AUTOMATIC FARE COLLECTION SYSTEM

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***Abstract*—In this fast-developing country like Bangladesh public transportation system is quite backdated. To bring in an intuitive and convenient system to the mass we much introduce an efficient, innovative, and effortless system, which will increase the workflow and add a good rendition to the development of Bangladesh. We have been using paper ticket or conductor-based fare collection system for decades. This system resulted in revenue loss to the GDP of Bangladesh. Moreover, creates passenger hassles regarding the fare. Therefore, to solve the problem this study proposes a contactless fare collection system using RFID technology, GPS and IoT for the public transportation system.**

Keywords—Fare, Public transport, RFID, GPS, Metro

I. INTRODUCTION

The public transportation system in other western countries has advanced quite a lot compared to our country, Bangladesh. Although there have been improvements here and there like importing new and advanced transportation vehicles or the new development project of metro rails inside Dhaka city is quite a milestone. However, to maintain this overpopulated country the government must go through tolls. To ensure passenger safety and mode of convenience moreover to increase the performance of the system a system should be introduced for the sake of development itself. If we look at how our current system functions, we see that in intercity public transportations we have a conductor who goes to each passenger and collects the fare manually. However, in long route public transportations we have paper based ticketing system, where we buy a ticket from a specific counter and use that as a valid documentation of our travel. For these manual transactions of money, we must carry changes in our pocket for it to be used when the conductor can not give you back the change. This process of the current system requires a lot of time and wastes human resource moreover both the passenger and the conductor are facing issues most of the time. There is always a bargain or conflicts between the conductor and the passengers regarding the fare which may even results in fights or physical abuse in the worst-case scenario. On the other hand, due to corruption inside the transportation system, government faced revenue losses from this sector.

This study aims to solve the existing fare related problem and introduce a system which will automatically collect the fare from a passenger upon entering a public transportation. The system will be integrated with IoT (Internet of Things) which is an internet connected object to fetch and exchange data from the device to the cloud. The system includes the use of RFID technology to identify a passenger in addition it will be equipped with GPS to track the location of the vehicle the passenger is travelling on. By using the coordinates between the boarding and destination location the travelled distance is calculated and the fare is deducted from the passenger's main balance.

II. METHODOLOGY

In this paper the system that is introduced is a GPS based contactless fare collection system which is integrated with the use of RFID card. The GPS will be used to track the location of both the bus and passenger. This data can be sent to cloud and used to determine the current location of the bus, as the GPS location is tracked real-time therefore a service could be introduced to the passenger which will show the location of the bus that they want to board on. This service will be very helpful to the passenger as they can see if they are running late or the bus will take longer time to reach the bus stop and take decisions accordingly. Moreover, the location data of the passenger could be used to get the boarding and destination location of the passenger, which could help the law enforcement department to track down criminals quickly. On the other hand, the RFID card can be made rechargeable, through which the passenger can recharge the balance by visiting a local recharge shop. However, the RFID card could be implemented in such a way that the card owner can wirelessly recharge the card using online financing applications or softwares. Therefore, the hassel of going to a local recharge store is deminised.

Fig. 1. Block Diagram

III. PROCEDURES

The implementation of the system is done by using a microcontroller such as Arduino UNO along with a RFID reader and card. We will also need a GPS module with a Wi-Fi module to access the internet and communicate with the server or cloud. Upon integrating all the modules with the microcontroller, we will have a running device. To demonstrate the working principles of the device, at first if a RFID card is detected by the RFID reader it will send the data over the internet to check the authenticity of the user. If the card is valid, GPS location will start to record and set it as the starting location. The GPS will keep recording the location coordinates on an interval. In the meantime, if another user is detected the device will keep simultaneous recording for each passenger. However, if a same card is detected the GPS will stop storing the locations under that customer and set the last location as the passenger's destination location. The distance will be calculated using the coordinates between the starting and destination location. The fare will be calculated by multiplying the distance with a fixed amount set by the government. The calculated fare will then be deducted from the main balance of the passenger's card.

However, due to limitations, hardware implementation of the project was not possible therefore, a virtual implementation was done writing a program in C++ language. In this program an ID input is taken from the user. The ID is matched with the IDs available in a text file, if matched display output, 'Valid ID!' along with the name and balance of the user. Then the user is given option to choose the destination and boarding locations. The predetermined fare from one location to another is displayed and the fare is deducted from the original balance of the text file corresponding to the user's input ID. The loop will continue, and multiple users can give input. The program will be terminated if the input is 0.

