IEUM: Bridging Transportation to Humans

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***Abstract*—IEUM, a small data cube, is a fundamental agent of transportation envisioned in a future shared mobility system. By communicating with the user, IEUM understands what its user needs at the moment and acts as a mediating agent among humans, cars, and other traffic infrastructures. While taking you to your personalized route of the day, IEUM will also enhance the traffic and energy efficiency of our transportation systems with other IEUMs out on the road. With your buddy IEUM, moving is full of fun.**

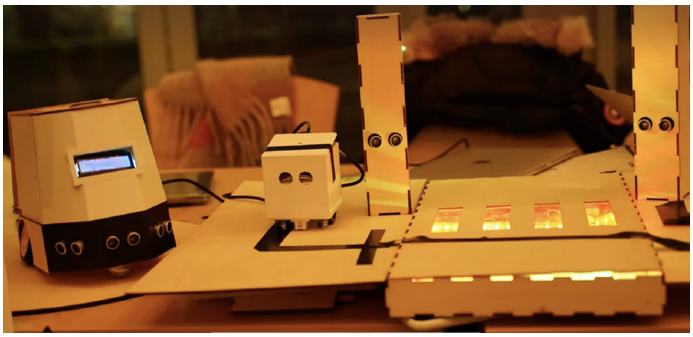

Fig. 1. Physcial Prototype of IEUM, Crossing a Crossroad

***Index Terms*—human robot interaction; transportation; autonomous driving; traffic optimization; data cube; future city; personalization; safety**

I. Overall Design

IEUM, which means connection in Korean, is a small data cube that bridges transportation and humans. The current initial prototype of IEUM system includes the IEUM body itself, pairs of interactive traffic lights, and an autonomous driving car. When a pedestrian has to cross a specific part of the road, one of the lights at that part of the road will turn into a traffic light, generating a crossroad for the person. Then the person and his or her IEUM will cross the road, and the interactive traffic lights will send the updated data to nearby cars , so that their autonomous driving system can be updated as well. Below is our initial prototype of IEUM with its other traffic infrastructure prototype, crossing the crossroad. The design of IEUM was inspired by the MIT Tangible Media Group's project HERMIT. [1]

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II. Application Scenario

A. IEUM, the Spiderman's Secret Helper

In the year 2032, the world has become a shared mobility system. The concept of individually owned cars has disappeared. Everyone uses an IEUM, a personal transportation agent that assists you in your daily transportation. With IEUM people can rent a shared mobility car, cross crossroads more safely, and personalize a shared car interior. With IEUM, transportation has become so easy that even Spiderman has an easier time doing his job in the city. But how exactly does IEUM help with this? Well let's take a look into the daily life of Spiderman with IEUM.

B. IEUM Helps Spiderman(Peter) Get Out

"RRRIIINGG!!" It's 8:45 am and Spiderman is late to school. Before IEUM, Spiderman would be in a hectic frenzy if he woke up late for school. But with IEUM, all Spiderman has to do is wait for his car to arrive. When Spiderman is finished getting ready, he finds IEUM waiting outside for him. IEUM has already called Spiderman a car and entered his route to school. To get to the car, Spiderman has to cross a road. In this new system, you can cross the road from anywhere. When Spiderman steps up to cross the road, IEUM communicates with the traffic lights and creates a closest possible LED crossroad for Spiderman to walk across. This means that all the other cars on the road have been signaled to stop. Spiderman hops into the car waiting for him across the road. When he inserts IEUM into the car, IEUM personalizes the shared car environment to fit Spiderman's taste. The car chair changes to a design that Peter likes, and a spider logo appears on the interior of the car. The car interface also changes into Spiderman's personal office mode. As Peter's favorite shiny neon lights shine, Peter sings "You're the sunflower " on his way to school. "Phew! It could have been a hectic morning but thanks to IEUM, everything is sorted out!" Peter thinks as he lets out a sigh of relief.

