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ANALYSIS OF LOW-COST BLUETOOTH-PLUS-WIFI DEVICE FOR TRAVEL TIME RESEARCH

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MOTIVATION

- ❑ Collecting real-time travel data via intelligent transportation systems (ITS) rely heavily on technologies that are expensive and challenging to maintain.
- ❑ Bluetooth and Wi-Fi are the most popular low-cost communication protocols that can give a good understanding of spatial and temporal nature of travel.

OBJECTIVES

- ❑ Present a low cost, modular, and readily adaptable generic Bluetooth-plus-WiFi (gBT) detecting device for researchers as an alternative to commercially robust Bluetooth systems.
- ❑ Ascertain the reliability of the gBT travel time data by comparing with data from a Global Positioning System-probe vehicle.

USEFULNESS

This will be important for two main reasons:

- ❑ Allow research to be conducted in a cost effective manner on all types of facilities.
- ❑ Offers the opportunity to undertake comprehensive empirical studies on link and path travel time distributions especially for arterial roads

gBT COMPONENTS AND COST

- ❑ A unit of the gBT consists of a single board computer (raspberry pi), a power supply, an adjustable antenna, a global positioning system, and a wireless adaptor (Figure 1).
- ❑ Estimated component cost is about $500 per location compared to about $8,000 for a vendor installed Bluetooth device.

gBT ARCHITECTURE

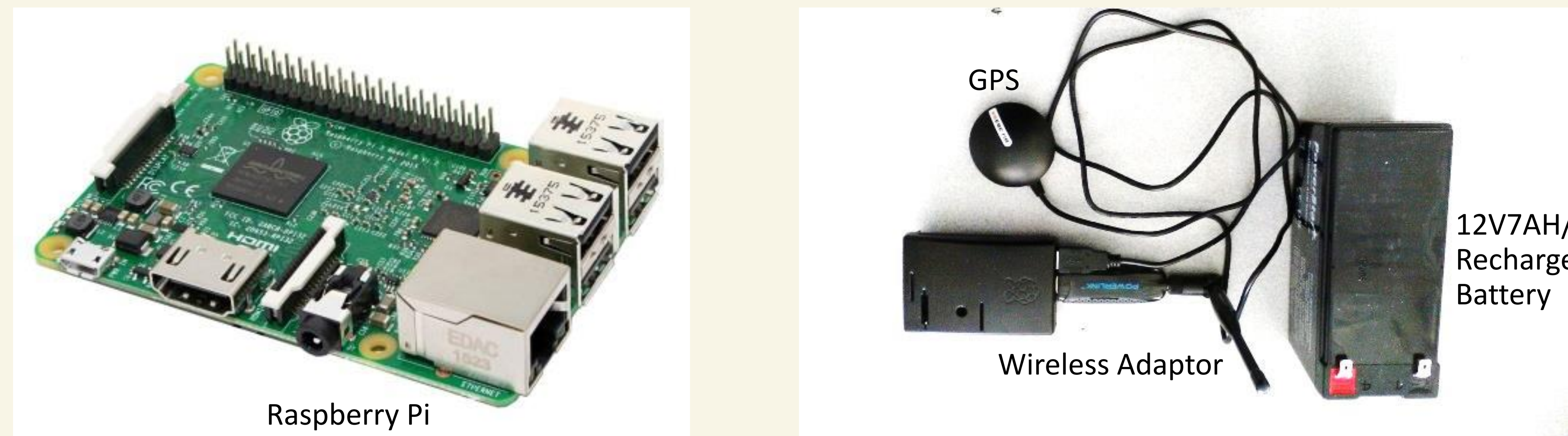

Figure 1. gBT system components

DATA COLLECTION METHODOLOGY

1. Test Site and Conditions

- ❑ Test bed is a 2 mi section (in both directions) of a major arterial corridor in Lincoln-Nebraska.
- ❑ Data was collected under good weather conditions

