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An approach to a microcontroller based GPS controlled autonomous bus

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Abstract: In many cars and buses GPS system has already been installed. But in those vehicles GPS signal is not used for controlling the wheels of the bus. In this project the signal from the GPS is feed to the microcontroller which will move the wheels of the bus and the bus will move in the specified direction. As the bus moves it will take care of all the safety measures like avoiding the obstacles. In this work the focus is also given on detecting the bus-stop and also the traffic signal. The main concern of this work is to reduce the accidents caused due to human errors. Hence, in this work the human intervention has been minimized thus increasing the accuracy of the bus.

Keywords: GPS, Obstacle Avoider, Traffic Light Detector, Bus-Stop Detector, 89c51 microcontroller.

I. INTRODUCTION

The 21st century has seen a huge development in technology. Due to this, the number of vehicles also started growing at a rapid pace. BUS, one of the most common transport systems around the world has also been increased to compensate the number of passengers. But, due to this the number of road accidents has also increased rapidly. One of the major causes of these accidents is reckless driving. The drivers sometimes start racing among themselves causing life risk to the passengers. The drivers stop the bus anywhere they wish to pick up passengers; hence causing a disturbance in the traffic leading to accidents. Sometimes they don't even hesitate to defy traffic rules.

So, in this project we are trying to build an autonomous bus which will move without any driver or helper. The route of the bus will be determined by GPS technology. The bus would be capable of avoiding obstacles, halt at traffic signals and at bus stops as and when required. In this way the traffic would be smoother and the rate of road accidents would come down. Hence, people would be able to travel more safely.

II. PROPOSED MODEL

The whole system is controlled by a centralized microcontroller which will have an inbuilt program which will receive the signals from the webcams and the sensors and see whether there is a bus stop, obstacle, the condition of the traffic light and then tally with the GPS system to find the route and move the wheels accordingly.

The Fig.1 shows that the different independent modules as the obstacle avoider, traffic light detector, bus stop detector and the GPS system are giving their inputs to the 89c51 microcontroller. The microcontroller following a complex algorithm decides which operation is to be done and controls the movement of the bus accordingly.

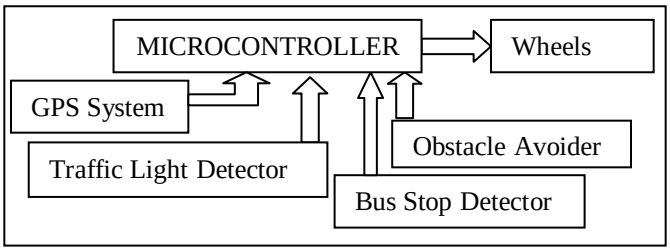

Fig.1. Diagram Showing the Working of the Automatic Bus

III. FEATURES OF THE BUS

All the features that will be present in the bus are already being used separately in various places. These modules are being assembled with a few added improvements to create the ultimate automatic bus. The various modules that will be used are described as follows:

A. GPS Control

The bus will contain a GPS system which will specify the route the bus will have to take. The signal from the GPS will be directly feed into the microcontroller which will then move the wheels of the bus in the required direction to reach the specified destination.

The GPS works in a process known as trilateration [1]. At present there are 30 satellites out of 24 are constantly used and 6 are kept for backup. 4 satellites are selected according to longitudinal & latitudinal position of the moving bus [2]. The first satellite encircles the bus by its radius according to its surveillance zone. Now the second satellite will do the same in order to get an approximate location of the bus. The common intersecting area is chosen from both satellite data and the third satellite gets informed about the previous result. It is then used to locate the nearer proximity of the bus after getting the closer focus on the real location of the

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bus and an approximation about its longitude and latitude position. At this instant, to get a perfect point of location, the fourth satellite joins in; it encircles the common intersecting point of the previous three satellites and calculates the nearest approximation about the location of the bus. The speed as well as the direction is also found out.

In order to get the direction from one point to another, the GPS uses a preloaded universal map data, the landmarks, road names, city names and other information are updated frequently. Each satellite has its own onboard time clock that can predict real time difference of object to reach from one place to another.

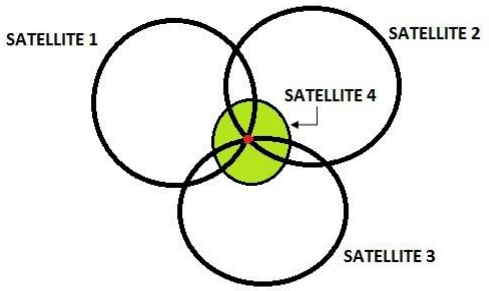

Fig.2. Diagram Showing the Working of the GPS Locator

GPS modules have a serial port to make a connection with microcontroller to fetch the data. Once the GPS module is powered, NMEA (National Marine Electronics Association) [3] data is sent out of a Tx pin at a specified baud rate and update rate. To read that data, the Tx pin of GPS is connected to Rx pin of a microcontroller. To configure the GPS module, the Rx pin of GPS is connected to the Tx pin of the microcontroller. There are 19 kinds of NMEA data that should be parsed so that a microcontroller can use the data coming from GPS module. Once the data is resolved, the microcontroller can manipulate it as required. NMEA data is prefixed with GP for GPS receivers, and the data is separated by commas so that it can be distinguished by processors. There are 19 types of interpreted sentences in NMEA data, amongst them $GPRMC is the most important one for this type of project.

