Executive Search Description
Connected Vehicle Energy Management
Executive Leader

A research team at the UMN has developed a system that predicts and optimizes the charge needed for commercial electric vehicles. The system is currently being applied to "last mile" delivery vehicles. The technology is a cloud-based software service that uses prior vehicle performance and external information like traffic and weather to train machine learning algorithms that, in turn, predict remaining vehicle range and battery state of charge. The result is a connected energy management system (C-EMS) that reduces range anxiety for fleet operators and enables greater penetration of electric vehicles into commercial fleets.

The team, in conjunction with the UMN Venture Center, is seeking a business executive to form and launch a business with the research team and then lead and operate the business.

The developed C-EMS technology is planned to be used as a third-party API implemented through an OEM vehicle supplier to a fleet (or individual) commercial vehicle customer. The initial target market is hybrid electric trucks used in commercial applications such as last-mile delivery and fleet services with a focus on telematics provider integration. Eventually the C-EMS technology will be used on all electric delivery vehicles such as those produced by Rivian and Workhorse.

The technology operates by sending high-resolution data from the vehicle to a cloud server. Combined with route information, traffic condition and weather data, machine learning algorithms with incorporated physics-based models are used to predict the remaining range and battery state of charge required to complete the route without running out of battery energy.

C-EMS will improve an operator's profitability and be packaged as an API and service for a fee by focusing on the following value added capabilities and benefits:

- Improved gasoline equivalent miles per gallon (MPGe) by 20% or more for plug-in hybrid trucks (initial market)
- Improved electric vehicle range prediction to eliminate range anxiety
- Optimized on-route charging schedule and rate for all-electric delivery vehicles
- Improved logistical efficiency through route optimization
- Reduced vehicle operational cost through reducing need for on-route charging

Potential Customers

- OEM Vehicle Suppliers
  - Last-mile Vehicles
  - Fleet Vehicles
- Telematics Providers
  - Fleet Management
  - Individual Users
- Hardware Providers
  - IoT Markets
  - Vehicle Aftermarket
- Software Integrators
- Aftermarket Municipal Vehicle Fleets

Roles and Responsibilities:

- Develop the business plan and business model with the help of the UMN research team and the Discovery Launchpad resources
- Set up/establish the business
- Finance the business with customer contracts or raise seed capital to get the business going
- Engage customers and channel partners, negotiating business relationships
- Operate the business and drive the business to success
- Scale the business to success

Qualifications Needed:

- Business experience in automotive and logistics
- Understanding of business strategy and planning
- Leadership skills to pull together the resources to operate the business
- Ability to raise capital as needed to fund the operation as needed
- Willing to roll up their sleeves and dig into the customer relationships and selling cycle
- Extremely effective communication skills
- Business negotiation skills
- Ability to motivate team members, investors and the general market to the growth vision
- Keep the business on a profit trajectory

Qualifications Desired:

- Experience in successful startup leadership
- Experience in raising early stage capital
- Experience in negotiating business relationship agreements
- Experience in working with a board of directors including outside investors

If you are interested in this opportunity please contact Russ Straate (612) 625-5878, rstraate@umn.edu.

2020

Intelengine LLC

Connected Energy Management System to Enable Battery Electric Last-Mile Delivery Vehicles

COMPANY SUMMARY

Intelengine, LLC is developing a connected energy management system (c-EMS) for the rapidly expanding electrified last-mile delivery truck market, which builds on its current product offering for range-extended hybrid delivery trucks. With increasing desire to decarbonize, lower maintenance costs, and meet increasing regulatory requirements in urban areas, delivery fleets are motivated to electrify large portions of their fleets. Although the driving range of electric vehicles (EVs) is increasing as battery technology matures, many delivery routes are not appropriate for electric vehicles with 100% certainty.. Range anxiety is therefore a key factor in steering fleet operators away from adopting electric vehicles. To solve this challenge, ***the goal of the company is to accurately predict the range of last-mile delivery EVs for a given route and to reduce the need for expensive on-route charging.***

The Company has been awarded a Phase I DOE SBIR grant where the primary technical objectives are to: 1) Use collected data from delivery routes to model last-mile electric delivery vehicle energy use and battery energy use on upcoming routes; 2) Develop and test a c-EMS that takes input data including desired route and exogenous data, and predicts vehicle range and on-route charging requirements; 3) Quantify potential cost benefits to fleet owners of implementing EV for package delivery with and without c-EMS using a techno-economic analysis; and 4) Work with a university research laboratory to develop new machine learning algorithms for predicting battery SOC trajectory for a future route using historical and exogenous data.

