RFID for Optimization of Public Transportation System

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Overview

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Introduction

- Public Transportation System is under constant pressure for betterment of the
  - customer service
  - Security
  - safety and contentment
- Mathematical model for realization of the optimized public bus transportation system through the use of
  - wireless sensor technology and
  - radio frequency identification (RFID)
- Simulation results demonstrate that a higher quality of service could be provided by emphasizing the improvement of
  - the vehicles and
  - their scheduling

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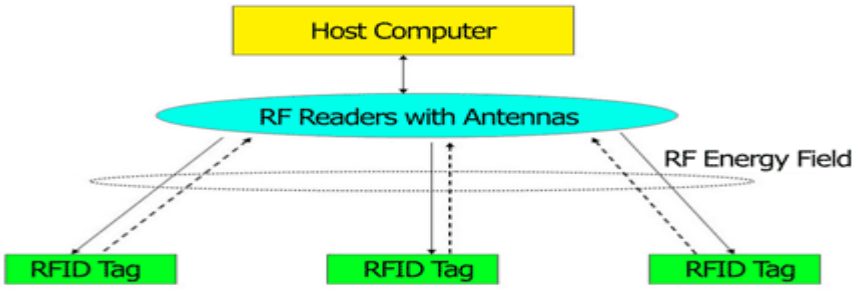
Background

- **Efficient and reliable bus transport system could be developed utilizing RFID tags and readers**
- **IT personnel, bus dispatchers and commuters would all know where the buses are at any given time**
- **Bus equipped with RFID tag, leaves a bus stop that is equipped with RFID reader, the bus is read by the bus stop and a database is automatically populated allowing the IT personnel to know where the bus could be located**
- **The variable message signs are electronic traffic signs used to give travelers information on their journey**
  - **signs are very dynamic since the information relayed to the commuter can be set automatically or manually by the control room**
  - **signs could be automatically updated every time a bus passes a bus stop with the use of RFID tags and readers**



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Simulation Environment

- RFID and VMS technologies were used since they are affordable and provide real time information to commuters and management at strategic locations
- Simulator was designed and implemented using the PTV vision software package and JAVA programming
- The PTV vision – VISSIM – state of the art multi-modal simulator – is a microscopic simulator model which was developed in Germany and it is a powerful tool for simulating multi-modal traffic flows. Its flexible network structure integrates microscopic simulation with strategic transportation planning and travel demand modeling
- Simulation environment is highly portable

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Pseudo-code Illustrating the Simulation Process

Simulation shows in real time the buses approaching and leaving their respective stops in a timely manner, allowing the commuters, bus drivers and public transport system management to know where a certain bus is at any given time

```
DECLARE geometries
GET geometries
DECLARE vehicles
GET vehicles
DECLARE traffic signals
GET traffic signals
DECLARE transit info
GET transit info
LOAD VIS
PRINT log file
PRINT statistics
LINK database:
Travel and dwell times
Bus locations
Bus type
Trigger message box (bus, location, time)
```

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The Dwell Time

The *dwell time* TD is the time a bus takes at a bus stop, taking into consideration such factors as the bus doors opening and closing, passengers boarding and alighting from the bus

$$\mathbf{TD} = \boldsymbol{\mu} + \alpha\mathbf{A} + \beta\mathbf{B}, \text{ where}$$

μ: clearance time (opening and closing of doors), equal to 6 secs
α: alighting time per passenger, equal to 4 secs
A: number of alighting passengers
β: boarding time per passenger, equal to 5 secs
B: number of boarding passengers

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Algorithm Outlining a General Bus Scenario Along its Everyday Journey

Declare variables (bus, traffic light, stop, speed)
DECLARE bus stops
DO start bus journey
WHILE bus stops = FALSE
PROCEED
If traffic light green
If passengers not boarding or leaving
WHILE bus stops = TRUE
COMPUTE η
If human conditions
COMPUTE Ω
If traffic congestion
COMPUTE δ
If traffic light red
COMPUTE μ + αA + βB
If bus is at bus stop
If passenger boarding or leaving
If doors opening and closing
If bus continues delayed journey
ELSE
COMPUTE ψ
If mechanical difficulties
Bus = HALT

The time taken at a red traffic light is $T_{TL} = f(\delta, q)$, where δ is the time in secs a red traffic light stays on red, q being dependent on the number of vehicles waiting to go through.

