DATA ACQUISITION SYSTEM USING ELECTRIC VEHICLE

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ABSTRACT:

A data collection device combined with a sensor bundle product was developed and attached to a mechanically controlled gift device to collect additional data about the user's usage habits. The data collected through the developed device includes GPS route, vehicle speed and acceleration, engine status, transmission status, seat occupancy, fuel level, and video recording. Sensor bundle products are designed and covered to not interfere with the driver's ability to operate the device. Cellular connectivity is used to capture sensor data, reducing human effort and maintaining daily usage patterns of the deployed system. Testing and validation showed that the developed device can effectively and efficiently report important facts for further evaluation and optimization. In particular, the data collected will drive equipment simulation to help optimize artwork printing and improve personnel efficiency in large commercial buildings.

KEYWORDS:

Data acquisition system; Sensor package; Cargo tractor; Testing and validation

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1. Introduction

When operating a large number of cargo tugs at an airport to transport heavy container cargo to and from aircraft, maintaining high performance and reliability requires the use of cargo tugs at each location so that the coordinator can decide on the type of use. All important parameters of the driving situation need to be known on the fly. You can view these tractors. The information collected is also important to ensure the protection of propulsion and ground support equipment (GSE). To meet these requirements, data acquisition devices (DAQ) and sensor packages must be developed and integrated into all new and old delivery tractors to enable these vehicles to collect useful information while in operation. there is. The generational developments in the use of sensors developed by the economical car market are no longer transferred to his

GSE fleet. Based on small business expert (SME) comments provided by employer engineers involved in this study, the production lifestyle at GSEs (particularly delivery tractors) is even more seasonally restricted than commercial fleets. It has been. Because GSE equipment is purchased in much smaller quantities and the equipment is expensive ($60,000 or more for a new delivery tractor, for example), most consumers choose to own their GSE fleet for many years and Keep updating. Fully depreciated for tax purposes. Therefore, orders for GSE and load-bearing tractors are regularly small and occur annually as companies purchase equipment in their annual price range. Companies that regularly appear on airport ramps can order new devices after receiving a price range. Manufacturers of delivery tractors receive orders, hire workers accordingly, and fill orders with minimal incremental adjustments for each annual release to avoid increased complexity until the next order arrives. Fire workers. This destroys continuity and takes away much of the joy some people were enjoying.

Another new complication with this escalating, escalating seasonal lineup is that delivery tractor models that use the same manufacturer and are produced at the same time on the same production line are generally not widely available for new generation applications; Find the version number. . For example, wiring harnesses are functionally the same, but may be installed in specific locations. Mounting brackets can be attached to dedicated positions. The simple areal gap between additives can also vary. Engineers involved in this study found that this manufacturing tradition inhibits innovative improvements. Significant feature improvements create an opportunity for companies interested in even more advanced features to fund research and development (R&D) while maintaining demanding ownership over installed generators for delivery tractor or GSE manufacturers. always arises by giving to. between seller and customer. The least "painful" solution is to simply accept the incremental version changes and change the images and features to correspond to a minimally better GSE feature set. Therefore, by integrating a DAQ device and a sensor package, engineers responsible for selecting delivery tractors on airport ramps can gain a comprehensive understanding of the vehicle's operational behavior, which is useful for optimizing workflow and force efficiency. Now you can extract the data. One of these DAQ devices and a sensor bundle were used in this study. It has been designed and integrated into GSE vehicles to collect statistics on transport tractor usage types and has been validated through field testing in a real production environment. Before starting this project, we created a theoretical history for the current study by reviewing current vehicle statistics collection systems developed for specific purposes in collaboration with various researchers. . DiGenova et al. [1] designed, installed, and tested an integrated data acquisition device in a 1991 Chevrolet Lumina to collect engine and vehicle operating statistics, including exhaust pipe pollutant concentrations. The accompanying equipment used a portable fuel analyzer to measure and record manifold air pressure and temperature, vehicle speed and acceleration, tool settings, and contaminant concentrations in the engine exhaust. Zhao and Shibasaki [2] proposed the use of a portable device to measure 3D urban statistics and a single-row laser scanner to measure 3D urban scenes. Precise positioning was performed using a single-row laser scanner mounted on the roof of the vehicle, and 3D reconstruction was performed based on the recorded horizontal and vertical profiles of the vehicle. Wang et al. [3] developed his laptop-controlled DAQ device that uses Labview to collect statistics on the armature current of an electric motor, wheel speed, and frame speed of an electric vehicle. Tests and experiments showed that the presented approach avoids complex laptop programs, reduces software development time, simplifies the development process, and increases flexibility benefits. Zhao and Feng [4] performed data collection over GPRS network, which is a fast and reliable data transmission channel. Such an approach is suitable for use in protective operations at guard posts and for transport surveillance.

