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Full Length Research Paper

A novel identification and monitoring technique of multi ID public transport for station reporting

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The intercity passenger market has been expanding rapidly. Nowadays, it is easily observed that many people stand on the bus stations in order to get their desired bus, but sometimes it takes too much time for them to, due to many remarkable reasons. In this research, a new intelligent model for multi ID buses movement monitoring and station reporting system based on GPS and succession of RF Transceivers is presented. With this trend, wireless sensor networks for position tracking of a particular vehicle have been considered new parts for the proposed intelligent transportation systems deployed into buses station networks in order to enhance further the monitoring plan. In addition to some fundamental functions such as real-time monitoring, some featured functions are tightly combined to make the system compatible with the daily operations of any public transport scheme. The proposed method will surely improve the linear transmission to the bus stations which led people to take decision either to wait for the bus or not.

Key words: Global positioning system (GPS), buses monitoring system, Xstreme transceiver, embedded system design

INTRODUCTION

Passengers at the bus station had been the victims for long time especially in the big cities where the public transport facilities are not compatible with the city's problem. Public traffic facilities with high-tech and intelligence system have been a standard to estimate the development of the country and its international image (Liu, 2008; Zhang et al., 2007). Nowadays, passengers want to get the clear information of the station like the position and estimated time of arrival of bus etc. So the extracted problem statement can easily be justified in the under developed countries where significant amount of people are found travelling using public transport.

Before the advent of the newest navigational equipment and transmission tool, the traffic monitoring infrastructure has mainly comprised the specific equipment, such as loop detectors, cameras and radars. Through the development of GPS technology, conventional navigational methods have been replaced. Currently, GPS is the tool for a large number of kinematic, monitoring and other applications. By utilizing GPS for the surveillance of vehicles and the traditional display of several parameters, the use of its data had been a part of many papers and researches for real time monitoring, but no progress has been observed for the efficient transmission of coordinates, using embedded systems, and to manage the accuracy of getting optimum calculation by the modern technology cooperation. The application of GPS in the land transportation system was explored by Mintsis et al. (2004). He suggested a traffic monitoring system based on GPS-enabled smart phones and exploits the extensive coverage provided by the cellular network, in position and velocity measurements provided by GPS devices, and the existing infrastructure of the communication network. Kai et al. (2008) proposed system is about the entire system using the existing GPRS network to transmit information collected from the GPS module to the IP-fixed control centre in the internet.

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He gave some good answers related to long distance wireless transmission in his article. Hu et al. (2009) developed a navigational system for the overall solution on Beijing Bus Monitoring System (BJ-BMS) based on GPS. The BJ-BMS is composed of GPS satellite positioning and ground moving control system and the ground moving control system is divided as on-board GPS terminals, GPRS mobile communication network, transmission center server, client background program and GIS interface. Ming et al.'s (2007) article is based on positioning and tracking of construction vehicles in highly dense urban areas. In his paper, he reviewed previous radio frequency (RF)-related research in construction and further evaluated the pros and cons of several RF-based technologies including GPS, RFID and Bluetooth for monitoring and applying GPS for tracking construction vehicles in a dense area by conducting extensive field tests.

The related art clearly described that in the vast areas of Inertial Navigation System in the field of public transportation, the key issues are the consistent monitoring system with reliable error compensation using maximum faultless techniques. This paper focus on developing a new monitoring system for buses based on intelligent system. The package of designed embedded system consists of the advanced control technique comprising the master part, mounted on the bus, and the slave part, mounted on every bus station. This system would be able to expect the time as well as position to display the graphical LCD at every bus stations found at every particular route, in the convenient way for the persons that come to the bus stations. This required core software is used for programming the setup and creating a replica of the real network. While the bus is on the move, its real-time parameters such as the position, estimated time of arrival, the delivery date and time, the shipping origin and release date, finding the last location and event etc, could be observed. Although many researchers have addressed and proposed monitoring systems to track vehicle or critical moving objects, but still the accuracy is the big question mark. So for the optimum calculation and accuracy, the proposed system suggested the looping of installed embedded radio chip found in every bus station. So the system will be responsible for collecting GPS data and transmitting it to the base station and mainly to the bus stations found in the way to bus routes by means of navigational processing.