$60 \text{ secs} \leq T_{TL} \leq 180$ secs with a probability p $(0 \leq p \leq 1)$ that the bus stops at a red traffic light.

η, Ω, and ψ are other time delay factors

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Experimental Results

- Independent simulations are conducted on various types of buses and different routes
- Comparisons are made between the simulation results and actual data.
- Available information including statistical data on the routes, number of passengers, number of buses, number of bus stops, peak and non-peak hours and number of people that the buses handle during these times are compared to simulation results
- Simulator shows the traffic light activity and movement of all vehicles
- Data is collected and stored in special database where a pop-up window on the screen relays info showing the name, location and travel time of the bus as each bus passes its respective stop.
- RFID tags are placed on the buses while the RFID readers are placed on the bus stops. As the bus passes or stops at a bus stop, the reader detects the tag and populates the database with info as to where the bus is located. This occurs for every stop where the reader is placed.

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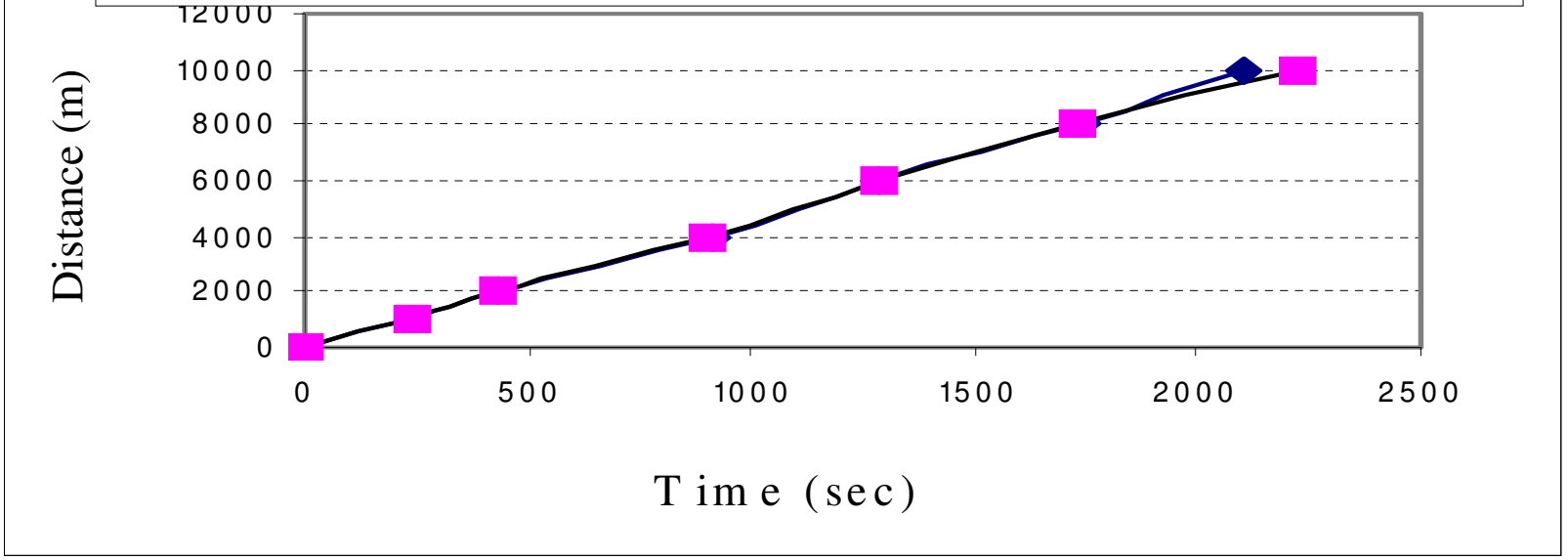
Simulation Travel Time VS. Actual Transit Bus Time