In the Alkar and Karaca study [5], the researchers described a low-cost method that relies entirely on embedded hardware and collects information that can be accessed from anywhere in the world via a web server integrated into the embedded device. Introducing a simple yet flexible internet-based DAQ device. This device proved suitable for good embedded programs by connecting a large number of real-time modules through suitable interfaces. Kucera and his collaborators developed his Auto-DAQ machine for automotive traffic protection projects. This machine aims to reduce dangerous conditions on the road by analyzing driver behavior and determining the decline in driving ability [6]. Through advanced machines, publicly accessible data archives are created from real vehicle behavior under a variety of real-world driving forces and road conditions. Such facts were then processed with the purpose of studying them, monitoring changes in the power's capabilities, and ultimately warning its power and passengers. [7] designed a data acquisition and telemetry machine and integrated this machine into a prototype solar car. Practical implications of data collection and field operation of telemetry machines were also presented and discussed. Y.Wang [8] designed a temperature signal acquisition device to provide remote diagnosis of automobile frame machinery. Osman and Magdy [9] proposed a low-cost, configurable DAQ device that includes a sensor, an analog-to-virtual card, and a software package for acquisition and processing. Such machines can measure cylinder pressure, his 3D vibration of the cylinder block, abnormal temperature conditions, crank angle and engine speed.

2. Problem description

Figure 1 shows a version of a delivery tractor that is commonly rented at many airports. These delivery tractors have a top speed of about 13 miles per hour and a towing capacity of 40,000 pounds. These delivery tractors are typically equipped with both fuel and diesel engines. DAQ machines are designed for tractor dispatch and are useful because they create a database of pressure cycle records and gasoline consumption. The designed machine must be able to collect data on fuel level, wheel speed, wheel perspective, tool position, engine speed, engine on/off status, seat occupancy, brake pressure, throttle position, GPS position, and acceleration. It was determined that this is not necessary. , Start the counter, temperature/humidity and video. Additionally, the entire DAQ machine must be waterproof. It is durable and can withstand harsh and dirty environments with high temperature fluctuations. The company's engineers working on this observation believe that all additives should be minimally visible to the driver, and these layout requirements, personnel additives, and devices must be determined and incorporated into the machine. I pointed out that there is.

Figure 1: Example of truck tractor model [10]

3. Design of the DAQ system

The hardware needed to make the DAQ device fully functional was first identified. A list of major DAQ additives with their functions and version numbers is shown in Table 1. The wheel speed sensor includes a Hall impact sensor and a magnetic shaft collar attached to the force shaft. A Hall impact sensor detects the magnet in the break-open ring and sends a virtual alert to the controller. A vertically mounted FAST-A gas level sensor sends an analog signal to the controller and updates the modern visual display. The rotary potentiometer is used to detect the device position and wheel angle, and sends an analog signal to the controller based on the change in output voltage. The Influx Rebel LT statistics logger has 12 virtual channels, ±30V input range, and up to 15 widely used analog sensor inputs that can be accessed remotely to log statistics via email or FTP server. We are prepared. This statistics logger is configured to use the "Dialog" software, which allows the user to convert raw data to her CSV data and easily convert it to a file format for further data processing. The digital camera selected is an HD backup digital camera to record the surrounding conditions of the transport tractor. Video recording is done using a Sprint Cam DVR. Memory cards and screen films can be accessed to recreate the delivery tractor's surroundings. The statistics logger has a USB slot for statistics transfer and an Ethernet port for audio exchange with a PC. Interlink Electronics RB-int-04 Driving Force Presence Sensor is very thin, so it can be easily shrunk to a great size to fit any space. All sensors listed in Table 1 and the delivery tractor's CAN bus are connected to the Parker Raptor controller, where sensor signals (analog and digital) and the CAN bus are directly converted into CAN messages that are recorded through this tool. can. Recording logger (Figure 2).