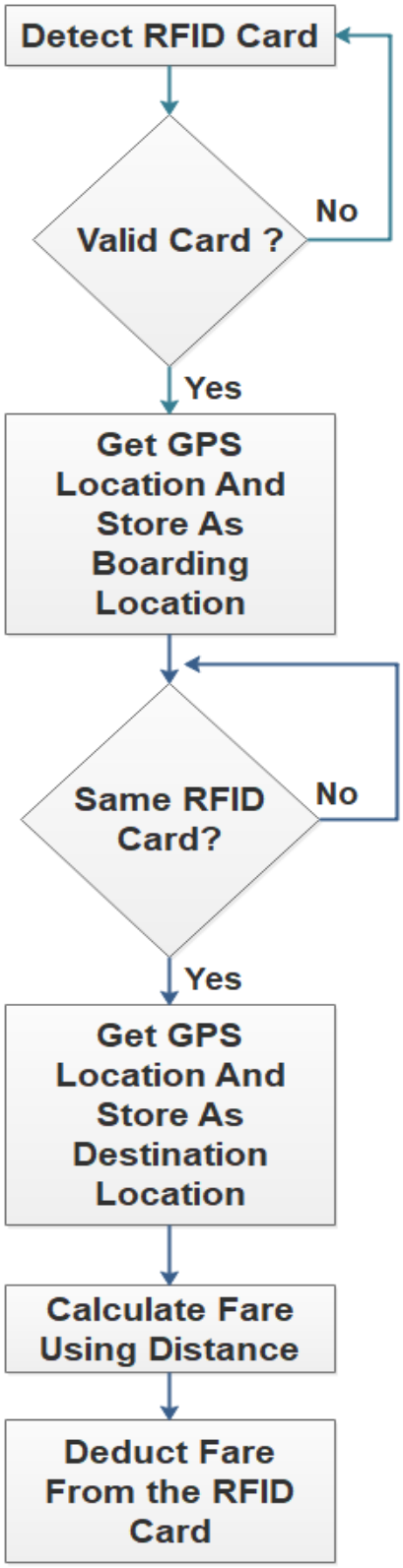

Fig. 2. Flow Diagram [1]

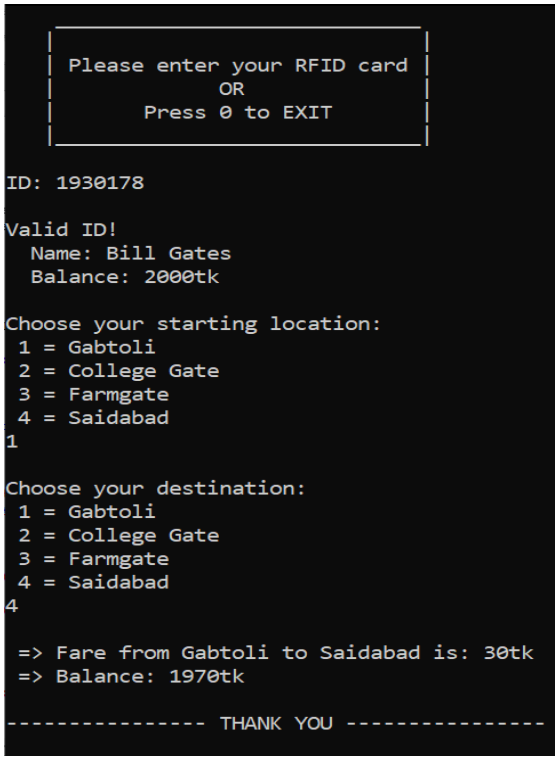

Fig. 3. Simulation uing C++

IV. FINDINGS OR RESULTS

Due to unavailability of this system in Bangladesh, I was not able to get my hands on some statistical data. However, I have collected some data from another research paper. [2] Where the data shows that the existing system's fare was determined from on location to another despite the distance. On the other hand, the proposed system's fare is calculated using the distance-wise fare mandated by the government which is P8.00 for the first 5 kilometers and additional P1.00 for the succeeding kilometers. In Table-1 Fig. 5 we see a data of fare comparison between the traditional system and the proposed system, where data shows improvement in the system. Moreover, the line Graph proves the improvement in a visual representation. Fig. 4