The base and bus station hardware is responsible for receiving the GPS data transmissions and making them available for the computer and graphical display. The software part includes the monitor and IDE parts. A graphical user interface (GUI) and a software management package are also developed to monitor and maintain the system. MPLAB has been selected as the IDE and C18 as the compiler for the advanced controller unit as explained by Mazidi et al. (2008). So both the hardware and software solutions are integrated in the proposed system to make it most reliable and user friendly.

This paper is organized thus. It introduces the theoretical background and context related to GPS system and its transmission tool. It contains the proposed system and its smart error reduction techniques with implementations. Finally, it talks about the experimental result and gives the conclusion.

THEORETICAL BACKGROUND

GPS system

The GPS system as explained by El-Rabbany (2002), consists of 24 satellites in the orbit around the earth, and its positioning is available 24 h a day all around the world. GPS satellite actually transmits two power radio signals, termed as L1 and L2. The GPS used by the civilian is L1, having frequency 1575.4MHz in the UHF-band. It contains a 'Pseudo random noise' code along with 'ephemeris' and 'almanac' data. Ephemeris data contain a very precise orbital and clock correction message as well important information about the health of the satellite, while the almanac data consist of coarse orbit and status information for each satellite in the constellation. However, an iono-spheric model and information relate GPS derived time to the coordinated universal time (UTC). The user segment utilized the direct line of sight GPS satellite signals to determine the user position velocity and time with accuracies specified by various receivers. It measures the apparent transit time of the satellite signals to the user, described already as pseudorange, and it consists of the propagation delay and receiver clock bias.

The major cause of error in the existing system

Two important error sources for precise geodesy with GPS are phase multipath and direction-dependent variations in the antenna phase center as described by Chiang et al. (2009) (Geodetic applications generally mean the carrier-beat phase and the primary GPS observable). Both of these problems are discussed from the basic drawing of GPS antennas, which are required to accept radiation from multiple directions simultaneously. The effect of GPS locational error is especially critical when a bus stop is close to another one in urban areas. For this purpose, Xu et al.'s (2007) method was put forward on error compensation of velocity and position coordinates by the GPS using 'neural network'. His research aimed at an effective solution that can estimate and correct the navigation errors caused by the initial misalignments as well as the inertial sensors errors by utilizing neural network ensembles with the Kalman filter. In Rashad and Aboelmagd (2005) idea, it aims to introduce a multi-sensor system integration approach for fusing data from INS and GPS utilizing artificial neural networks (ANN). A multi-layer perceptron ANN has been recently suggested to fuse data from INS and differential GPS (DGPS). The multi path error compensation was elaborated by Axelrad et al. (1996), while the error factor in the GPS based station reporting system was analyzed by Bo (2006). Lundberg (2001) presented two new closed form algorithms as an alternative for the GPS static positioning solution.

Amongst all studies cited, some gave good answers for the effective wireless navigation system of the buses location, while some provided optimization based ideas, but these measures and dimensions have not been consolidated in an integrated framework where different views are considered along with multiple goals. For effective design of decision support system, it is important to link the measures of performance described in the literature to a single monitoring system that represents multiple factors/dimensions of performance. In the proposed system, the signal multipath error is more significant to be considered. It is because multipath occurs when signal from satellite bounce off various local obstructions like buildings, etc., before it gets to the receiver at the bus. For this purpose, it is either some artificial intelligence techniques are utilized, or the intelligent transmission modeling is suggested to make the overall system close to the real world and implementable.

