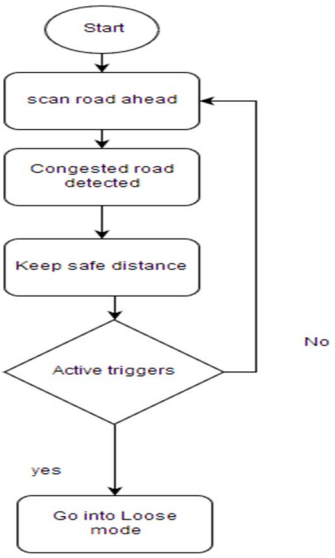

Fig. 3 Loose mode

D. *Lane Changing Problem*

Lane changing will be triggered if any of the combination of the following triggers is detected:

1. Car needs to speed up but is in a slower lane.
2. The car needs to slow down and is in a faster lane.
3. The car is in the wrong lane
4. Car wants to stop/park.

The car will first determine the lane it wants to switch to. It will then calculate the lane distance and decrement the distance with each lane switch. The car will only switch lane if no vehicle in the targeted lane is approaching or has any chance of being while the car is changing lane. It will also check whether lane changing is allowed in the street. If these conditions are met, the car will continue to change its lane until the target lane is achieved.

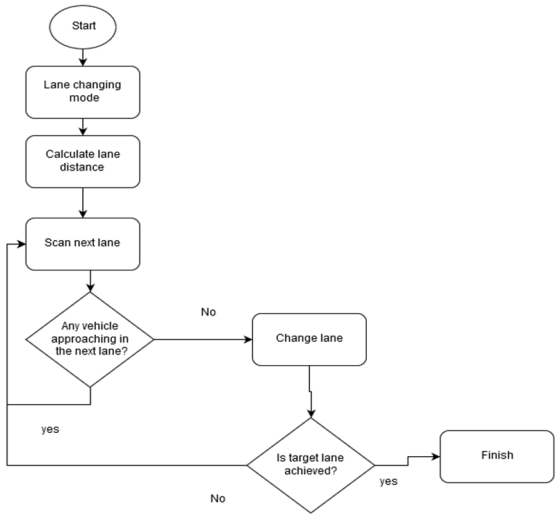

Fig. 4 Lane changing mode

E. *Parking*

The car needs to be in the parking mode for this to work. Parking mode is triggered when the car needs to stop for an emergency, has arrived at the destination or is asked by the passenger to stop. In this mode, the car will look for designated parking spots in the area, if no such area found, the car will go in to "Loose parking mode." In this state, it will look for an extension of the road that might be a potential parking spot. If the width of the extension is equal or bigger than the car's width, it will park itself in the spot, provided it's free. How long it will stay in the spot depends on user's return and spot's occupancy.

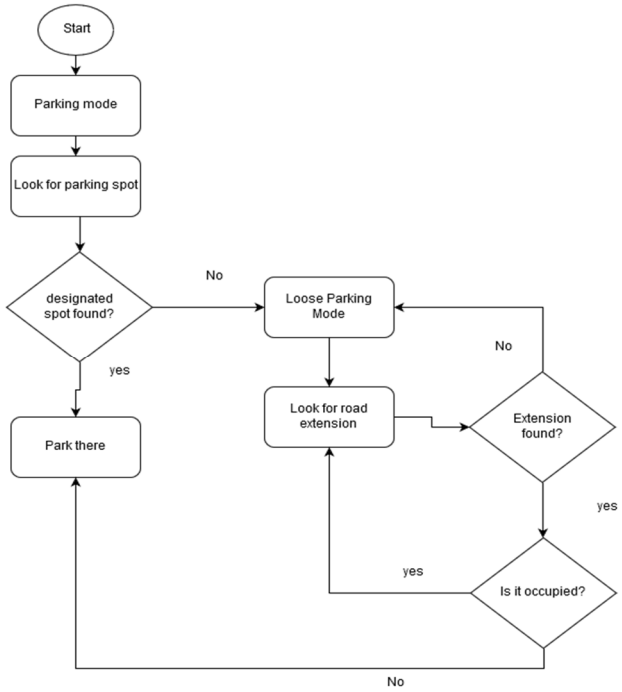

Fig. 5 Loose parking mode

V. CONCLUSIONS

Self-driving cars have potential to become the permanent solution to Bangladesh's infamous traffic problem. In this research, we have tried to achieve just that by finding out the issues and possible solutions. Despite our limitations like not having an actual self-driving car and lack of funding for building a prototype, we believe our study is a good path forward for other researchers to follow. We have made necessary adjustments by observing our simulations. If the simulations are any indications, it will be possible to build a prototype on this that will work on Bangladeshi roads. With proper implementation and adjustment, Bangladesh can also take part in this driverless car revolution.

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