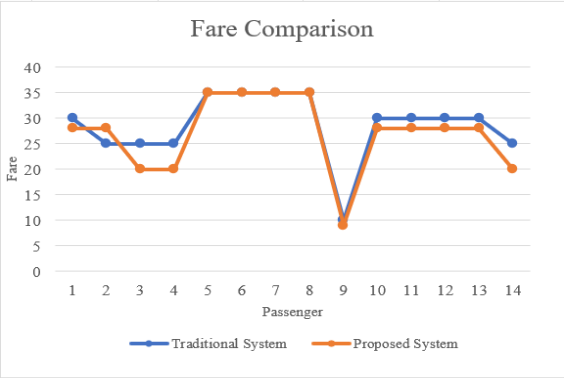

Fig. 4. Graph of fare comparison [2]

TABLE – 1

No.	Origin	Destination	Traditional System	Proposed System
1	Dao Bus Terminal	Ilaya, Lila	30	28
2	Dao Bus Terminal	Taug, Lila	25	28
3	Dao Bus Terminal	Tayong, Loay	25	20
4	Dao Bus Terminal	Tayong, Loay	25	20
5	Dao Bus Terminal	Pulang Yuta, Dimiao	35	35
6	Dao Bus Terminal	Pulang Yuta, Dimiao	35	35
7	Dao Bus Terminal	Pulang Yuta, Dimiao	35	35
8	Dao Bus Terminal	Pulang Yuta, Dimiao	35	35
9	Dao Bus Terminal	Laya, Baclayon	10	9
10	Dao Bus Terminal	Lomanoy, Lila	30	28
11	Dao Bus Terminal	Lomanoy, Lila	30	28
12	Dao Bus Terminal	Lomanoy, Lila	30	28
13	Dao Bus Terminal	Lomanoy, Lila	30	28
14	Dao Bus Terminal	Botoc Occ., Loay	25	20

Fig. 5. Raw data of the test system [2]

TABLE – 2

No.	Traditional System (X)	X^2	Proposed System (Y)	Y^2
1	30	900	28	784
2	25	625	28	784
3	25	625	20	400
4	25	625	20	400
5	35	1225	35	1225
6	35	1225	35	1225
7	35	1225	35	1225
8	35	1225	35	1225
9	10	100	9	81
10	30	900	28	784
11	30	900	28	784
12	30	900	28	784
13	30	900	28	784
14	25	625	20	400
	Mean (X)	28.57	Mean (Y)	26.93
	Standard Deviation (X)	6.39	Standard Deviation (Y)	7.24

Fig. 6. Statistical Data from the raw data [2]

V. DISCUSSION

From Table-1 the data shows that the proposed system requires less fare in majority, or all the cases compared to the existing system. However, we see that in the second row the existing system is displaying less fare than the proposed system but that is a small margin. Overall, the proposed system is promising if we look at Table-2 Fig. 6 a statistical data where the mean fare is calculated for both the system. The mean fare shows the improvement in proposed system where it's mean fare is 26.93 which is less than the existing system's mean fare which is 28.57.

Moreover, the proposed system will be controlled directly by the government so there would not be a middleman hence the corruption will decline, and the revenue will be retained. Furthermore, the fare related clashes between the passenger and the conductor would not happen. Human resource will not be wasted moreover, time will be saved significantly.

VI. CONCLUSION & RECOMMENDATIONS

The study concludes that despite the lacking in the public transportation system of Bangladesh, the workflow can be improved significantly using the proposed system. We have seen 6% to 20% deduction in fare rates in the proposed system which is very beneficial for the people of Bangladesh. Moreover, the quarrel and fights would not happen regarding fair fare rates between the conductor and passengers. Furthermore, the proposed system is more efficient, optimized, and economical than the existing system. Both human resource and labor is minimized moreover, raw materials such as paper used in paper ticketing method is cut down, which is also beneficial for the environment as well. The existing system used an estimated distance to determine the fare. However, the proposed system uses GPS for more accurate positional coordinates to determine the distance, which results in less fare rates.

The following are few of the recommendation that can be made in the process of this study:

a. Integrating card less methodology such as using smartphone as a way of authenticating a user and making transactions.

b. Introducing a service or application for monitoring public transports as the transports will have GPS built in with the device therefore passengers will be able to track the vehicle for improved productivity.

c. Using high sensitivity GPS receiver to get more accurate coordinates of the location.

d. Integrating Google APIs with the device to get more efficient algorithm to trace bus routes and for distance calculations.

e. Using a more efficient microcontroller for better productivity.

VII. REFERENCES

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