Transmission tool

Wireless data communication technology is the core technology in collecting position data and operating information for most of the monitoring and management system. Currently, the wireless technologies are growing day by day. Many enhancement and innovations are going to be observed in the field of wireless technologies. Beside satellite communication, long range point to point or point to multi point communication protocols have been developed. The beacon resembles the RFID tag in functionality, but operates on the bluetooth for establishing communication links with the in-vehicle navigation unit. In addition, the real-time location and status of a particular bus can be transmitted to the bus station by the use of short message service (SMS) over mobile phone networks as discussed in the literature cited before. Also, wireless communication technologies such as Wi-Fi (IEEE 802.11b) and ZigBee (IEEE 802.15.4) have enabled wireless LAN (Local Area Network) and PAN (Personal Area Network) and are also widely used for tracking and automation applications. In particular, ZigBee holds the promise of providing a more cost-effective wireless sensor technology and replacing Bluetooth. This change in scale of communication network activity has to be accompanied by technological changes to the management system. That is why many researchers are keen on utilizing this rising wireless technologies discussed by Bong et al. (2007), especially in the transportation based navigation systems. Beside, Herrera et al. (2010) evaluated the traffic monitoring system by utilizing the GPS enabled mobile phones. The increasing utilization of this technology in almost every walk of life encouraged its use in this research. For this purpose, specially designed long range XSTREAM RF modules are selected. The Xstream module provides OEMs and integrators with reliable, long-range wireless data communications. The module typically yields two- to eight-times the range of the competing RF modules due, in large part, to its superior receive sensitivity. Since the system must be carefully examined for transceivers capacity to collect and transmit information about the operating dense urban area, the onboard high tech MCU is selected and is made fully compatible with the overall system as well the transmission modules through software. The novelty of the proposed frame work lies in the intelligent configuration of these embedded radio chips which are carefully made companionable for the better system design.

METHODOLOGY

According to the present invention, the GPS based multi ID buses monitoring system is a first embodiment of the bus navigation system in which accuracy measures are given importance. The structure of the presented bus monitoring system can be differentiated into two major parts, comprising master and slaves 1 and 2. Firstly, the GPS bus system module is provided with the signal received from the satellite by GPS antenna, and is typically considered as the input to the master part of the so called terrestrial C/A code. The GPS receiver system digital samples filter and store a segment of 11 half chips of the received composite as a binary number and multiplies this number by a parallel correlation with each of the series of multi bit code replicas for the satellite to be tracked. Secondly, after tracking the position coordinates, the advanced wireless protocol is utilized to transmit the acquired signal if the coordinates matching the control unit is successful, to the slave part 1 and so on. This is considered as the output to the display which is the real time position monitoring. In Figure 1, an overall GPS navigation system that incorporates the aspects of the proposed invention is shown.

In order to initialize the system and continue it in the most convenient way, the bus operator has to input some current data

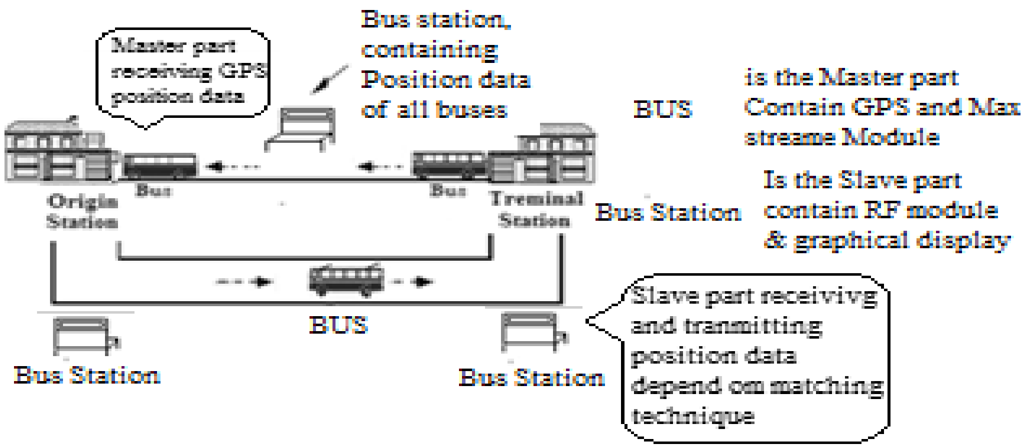

Figure 1. Bus monitoring system.