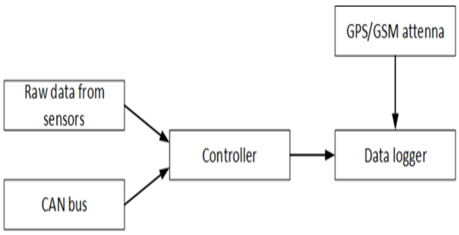

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Table 1: Hardware components for the DAQ system and their functionalities

Components	Model numbers	Functions
Driver presence sensor	Interlink Electronics RB-Int-04	A pressure sensitive strip to measure pedal forces applied by the driver so as to evaluate the situation and performance of the driver
Seat switch	John Deere AM124426	Binary control to monitor seat occupancy
Weather proof fuel gauge	Wema USA SSS/SSL 04.0	Display the fuel level of the cargo tractor
Wheel speed sensors	Honeywell – 1GT101DC	Measure wheel speed
Brake pressure sensor	AiM 2000 psi	Measure brake pressure
Wheel angle & gear position sensor	ACDelco 22666955 rotary potentiometer	Detect the wheel angles and gear position
Data logger	Influx Rebel LT	A data collector to send and receive all data collected from the cargo tractor
Camera	A universal rearview backup camera	Monitor road and ambient conditions for the cargo tractor
Video recorder	A two-channel digital video recorder	Monitor road and ambient conditions for the cargo tractor
Thermocouple data logger	Omega OM-62	Measure ambient temperature and relative humidity
Voltage regulator	KEEDOX DC/DC converter	Regulate voltage from 12 V to 5V and supplies up to 3A
Storage case	Battery box	Store all sensors and hardware components
Fuel level sensor	FAST-A	Provides fuel level signal

4. Prototype

A modified transport tractor version was then prototyped using the designed DAQ device and incorporating all indexed hardware components. To simplify the setup process, the brackets for mounting the sensor and digital camera were first designed using CAD. Subsequently, both 3D cameras and 720×480 resolution and infrared night vision cameras were developed into standard 170° and 170° rear view cameras. Two versions of the camera mount were developed and a single-channel virtual video recorder (DVR) was installed in a separate housing at the front of the transport tractor. The camera is sent to the DVR to capture and monitor the road and other environmental conditions for the transport tractor. The tool roll lever palm is designed to mount a tool roll sensor. The tool roll sensor was installed between the tool slide holder and the designed lever arm assembly. The same rotary potentiometer used to detect tool roll is also used to detect wheel angle. During construction, the wheel angle sensor is screwed into the wheel angle insert. Wheel angle sensors allow you to detect the wheel angle based on the transport tractor's current route. Wheel position inserts, brackets and roller positioning are specifically designed for wheel position sensor installation. The current van version no longer has space to mount a wheel speed sensor, so an adjustable wheel speed mount was manufactured. To insert the brake force sensor, a custom T-shirt was introduced to reduce the overall variety of fittings used. Next, I screwed the brake force sensor into the T-piece and pressed it against the controller. A climate protection gas meter was placed near the fuel cap to determine the gas level and facilitate analysis of gas consumption. Two seat switches (one in the center on the driver's side and one on the passenger side) were integrated and fixed into the transport tractor's seat display. With the help of these seat sensors, you can determine the seat occupancy of a transport tractor. Finally, a statistics logger that collects and transmits all the statistics collected by sensors connected around the delivery tractor was attached to the electronics cover and connected inside the battery box. All connected sensors and hardware additions were transferred to the statistics logger for moving and sharing statistics. Finally, a detailed installation guide was created during initial prototyping. This manual consists of installation instructions for all DAQ components, maintenance plans, and instructions for removing all DAQ units and repairing the modified delivery tractor to the original model.