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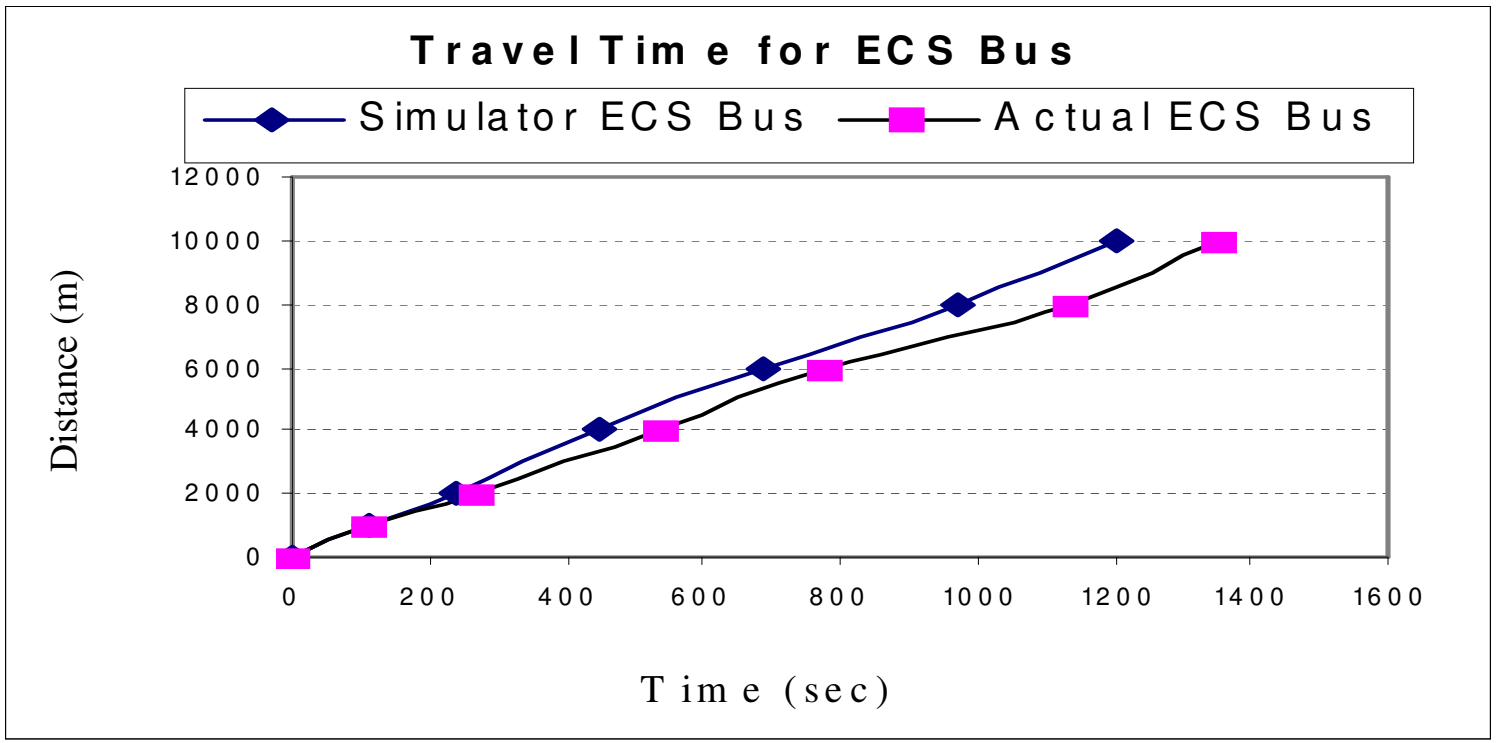
Simulation Travel Time VS. Actual ECS Bus Time