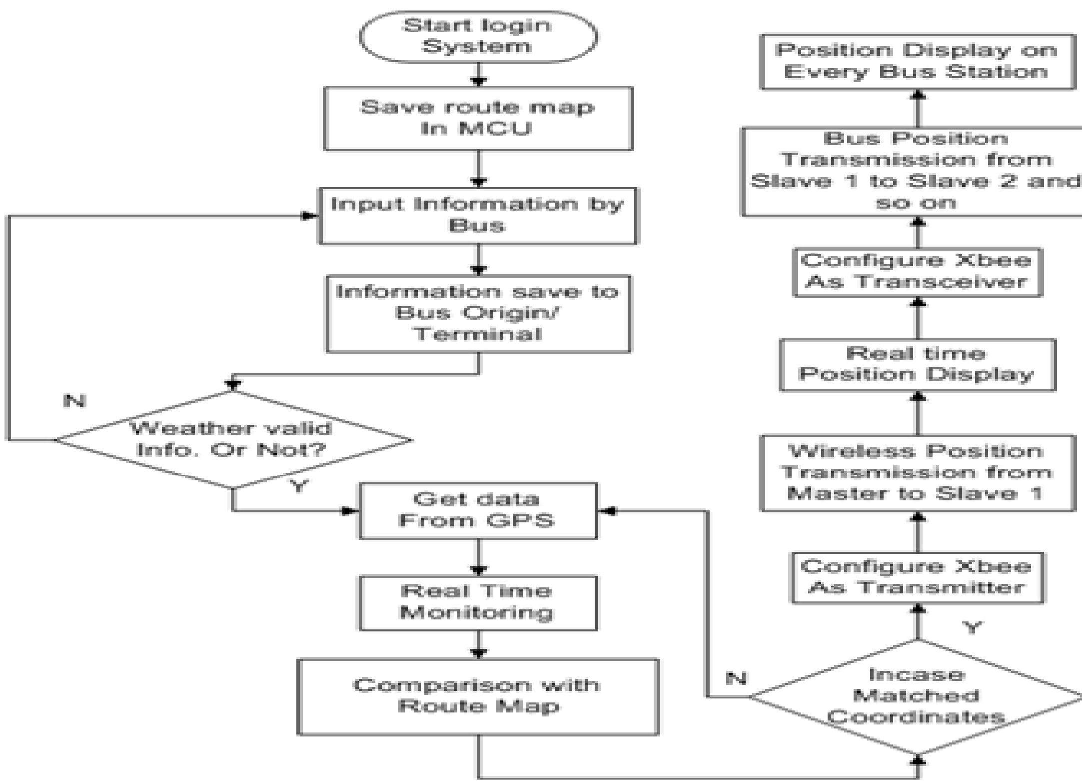

Figure 2. Process flow of bus monitoring system.

like bus unique ID, time of departure and another sign like either 'up' or 'down' (input information by bus) and surely provide the output to all the bus stations that appear in the particular bus route, for example GPS map display of the current location of bus through wireless. The intelligent system is designed to make several decision based on the scenario. Figure 2 shows the overall proposed designing process flow of the buses monitoring system.

Hardware designing

In the practical monitoring system, using GPS, certain time intervals can be set to update the latitude, longitude and time data according to the need in order to get the space positioning data. The GPS module that is used follows the NMEA0183 protocols. In most of the navigational systems, the positioning data we are concerned about