5. Testing and validation

After installing the DAQ device on a transport tractor, we validated the device by pushing the vehicle along a specific route and reviewing all datasets collected through the DAQ device. Several instance data sets are provided here. Figure 3 shows the temperature and humidity records and curves recorded by the thermocouple recording logger. figure. 4 and 5 display the speed and heading of the transport tractor recorded via the recording logger. A celestial rotor (Figure 6) equipped with a high-speed camera was then tasked with taking images of the transport tug at 1-second intervals to capture the angle of its direct heading. The angles measured from the images were compared to the transport tractor angles recorded via the recording logger and are shown in Figure 7.

Samp	Temp (F)	Hum (%RH)	Dew Point (F)	Date	Time
1	70.66	50.73	51.52	12/9/2015	1:52:45 PM
2	70.66	50.73	51.52	12/9/2015	1:52:46 PM
3	70.66	50.73	51.52	12/9/2015	1:52:47 PM
4	70.74	50.74	51.59	12/9/2015	1:52:48 PM
5	70.74	50.74	51.59	12/9/2015	1:52:49 PM
6	70.74	50.71	51.58	12/9/2015	1:52:50 PM
7	70.74	50.67	51.56	12/9/2015	1:52:51 PM
8	70.74	50.67	51.56	12/9/2015	1:52:52 PM
9	70.74	50.67	51.56	12/9/2015	1:52:53 PM
10	70.74	50.67	51.56	12/9/2015	1:52:54 PM
11	70.74	50.64	51.54	12/9/2015	1:52:55 PM
12	70.74	50.64	51.54	12/9/2015	1:52:56 PM
13	70.74	50.61	51.52	12/9/2015	1:52:57 PM
14	70.74	50.58	51.51	12/9/2015	1:52:58 PM
15	70.74	50.54	51.49	12/9/2015	1:52:59 PM
16	70.74	50.58	51.51	12/9/2015	1:53:00 PM
17	70.74	50.54	51.49	12/9/2015	1:53:01 PM
18	70.74	50.54	51.49	12/9/2015	1:53:02 PM
19	70.74	50.54	51.49	12/9/2015	1:53:03 PM
20	70.74	50.51	51.47	12/9/2015	1:53:04 PM
21	70.74	50.54	51.49	12/9/2015	1:53:05 PM
22	70.74	50.48	51.45	12/9/2015	1:53:06 PM
23	70.81	50.48	51.52	12/9/2015	1:53:07 PM
24	70.74	50.48	51.45	12/9/2015	1:53:08 PM
25	70.81	50.48	51.52	12/9/2015	1:53:09 PM
26	70.81	50.48	51.52	12/9/2015	1:53:10 PM
27	70.81	50.48	51.52	12/9/2015	1:53:11 PM
28	70.74	50.41	51.42	12/9/2015	1:53:12 PM
29	70.81	50.45	51.51	12/9/2015	1:53:13 PM
30	70.74	50.45	51.44	12/9/2015	1:53:14 PM
31	70.81	50.42	51.49	12/9/2015	1:53:15 PM
32	70.81	50.45	51.51	12/9/2015	1:53:16 PM
33	70.81	50.42	51.49	12/9/2015	1:53:17 PM
34	70.81	50.42	51.49	12/9/2015	1:53:18 PM
35	70.81	50.39	51.47	12/9/2015	1:53:19 PM
36	70.81	50.42	51.49	12/9/2015	1:53:20 PM
37	70.81	50.39	51.47	12/9/2015	1:53:21 PM
38	70.81	50.39	51.47	12/9/2015	1:53:22 PM
39	70.81	50.35	51.45	12/9/2015	1:53:23 PM
40	70.81	50.35	51.45	12/9/2015	1:53:24 PM
41	70.81	50.32	51.43	12/9/2015	1:53:25 PM
42	70.81	50.32	51.43	12/9/2015	1:53:26 PM
43	70.81	50.32	51.43	12/9/2015	1:53:27 PM