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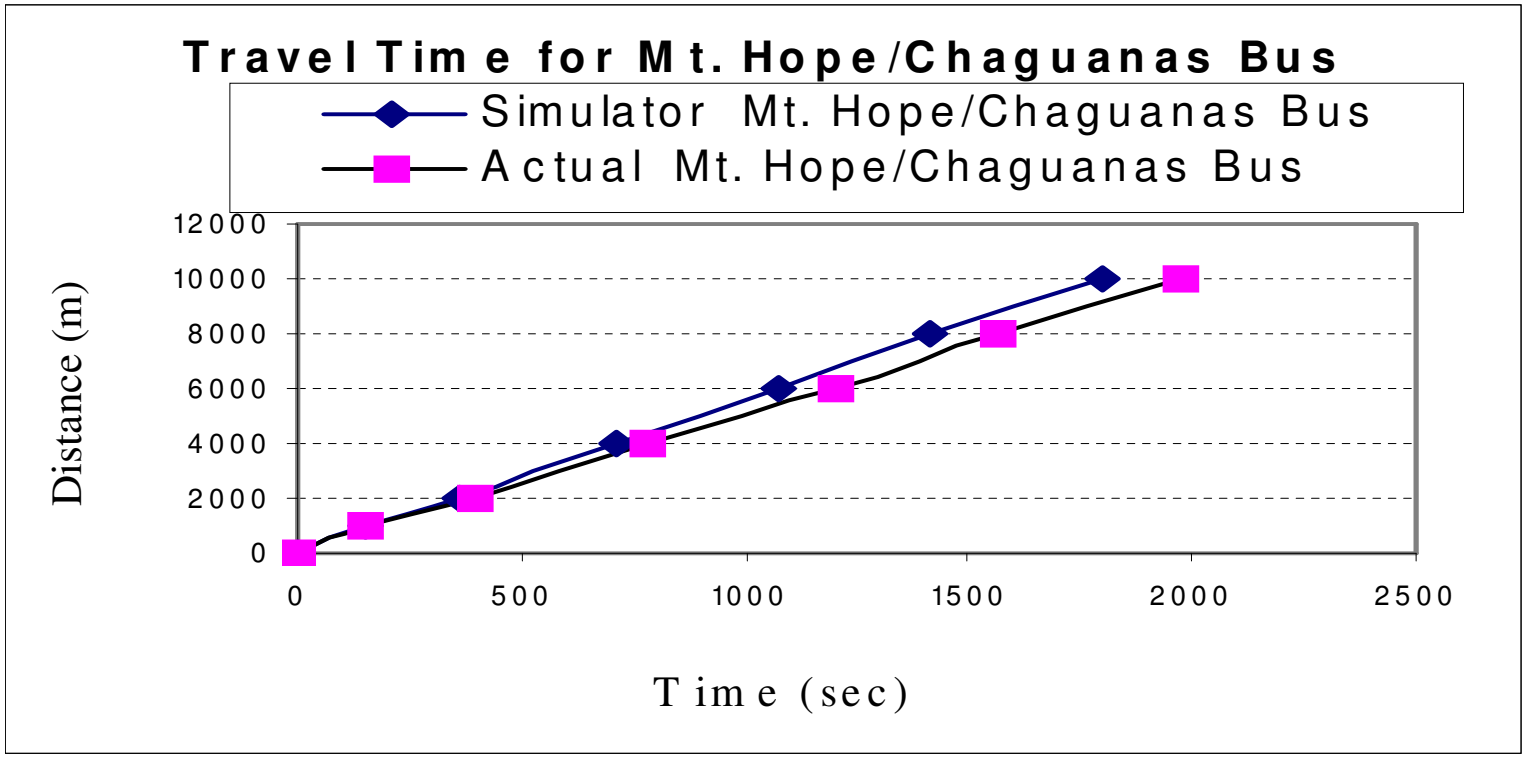
Simulation Travel Time VS. Actual Mt. Hope/Chaguanas Bus Time