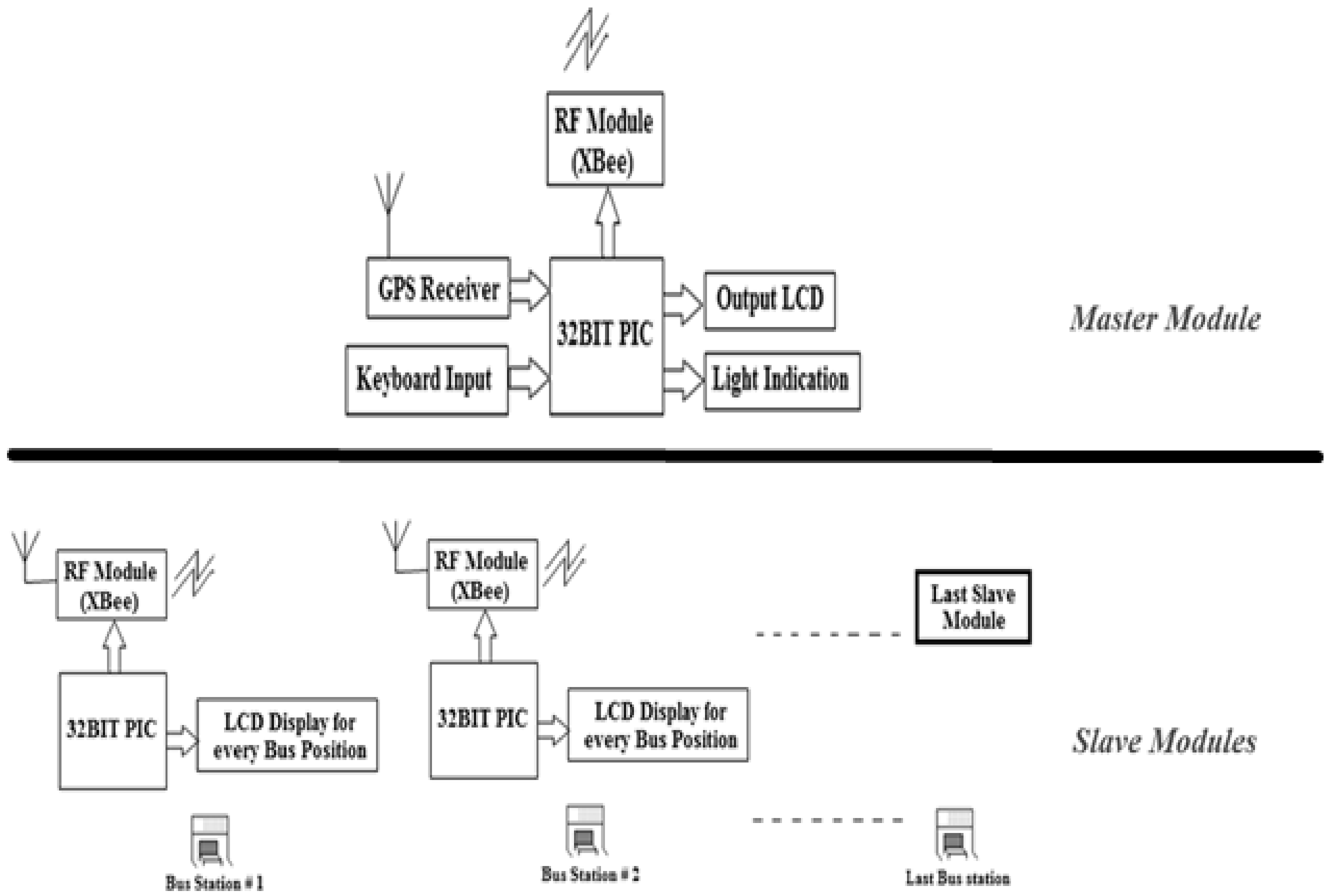

Figure 3. Overall system hardware.

such as latitude and longitude, speed and time can be gained from the "$GPRMC" frame which the GPS receiver sends to the MCU. So this study's bus positioning data can easily be selected by using this frame. However, the output baud rate is 4800. MCU communicate data with GPS module by serial port. This is the standard asynchronous communication mode. When the same baud rate of MCU is set with the GPS output baud rate, the GPS module will send the positioning data to MCU by serial port. It is programmed to allow MCU to receive and store data, and then the bus location will be calculated. Complexity is ensured to reduce by dividing the entire presented system into two basic parts: master part and slave parts 1, 2 and so on, depending on the number of bus stations as shown in Figure 3.

Master module

This designed will provide the right answer for multifaceted problems found in the existing buses monitoring system. The whole proposed system is typically divided into two basic parts, out of which one is the master. This part is embedded on every bus. The system comprises the 32bit PIC produced by microchip. MCU is responsible for receiving information, which means it will receive the positioning information sent by GPS module to MCU, deal with the input of keyboard information, like bus unique ID, either 'up' or 'down' and time of departure. MCU will compare the bus position information received from GPS module with the station position information recoded in advance. In case of matching, the advanced RF module will be triggered just like the transmitter first corresponding actions (such as the display of position, time of departs and the special sign to recognize which side the bus is coming from) by the system. In a word, MCU is responsible for the control and management of the system. At the same time, it will connect the slave parts wirelessly in order to transfer GPS data.