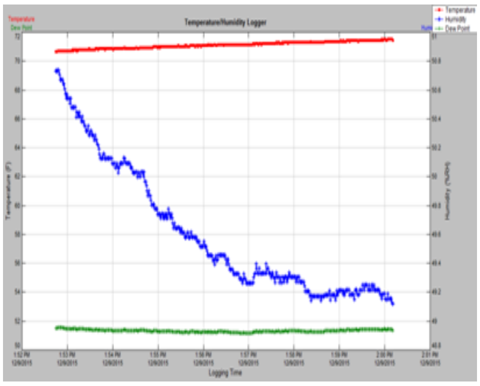

Fig. 3: Temperature and humidity data (top) and histories (bottom) readings from the csv report output from the thermocouple Omega-OM 62

As shown in Figure 7, it can be seen that the values obtained from the information logger accurately reflect the actual heading angle of the transport tractor. Finally, the operator's operation after using the modified transport tractor proved to be exactly similar to the original transport tractor, with no interference from his attached DAQ device. Most information was obtained via the mobile phone network, requiring minimal human effort in data collection. Test results confirmed that his DAQ device was highly reliable. All additives are properly integrated into this device, which provides real-time information to the customer and shows the scenario of the delivery tractor moving under certain conditions. Maintenance costs are low because each element can be easily assembled and disassembled.

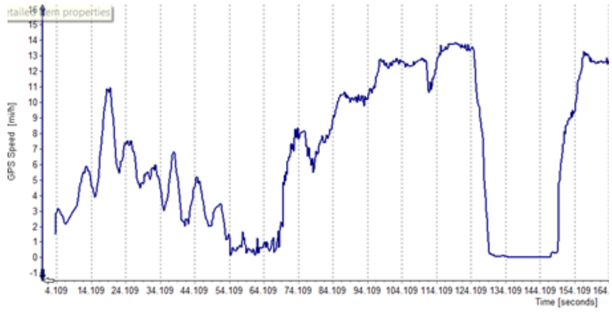

Fig. 4: GPS speed of the cargo tractor

Fig. 5: GPS route the cargo tractor tracked by the data logger

Fig. 6: Sky rotor used for photographing

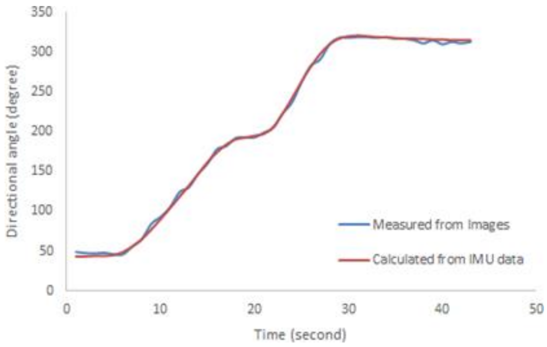

Fig. 7: Comparison of the cargo tractor angles recorded by thedata logger with the angles measured from photographs

6. Fuel usage analysis

Fuel consumption was recorded by looking at typical gas consumption over the entire mileage during the test period. Fuel replenishment was determined using datalog analysis of activities where gas levels increased significantly over a short period of time. The data was then filtered to exclude false positives due to fuel splashing in the tank due to road interference or unexpected starts/stops. This was done by eliminating the factor of the fact that the car started moving, as determined using a 3-second moving average. The resulting filtered data corresponds to the total gas delivered to the gas tank according to the experimental instructions. The vehicle's gas consumption was also measured using a modern fluid-consin vortex roller dynamometer. The performance cycle was enhanced by using sample data from the vehicle data log (see Figure 8). The power cycle was 10 miles (16.1 km) long, lasted 150 minutes, and protected 552 stops. Testing was completed using the best possible simulated vehicle weight equal to the actual vehicle weight plus a simulated towing capacity of 7,400 pounds. The engine was warm when the test started. Chassis dynamometer fuel consumption was measured using mass. This gas was commercially available as 87 octane gas (certification not required). To limit the effect of gas loss due to evaporation, the gas volume was measured immediately before and after the test. The test setup is shown in Figure 9.

