RFID for Optimization of Public Transportation System

Assaf M. H.

Assaf_m@usp.ac.fj

December 2011

ISSNIP 2011 - The Seventh International Conference on Intelligent Sensors, Sensor Networks and Information Processing

Adelaide, Australia
Overview

• Introduction
• Background
• Simulation Environment
• Simulation Results
• Conclusions
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
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
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.
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.

```plaintext
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)
```
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.

$$TD = \mu + \alpha A + \beta B,$$

where

$\mu$: clearance time (opening and closing of doors), equal to 6 secs
$\alpha$: alighting time per passenger, equal to 4 secs
$A$: number of alighting passengers
$\beta$: boarding time per passenger, equal to 5 secs
$B$: number of boarding passengers
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 $\eta$
                If human conditions
                COMPUTE $\Omega$
                If traffic congestion
                COMPUTE $\delta$
                If traffic light red
                COMPUTE $\mu + \alpha A + \beta B$
                If bus is at bus stop
                If passenger boarding or leaving
                If doors opening and closing
                If bus continues delayed journey
                ELSE
                COMPUTE $\psi$
                If mechanical difficulties
                Bus = HALT

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

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

$\eta$, $\Omega$, and $\psi$ are other time delay factors.
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.
Simulation Travel Time VS. Actual Transit Bus Time

Travel Time for Transit Bus

- Simulator Transit Bus
- Actual Transit Bus

Time (sec) vs. Distance (m)

0 500 1000 1500 2000 2500

0 2000 4000 6000 8000 10000 12000

USP

ISSNIP
Simulation Travel Time VS. Actual ECS Bus Time

Travel Time for ECS Bus

Distance (m)

Time (sec)
Simulation Travel Time VS. Actual Mt. Hope/Chaguanas Bus Time

![Graph showing travel time for Mt. Hope/Chaguanas Bus](graph.png)
Simulation Screenshot

Transit Bus at bus stop

Mourant Junction

Pop-up window showing PoS-Curepe Transit at stop Vmct at time 04:03:56
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
Questions?

Thank You...