Slave modules

The novelty of the study lies in the slave modules, which are a critical part of this paper. As discussed in the literature cited, several measures had been taken to send the buses location down to specific bus stations, but due to many reasons growing day by day, most of them seem unable to provide reliable solutions to the suffered passengers. For this purpose, special algorithms are designed to operate the number of slave modules corresponding to the number of bus stations. These algorithms made this decision support system capable of holding the promise to overcome the lacks of past research. So a number of steps are described to

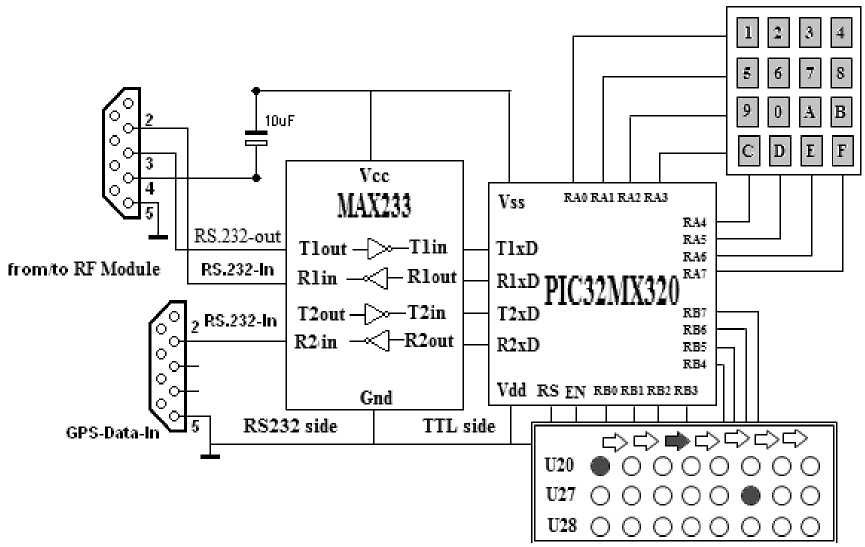

Figure 4. Generalized connection diagram.

facilitate the passengers waiting for the bus. When the bus (master module) is ready to move, after some data are inputed as described previously, the master system will be configured first as the transmitter and the nearest bus station (slave module 1) will be configured as the receiver similarly. So after login the system, the master module will receive the GPS signals for the bus location, then after matching with the predefined coordinates being saved in the registers of MCU, it will literally start to transmit to the first nearest bus station. Now when the bus is on the move, the slave module 1 will be configured as a transceiver and will send the bus position data to slave module 2 (2nd next bus station) and so on. This chain for transmitting, receiving and displaying the bus positioning information will last until it gets to the final bus station for every bus found in the particular route as shown in Figure 2. Regarding the display, the graphical LCD is selected. The main concept is designed via core programming to provide maximum benefits to the passengers. The facilities contain the current position of the total buses coming to a particular stop, even if any of the buses found in between two bus stops, would be shown by the arrow in between the targeted stops with spaced out poles IDs.

The connections

In this part, there are three key modules: MCU: PIC32MX320, GPS module SANAV FV-M8 and the advanced wireless: XStream RF Modules (IEEE802.15.4). The MCU of the embedded gateway is 32 bits and it is produced by MICROCHIP, designed to provide a cost-effective and high performance microcontroller solution for general applications. To reduce the total system cost with maximum efficiency, it also provides the following: speed 80MHz, 1.56 DMIPS/MHz, 32-bit MIPS M4K Core, 2-channel UART with handshake, System manager (chip select logic, FP/ EDO/SDRAM controller), I/O ports, RTC, IIC-BUS interface and so on. For GPS module, SANAV is adopted, and its characteristic is: 32 parallel channels, Sensitivity -158dbm, 5Hz Update Rate, support DGPS technology, NMEA 0183 protocol and 9600 bps. Regarding coordinates transmission, XStream® OEM RF module is selected. The module provides OEMs and integrators with reliable, long-range wireless data communications. It is available as 2.4 GHz (worldwide) RF solution.