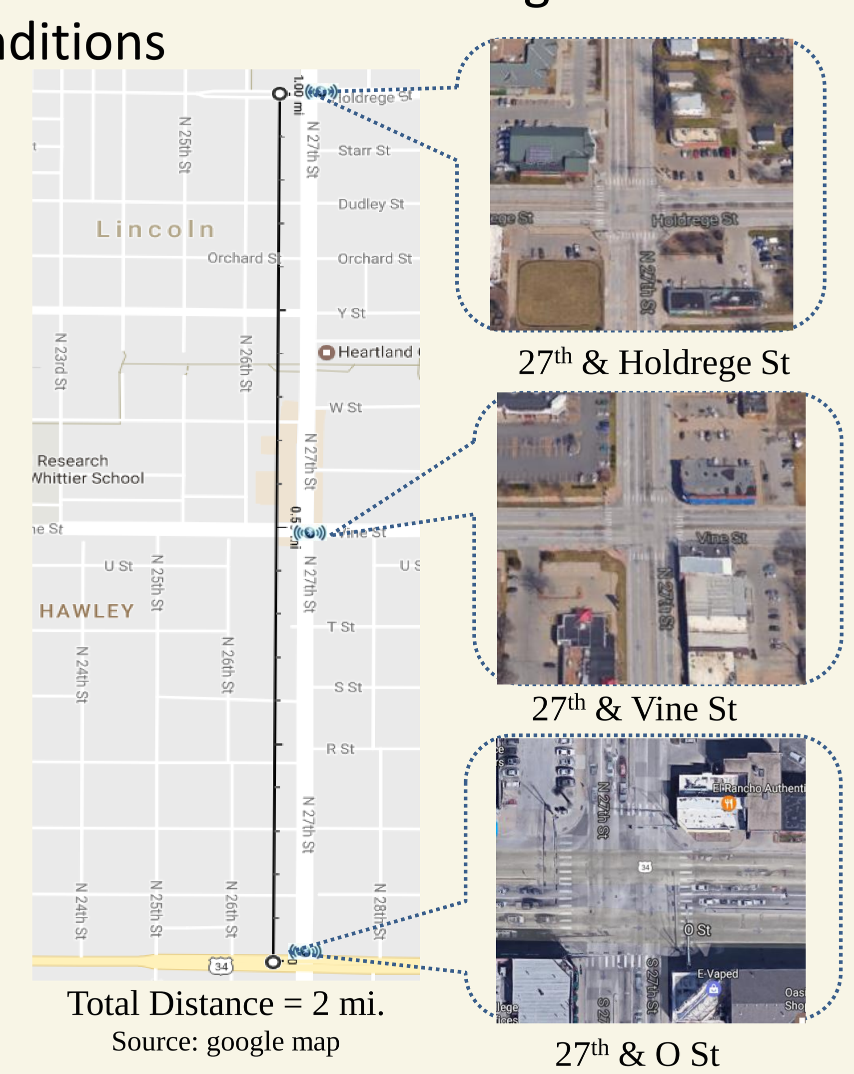

Figure 2: Test beds with location of gBT detectors

2. Data Collection System (DCS)

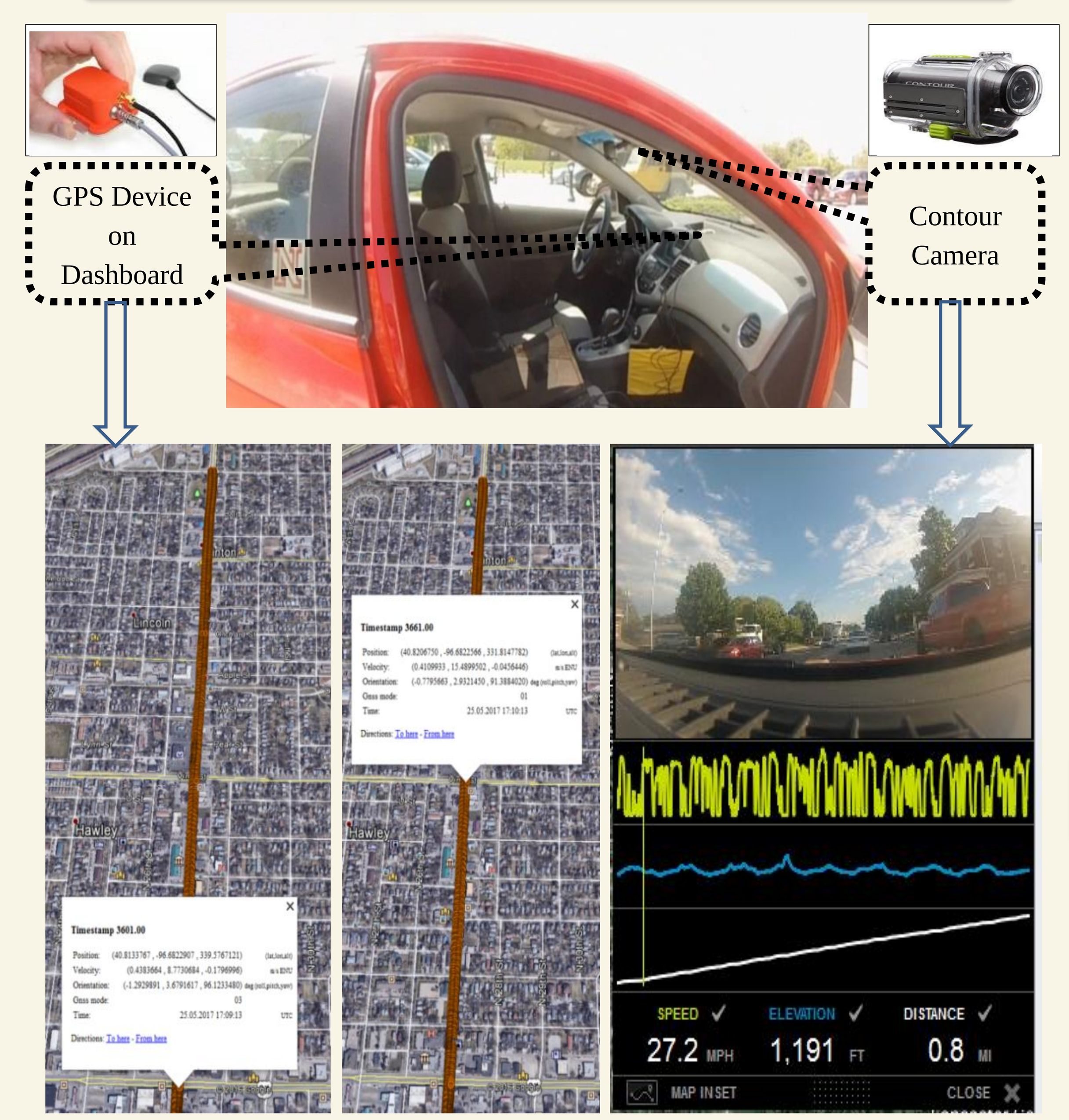

Figure 3: Test vehicle setup showing (a) GPS trajectory with time stamps, and (b) speed profiles

3. Data Collection Process

- ❑ The gBT devices were installed at the signalized intersections along the test bed and the floating car method was used to collect GPS data.
- ❑ Travel times were from 7:00 a.m. to 1:00 p.m. on May 23-25, 2017 were collected for each device.
- ❑ A total of 29-30 runs per day on each link were undertaken for a comparative analysis.