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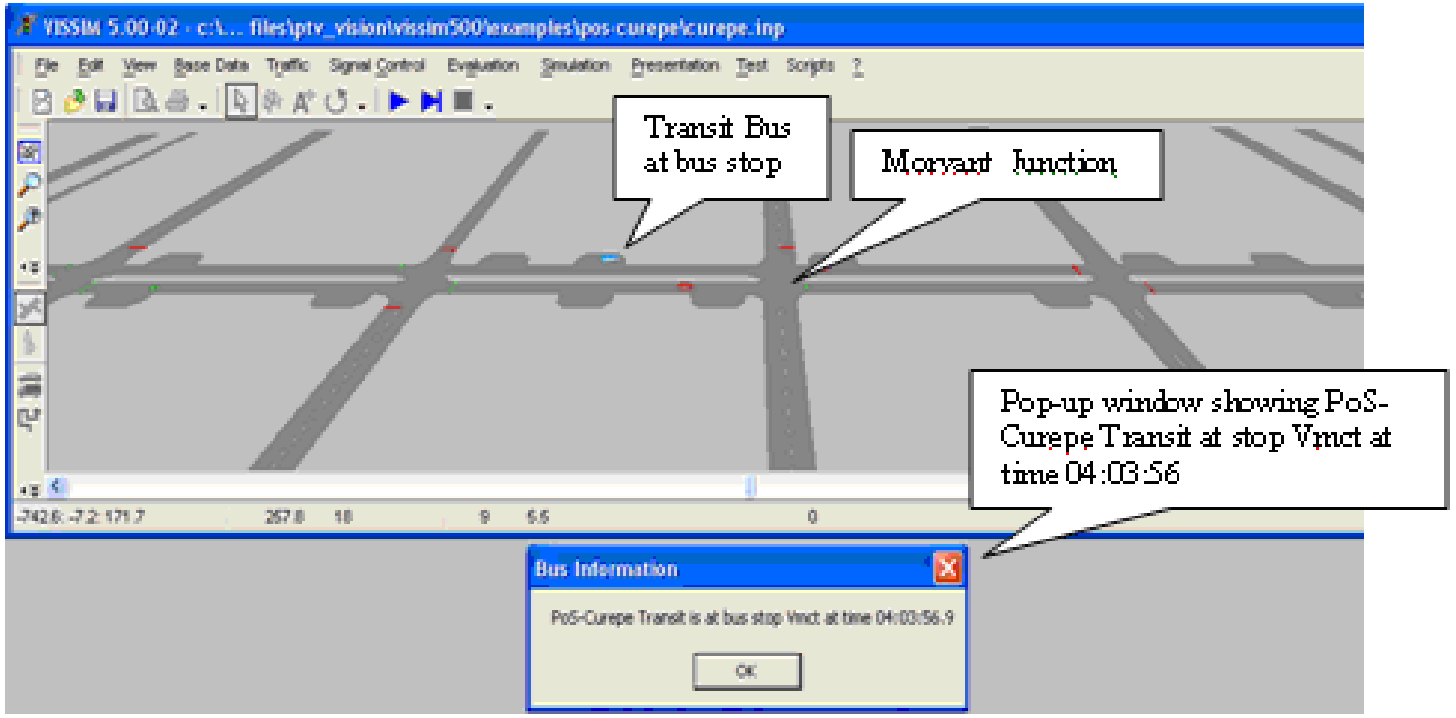
Simulation Screenshot



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Conclusions

- optimized public bus transportation system was implemented using wireless sensor-based technology and variable message signs (VMS)
- real time simulation environment designed and implemented in JAVA programming language and using the VISSIM software package
- bus route networks and related statistical analysis emulate efficiently and accurately the public bus transport system of TRINIDAD AND TOBAGO
- simulation environment is
  - interactive and
  - shows the movement of the buses in the traffic along the routes with designated stops
  - buses can be tracked in real time.
- scalable design
- simulation results are promising for further investigation

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Questions?

Thank You…

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