Commercial Applications and Other Benefits:
With the immense growth of e-commerce in the US, most consumers will do at least some of their shopping online and have their goods shipped using a last-mile delivery service. Increasing the number of electrified vehicles used in those deliveries has a significant impact not only in terms of fuel use, but also will reduce local criteria pollutant emissions and noise currently emitted by gasoline or diesel delivery trucks. This positively impacts public health and reduces delivery vehicles' negative impact on the environment. The company and the Phase I project proposes to realize and test a c-EMS system that will reduce range anxiety among fleet operator companies and allow them to incorporate electric delivery vehicles at a higher rate. A Phase II SBIR project along with additional investor funding is envisioned to refine the technology further and deploy it as a fully demonstrable product and service. Further growth is expected to refine the technology, growing Intelengine's c-EMS into a viable and profitable service.

DETAILED NARRATIVE

Identification and Significance

Intelengine, LLC will develop a connected energy management system (c-EMS) for application in the nascent electrified last-mile delivery truck market, building on its current product offering for range-extended hybrid delivery trucks. E-commerce is projected to grow 65% in five years from a market size of $587 billion in 2019 to over $969 billion in 2023 [1]. With such meteoric expected growth, package delivery will expand in the coming decade. Last-mile delivery, the leg from the distribution center to the final customer makes up at least two-fifths of the total cost of package delivery [2]. Reducing last-mile delivery costs is of paramount importance to shipping companies.

Fuel consumption is a significant portion of the cost associated with last-mile package delivery. For example, UPS vehicles travel approximately 3 billion miles per year. At an average fuel economy of 10 mpg, UPS delivery vehicles consume about 300 million gallons of fuel/yr, with yearly fuel costs exceeding $600 million [3]. Over the past decade or more, UPS has invested in connected vehicle technology and advanced telematics to save fuel. Most famously, they used in-use data to reduce left turns in 2008, reportedly saving over 3 million gallons of fuel that year [4]. Saving energy and maintenance costs are a key motivating factor for fleets like UPS to electrify their vehicles.

The electrification of last-mile delivery fleets represents a significant sea-change in how vehicles will be operated and maintained. With increasing desire to decarbonize, lower maintenance costs, and meet increasing regulatory requirements in urban areas, delivery fleets are motivated to electrify large portions of their fleets and overcome any problems accompanying this switch. Although the driving range of electric vehicles (EVs) is increasing as battery technology matures, many delivery routes are not possible to achieve with current vehicles. Range anxiety is therefore a key factor in steering fleet operators away from adopting electric vehicles. To solve this challenge, ***the primary goal of the company is to accurately predict the range of last-mile delivery EVs for a given route and to reduce the need for expensive on-route charging.***

The project team hypothesizes that with greater certainty of completing a route on one battery charge, last-mile fleets will adopt EVs at a higher rate, therefore reducing fleet energy use. Further, OEM range prediction does not take future route information or climate/traffic information into account, resulting in lower accuracy. Although OEMs could implement a similar EMS to what is proposed here, fleet operators like UPS and Ryder are concerned about relying on one vehicle manufacturer to provide telematics services. ***We propose to develop and market a vehicle agnostic c-EMS service that can predict the range for any last-mile EV deployed by fleet operators.***

Initial market analysis by Intelengine shows that medium-duty delivery vehicles with routes varying from 50 to 100 miles are ripe for conversion to electrification in comparison to other sectors. Reasons cited include route predictability, vehicle management from a central depot, significant stop-and-go traffic to take advantage of regenerative braking, and operation within a "sweet spot" of daily range for current battery technology. Fleets are already planning large expansions of their electric truck fleets. Recent press releases illustrate market trends in the last-mile space. Hyundai and Kia are investing $100 million in electric vehicle startup Arrival, and will

develop electric vehicles together. In addition, UPS intends to invest in Arrival and order 10,000 EVs. Amazon plans to order 100,000 electric delivery vans from electric vehicle startup Rivian. Eleven major companies including Amazon, DHL, Lime, and Siemens, joined a newly-formed Corporate Electric Vehicle Alliance to advocate for business sustainability and to meet their fleet electrification targets.