B. Bus- Stop Detection

The bus is supposed to stop at the bus-stop for passengers to get down or board the bus. So for the bus to detect a bus-stop there will be a signal that will indicate that there is a bus-stop ahead. The bus will have image sensors installed in its left side which will sense the signal and send it to the microcontroller which will be programmed to decelerate and stop at the bus-stop. Here the buses will stops and opens the door for sometimes intended for passengers to board or leave the bus. After that the bus will again start moving on its route given by the GPS system.

In this project, by making the buses stop only at stipulated bus-stop decrease the people boarding the moving bus hence reducing the number of accidents caused due to this reason.

C. Traffic light Detection

The bus would have image sensors in front of it which will search for a traffic light. On detecting the light [4] it will send the feed to the microcontroller which will tally it with the direction given by the GPS and take necessary action as mentioned in the program, i.e., it the image reckon with the intended direction, the bus will continue moving, else the bus will come to a halt. Here it is considered the traffic lights would be red, right arrow, left arrow, forward arrow and U-turn. Now, if the signal shows red light, irrespective of any input from GPS, the bus will come to a halt. On the other hand, if the image received is an arrow, it will tally with the direction the GPS is indicating. If they match then the bus will move in that direction otherwise it will come to a rest and keep checking the traffic signal. Thus, traffic rules are followed and unnecessary casualties are avoided.

D. Obstacle Avoider

It may happen that when the bus is moving, there is an obstacle in front. So the bus will initiate a slowdown ultimately resulting in a halt following a calculation of the speed of the bus and the distance of the obstacle as soon as the bus detects it. Proximity sensors [5] are placed in the module which will not only detect the obstacle [6] but also calculate the distance of the bus from it. The module gives this input to the microcontroller which performs the required calculations and takes the necessary actions to stop the bus thus avoiding the accident.

In future, the work may be improved to find the algorithm which would be able to find the shortest path and over take the obstacle if there is space available in the path. For overtaking we may install four webcams at left and right corners of the front and back which will detect that whether it is able to get space for overtaking and if it is possible it will overtake.

IV. WORKING OF THE MODEL

The working of the bus is based on simultaneous inputs received from the different modules into the microcontroller. The two interrupt pins INTR0 and INTR1 receives the interrupt from the obstacle avoider module and the bus-stop detector module respectively. During initial conditions when there is no interrupt, the microcontroller takes the input from the GPS system about the direction [7] in which it should move the wheel. The present location and the destination are preset in the bus from the place where it starts. Thus, through the GPS system we get the direction. The directions are fed into the microcontroller and by finding the exact command regarding the received input, it gives a desired output. In this way the bus starts moving towards the destination.

The bus starts slowly. If there is no interrupt and it receives the input that it has to move forward, it starts increasing its speed step by step to a set upper limit. On the other hand, when the bus receives an input to turn left or right, it starts

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decreasing its speed well before the turning point to a predefined safe level.