RESULTS

Table 1: Descriptive Statistics of GPS & gBT data for midday peak (in seconds)

Direction	O - Vine		Vine - Holdrege		Holdrege - Vine		Vine – O	
Device	GPS	gBT	GPS	gBT	GPS	gBT	GPS	gBT
Mean	55.7	58.7	88.8	87.4	89.2	82.8	57.8	60.1
Std. Error	0.3	2.5	4.9	5.3	2.3	3.7	0.2	2.2
Median	56.0	55.0	81.0	78.5	82.0	79.5	58.0	56.0
Mode	56.0	54.0	75.0	80.0	81.0	85.0	58.0	52.0
Std. Dev.	1.7	17.7	26.3	34.2	12.5	27.8	1.2	16.6
Minimum	52.0	35.0	69.0	50.0	80.0	33.0	56	39.0
Maximum	59.0	118.0	171.0	194.0	116.0	169.0	60	156.0
Skewness	0.2	2.0	2.3	1.3	1.2	0.7	0.1	4.0
t Statistic	1.20*		0.19*		1.50*		1.00*	

*Not statistically significant at 95% confidence interval

Table 2: gBT Probability of Success

Reliability Index	Average Indices for GPS [95%CI]		Proportion of gBT Index within CI of GPS Index
Median	55.9	[50.82,60.98]	99%
80th Percentile	56.8	[51.64,61.96]	58%
Travel Time Index	1.39	[1.26,1.52]	87%

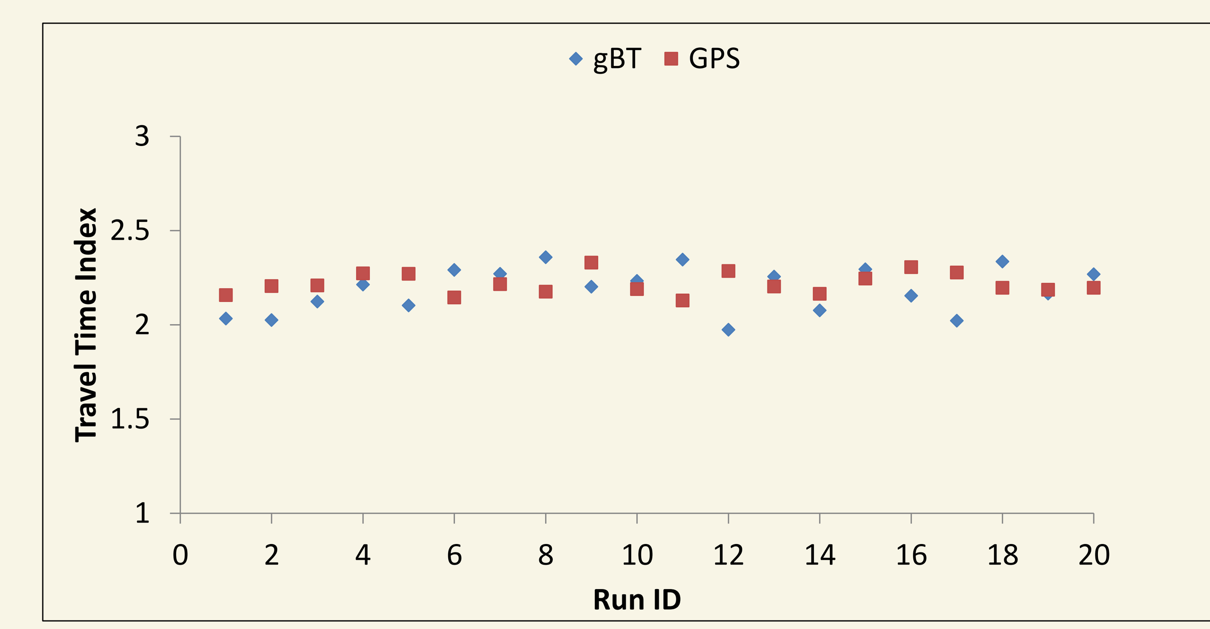

Figure 4: Graphical comparison of travel time index

CONCLUSION

- ❑ It was shown that the gBT is viable for determining link travel times. There was an average of 4% deviation of median values with relatively wider variations compared to the GPS data.
- ❑ There were no statistically significant differences between the mean travel times from both collecting systems.
- ❑ The theoretical lognormal distribution best fit the travel time data from both devices.