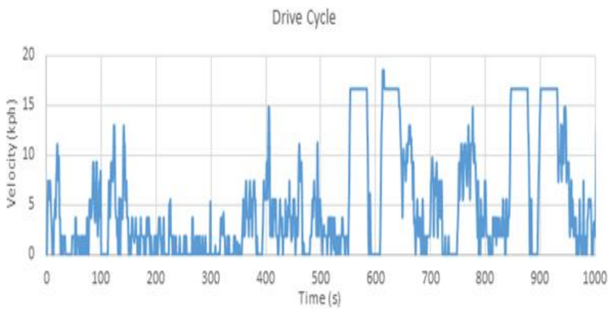

Fig. 8: Cargo tractor drive cycle

Fig. 9: Chassis dynamometer test setup

During testing, the vehicle's average fuel economy was measured at 4.93 mpg (miles per gallon). A good correlation with actual internationally recorded fuel consumption (3.94 mpg) has been observed, although this discrepancy is likely due to discrepancies between dynamometer drag figures and actual international test data. It's possible. Chassis dynamometers no longer allow towing hundreds of heights above what is normally visible in the operating environment. However, it turns out that the data collected during the three-month test was created based on empirical validation testing methods.

7. Discussion

The ability to retrofit existing and often aging transport tractors used on airport aprons for informational series was an important lesson learned on this project. This study not only provided a plan for how a larger fleet of transport tractors of any make, model, and type could be upgraded to quantify performance tests, but also all older GSE motor vehicles. Vehicles (e.g. forklifts, airport ramps and modified for information series for companies operating these ramps with limited system budgets and wishing to make operational decisions about the current state of their tractors) The purpose of this test is to demonstrate the implementation of DAQ devices into current systems, but research and development investment on the part of tractor manufacturers is limited. Information provided by this study. represents the actual added value from the company's perspective. A classic example found in the textile processing and logistics industry (often found on airport ramps) is ``doing more with less." The objective is to find a way to use the current system and plant components to produce more volume in a shorter amount of time. Increased optimization increases sales and reduces waste. Therefore, knowing exactly what the largest GSE vehicles are capable of will enable engineers to develop amazingly unique models to optimize operations. Real, quantified decisions about gas consumption, mileage, and fashion style. It can be performed on most parts of the system where preventive rather than corrective maintenance is considered. The decision to overhaul an existing system, rather than purchase a new one, can now be based on simple principles such as fuel economy, regular repairs, and alternative life cycles. Accurate depreciation and system utilization management can be more effectively “justified by the numbers” rather than relying on assumptions and the joy of soon-to-be-retired mechanics.

Additionally, decisions regarding a company's safety culture (or perhaps lack thereof) can be well evaluated in terms of serious injury prevention and more innovative training (and retraining) programs. The ultimate goal of this research is to be able to do more with less and make better decisions while continuously gathering actionable information. Now, with the rapid development of mobile phone technology, the indicators measured by data loggers can also be recorded using many apps on smartphones equipped with special sensors. This allows drivers to use their smartphones as information loggers to measure all metrics. However, because some companies prohibit or even prohibit the use of cell phones in the workplace, advanced DAQ devices are still used in various programs within the enterprise, such as in large organizations' power distribution facilities. can be detected.

Conclusions:

Sensor packages and DAQ devices developed for transport tractors to collect important statistics about tractor usage habits such as GPS route, vehicle speed, engine status, transmission status, seat occupancy, fuel level, and video recording. it was done. Statistics collected when using a DAQ device can serve as a guide to improve tractor transport simulations and can be used to optimize paint slippage and strength efficiency. To facilitate the combination of this DAQ device, various brackets were designed and manufactured to attach the sensor and various additives to the tug. Field tests confirmed that the developed device is able to correctly capture the statistics of the transport tractor and that the provided device does not adjust the way the transport tractor is used by the driver. Statistics collected through sensors are converted to CSV documents via statistics loggers, which can be easily converted to file formats for further processing and analysis. Future research could adopt the DAQ conversion plan described in this study and test additional vehicles such as transportation tugs in a comparable "sandbox" environment such as an airport ramp where some of the variables are within the facility's control. I plan to apply it to the type. Forklifts in factories housing warehouses are also a case where this technique can be used, but the resulting statistics may also indicate that this is highly dependent on operational optimization.

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