The main connections are shown in Figure 4. The MCU module has two Rx/Tx channels. One is specified for the GPS and the other one is reserved for the transceiver (XStream RF Modules). We only need the MCU RxD/TxD to connect with TXD1/RXD1 of the GPS. Position information can be gotten from the GPS module. The next is to connect the remaining RxD/TxD with the wireless. All of this can be used for the master module, but regarding slave modules, the only difference is that MCU will be utilized to control the mechanism of wireless reception and transmission, so no need of GPS is required at the slave module. That is why the designed solution is more reliable and cost effective.

Regarding display, the graphical LCD is selected. The main concept is designed via core programming to provide maximum benefits to the passengers. The facilities contain the current position of the total buses coming to the particular stop, even if any of the buses found in between two bus stops, would be shown by the arrow in between the targeted stops with spaced out poles IDs.

EXPERIMENTAL RESULTS

The proposed design phase contains a system that mounts the GPS based embedded system on every bus. The GPS containing the system that stands alone receives the raw signal. For this purpose, a prototype is designed to achieve the best result for the proposed solution. The specially designed long range transceivers are efficiently configured in the prototype system to make sure a practical communication loop can be only found in a particular bus route. Implementation and maintenance of management information systems are as important as the system design and development. This system would be able to expect the time, as well as position that the

Figure 5. The bus stop for B103**.**

LCD will display at bus stations coming from the particular bus route where it would be convenient for persons to get access to the bus.

In order to achieve the best real time monitoring with the finest and optimum results, several real data sets of coordinates are collected from a selected bus route. Each of the 8 inputs and outputs are associated with a location within a predefined region of 3 Km max diameter, since the area is likely to be covered by the prescribed RF transceivers. Those coordinates are analyzed according to the need of the criteria and then stored in the register of the proposed MCU to utilize them for matching. This matching is critical for the proper activation of the selected prototype that contains a radio chip supposedly meant to be installed at the bus station that was rightly found on the particular route. For this purpose, the route No.B103 is selected to get the position data as shown in Figure 5. Coordinations for the prescribed bus route are observed and saved in the MCU for matching purpose.

DISCUSSION

The proposed system is designed to transmit real-time location data accurately to the buses station. The implementation of the provided solution in the field of intelligent transportation system seems to be a huge task since it requires a profound cooperation of the transport service provider and the urban management system. So during the prototype designing, there are several problems faced. One of them is the delay in receiving the position data by GPS and the second one is the node failure for the wireless sensor systems at buses station because of poor working conditions and constraint of uncertainty. Therefore, as for the looping protocol, this condition should be taken into account so that the whole system can work properly, even if some of the temporary nodes do not work temporarily. According to looping routing mechanism designed using RF modules, the basic idea ensuring the reliability of communication is that: the unique ID of a bus must be transmitted properly, the main path must be created first from the master module to the slave module one by one and then the buses coming from both sides of the road at a time must be made to identify the sign of “up or down”. Taking this scenario into cognizance, this paper adopts an individual as well as a distributed looping algorithm, that is, the communication is utilized in several ways to have a greater exchange capacity in the network for the “intelligent transportation system”.

CONCLUSION AND FUTURE ENHANCEMENTS

This paper investigates the GPS based bus monitoring system using looping of embedded radio chips for the enhanced and reliable navigational performance in monitoring and station reporting system. Concisely, the design adopted a new kind of method, that is to say, the MCU was combined with the GPS and transceiver modules to achieve a GPS based automatic station-report function with multi ID buses movement monitoring system. Both modules were configured correctly to obtain the most efficient monitoring frame work. It can carry on the effective management to the public transportation vehicles in the most convenient way to the suffered passengers. It has many expandable functions, with considerable prospects for putting it on the market. After testing and modifications for about half a year, the system tends to be much stable and played an important role in dispatching buses and commanding public transit operations. With few workload of processing, this technique is quite feasible.

As for the future works, our focus will be on designing of centrally monitoring server based system by which the positioning data base of all the tracked vehicles could be examined. This would be helpful in realizing the driver efficiency as well as the factors affecting the well-organized monitoring system. For this purpose, it is suggested that the magic of GSM technology should be utilized.

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