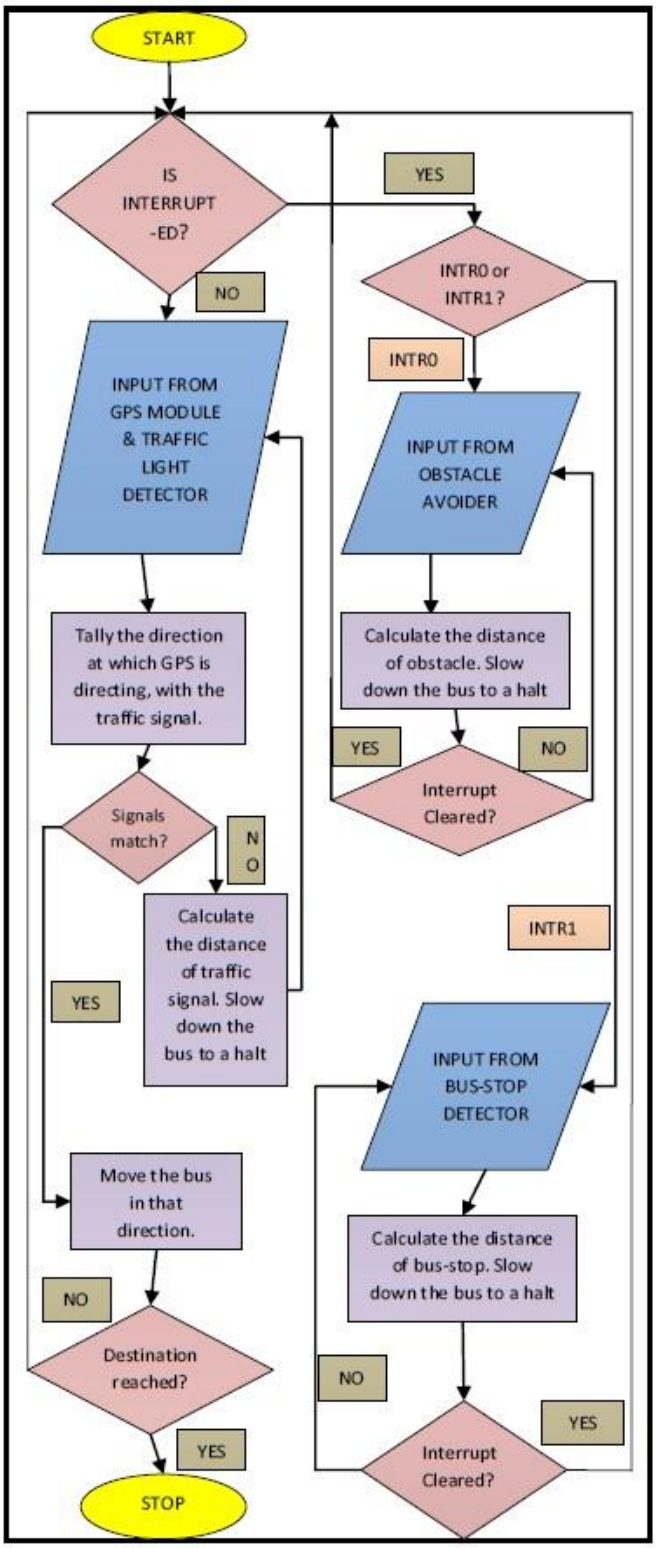

Fig 3. Flowchart showing working of the bus.

As it moves the other modules are active. Whenever an obstacle is detected, an interrupt is activated. The interrupt service routine (ISR) of the obstacle avoider is fetched. In the interrupt service routine, the microcontroller takes the detailed input from the obstacle detector module. The details contain the distance of the obstacle from the bus. The bus already have is current speed. The controller then calculates the time within which it must stop in order to avoid accident. Having calculated the time, the controller divides the speed into which it should drop before coming to a halt. This is done so that the bus does not come to a halt suddenly hence causing the bus to overturn. In this way the bus slowly comes to a halt in front of the obstacle. The bus stays in this position until the obstacle moves from the way, that is, it moves away at a certain distance where the obstacle avoider module cannot detect it. When the interrupt is cleared, the program leaves the ISR and returns to the main function. Here it again starts increasing its speed according to the input received by it from the GPS module.

The other interrupt that the bus receives is when the bus-stop is detected. Here the bus-stop is considered to be ideal and every bus-stop has a signal in front of it which the bus will be able to detect. The bus-stop detection module on receiving the signal sends an interrupt to the microcontroller. The program then enters the ISR corresponding to that interrupt pin. Inside the ISR, the microcontroller again receives the distance of the bus-stop and finds the time within which it must stop. The controller then slowly decreases the speed of the bus following a set algorithm and stops at the bus stop. At this point the doors of the bus open. The doors remain open for about 20seconds for people to board the bus or leave it. After this the doors get closed and the program returns to the main function. As the program returns to the main function the vehicle again starts increasing the speed according to the set values and input from GPS module. This module is necessary because using this process; the bus will stop only at the destined stoppage thus reducing the risk of people trying to board the bus at any juncture facing accidents. The doors also open only at the intended stoppage thus preventing people from boarding the moving bus. Hence this feature is one of the most important in this project.

As the bus moves, a sensor is placed on top of the bus which detects the traffic light. It has been considered that the traffic signals are all at the same level and it does not come in level with the intensity of sun light, street lights or other interference. The sensor detects the traffic signal as an image and tallies it with its predefined database. If the signal is red, the bus slowly decreases its speed and comes to a halt in front of the signal. When the signal shows the direction of the traffic, it tallies with the direction the GPS is prompting. If they match then the bus moves else it comes to a halt. For example, if the signal shows the direction for right bound traffic, the bus finds the GPS system is also prompting in that direction, the bus moves; otherwise it comes to a standstill.

The controller not only checks all these functions but it also controls the movement of the wheel. As the bus is a

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mechanical system, the controller has to send its output to a motor driver. The motor driver on receiving the required signals turns the wheel accordingly [8].

V. CONCLUSION AND FUTURE SCOPE

The main advantage of this work is that there are multiple features in the bus which will help the bus to travel safely. All the aspects have been taken care of so that there are no safety breaches that will give rise to casualties. Here various features have been implemented in the bus which can be used for practical use. All these aspects are necessary for even a person who is driving a bus. The work that a driver must do while driving a bus, those features have been implemented except the fact that the bus is not controlled by the driver.

The main drawback of the project at this moment that may hamper the smooth drive if the bus is the quality of the image taken of the traffic signal and the bus stop during fog and rain [9]. Another drawback of this is its inability to overtake. These problems are going to be encountered in future. Many countries like India where roads are very much congested, the implementation of such traffic system can be a bit problematic if the quality of traffic signal is not being improved, indeed this project can be implemented in near future traffic system, worldwide.

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