Intelengine's proposed c-EMS will solve a critical range anxiety problem for last-mile delivery fleet operators who intend to implement EVs throughout the US and worldwide. Electric vehicle range is lower than for the combustion engine vehicles they replace, and range varies significantly as a function of factors like driver behavior and ambient temperature. At the heart of Intelengine's proposed c-EMS technology are multiple machine learning algorithms that use prior data to accurately predict vehicle range using prior and real-time vehicle data..

Technical Approach

The Company's technology seeks to use machine learning algorithms to predict range and on-route charging requirements for last-mile EVs for given future routes and exogenous data inputs like weather and traffic. Algorithms will be trained progressively through the collection of high-resolution (1 Hz) vehicle data collected from individual vehicles on past routes. The technical approach taken by the project team will be to develop and deploy physics-aware algorithms that result in higher accuracy range prediction than is available from the on-board OEM prediction software.

Benefits

The potential operational energy and cost savings of last-mile delivery vehicle electrification compared to the conventional engine-powered vehicle paradigm is significant. According to DOE, Class 3-6 commercial vehicles make up 5% of the overall U.S. transportation energy landscape, consuming 556,000 barrels of petroleum today based on 2016 estimates [5]. Although last-mile delivery trucks only make up a portion of these vehicles, our calculations estimate that if 40% of the overall fuel energy were replaced with electricity, it would save $22M/day in energy costs for the overall fleet, or $8.1 billion/yr. These calculations are based on EIA average commercial fuel and electricity prices ($2.40/gal. and $0.10/kW-hr, respectively), US-EPA conversion of 34.02 kW-hr of electricity per gallon of gasoline, and assumed vehicle driveline efficiencies. Figure 3 illustrates the approximate fuel cost savings of this sector with increasing replacement ratio. Through the aforementioned fuel savings, the US can meet energy reduction targets and reduce its dependence on foreign fuel sources.

With the immense growth of e-commerce in the US, most consumers will do at least some of their shopping online and have their goods shipped using a last-mile delivery service. Increasing the number of electrified vehicles used in those deliveries has a significant impact not only in terms of fuel use, but also will reduce local criteria pollutant emissions and noise currently emitted by gasoline or diesel delivery trucks. This positively impacts public health and reduces delivery vehicles' negative impact on the environment more broadly.

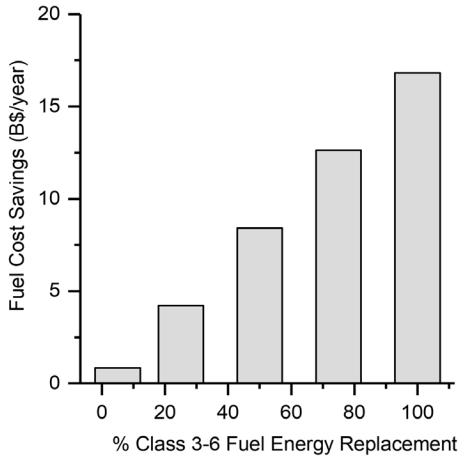

Figure 3. Calculation of potential fuel cost savings with replacement of all Class 3-6 commercial vehicles in the U.S. as a function of % fuel energy replacement at $2.40/gallon for fuel.

The current Company R&D efforts are focused on developing and testing a c-EMS system that will reduce range anxiety among fleet operator companies and allow them to incorporate EVs at a higher rate. A follow on project is envisioned to refine the technology further and deploy it as a fully demonstrable product and service with continued efforts to refine the technology to grow Intelengine's c-EMS into a viable and profitable service.

Key Personnel

Intelengine – Eddie Arpin is the lead company engineer and oversees technical software development and API integration. Mr. Arpin has significant experience leading software development and integrating activities for numerous startup ventures and he currently provides consulting consultant services in application and software development. Multiple contract software developers are anticipated to provide additional software development resources to further refine algorithms and integrate into an API-based product by the end of 2021.

University of Minnesota (Research Institution) – The University of Minnesota's (UMN) has and will continue to develop machine learning algorithms and physics-based vehicle/HVAC models for the current development project and will continue to develop algorithm technology. This technology is licensed to Intelengine through the UMN's Technology Commercialization office. Dr. Will Northrop, Associate Professor, Department of Mechanical Engineering is leading the algorithm and model development effort at UMN. Dr. Northrop is director of the T.E. Murphy Engine Research Laboratory (MERL) and is an expert in vehicles, electrification and the use of data-science in vehicles.