C. Connection between IEUMs: IEUM saves a Pedestrian

"Hmmm.. Did I have homework today?" On his way to school, Peter gazes out through the window while trying to remember if he had done the homework for today. Suddenly, he notices that a person starts walking across the road without any crossroads. The person seems to be blind and the silent mobility cars are too silent for him to notice one swooshing

right by. “Oh no, he’s going to get a car accident!” Peter gets ready to get out of his vehicle, changing into Spiderman’s uniform to save her. But much to his surprise, one of the shared mobility cars speeds down slowly towards the blind person. How did this happen? The IEUM in the car had signaled the situation to the other IEUMs inside shared mobility cars so that they can be ready for the encounter as well. The blind person keeps walking while other vehicles safely stops accordingly. “Ah, it seems like she’s gonna make it without my help!” Peter sighs with a relief. With the help of IEUM, road accidents which used to be one of Spiderman’s main jobs, is no longer something he has to worry about.

D. IEUM Manages Road Safety

In the meantime, Daily Bugle from the car interface reports that there is a jewelry robbery in Brooklyn. Peter notices that the thief is running away down the street. No explanation needed, IEUM notices Peter’s rising heart beat, shifty eyes, and the danger message and gets ready for an emergency mode. “IEUM! I’ll be back.” Peter leaves the vehicle, flying through the buildings. IEUM sends out the emergency protocol to the other IEUMS in Brooklyn, ensuring the safe traffic of the city. At the same time, shared mobility cars close to Peter notice fighting actions and back up. Under IEUM’s calculation, other cars can move around the block to avoid the scene. IEUM has been able to calculate this by signaling to other IEUMS and understanding how much traffic there is in the current roads. Additionally, more mobility cars idle from the renting station come to surround where Peter is, so the thief cannot run away from the scene. “Uggh! There’s no way out!” The thief yells out while frantically running, constantly changing his direction. “Haha, gotcha!” Spiderman snatches him up and starts gluing him around a utility pole. As Spiderman starts hearing the police siren coming, the mobility car with Spiderman’s IEUM approaches Spiderman, its screen displaying “9 minutes left for school”. “Oh no, I’ll be late for school! I can’t be late again!” Peter says, and the shared mobility cars optimize their arrangement to let the police cars in and Peter’s vehicle out.

E. IEUM Parks and Exchanges Energy

Post Malone’s Sunflower slowly volumes down and the Spiderman logo from the interior designs go away. “You have arrived to your school,” Peter’s vehicle announces. “Thanks! I’ll see you again, IEUM!” Peter quickly changes to his regular outfit and heads to school. IEUM follows Peter and parks down the ground in front of the school gate, sharing its leftover energy with other IEUMs under the ground and charging itself. The vehicle then moves away from school, headed back to its public renting station, trying to interfere with the least possible amount of traffic even if it takes long for itself to get back.

F. Connected Future Transportation with IEUM

Thanks to IEUM, Spiderman has much less work to do around the city. Future transportation with IEUM is much easier with the special connection that IEUM provides. IEUM communicates with other IEUM devices to signal danger, share road conditions and energy. IEUM also forms a connection between people and their cars. Even in a shared mobility system, using the data that IEUM holds, people are able to personalize their car. Future transportation with IEUM is connected, sustainable, and exciting!

III. DESIGN PROCESS

The future society will be constructed with blocks of smart cities according to the recent increased use of smart home devices and the Internet of Things. Among this trend, the rapid development of transportation systems such as the Internet of Vehicles is noticeable. It only took 10 years for Tesla’s electric car to go on the public since its first mass production and 5 years for electric, autonomous buses to be used as public transportation. As dramatic improvements in the smart transportation industry are being made, we found four problems that remain: data privacy, sustainability, and road efficiency. Therefore, we designed IEUM, a small, private data cube that everyone owns for a more reliable smart transportation system.

First of all, IEUM connects to humans to strengthen data privacy. Currently, the smart devices store the data and provides the produced data back to humans. This system raises concern about data privacy as the usage of data is unclear. To solve this problem, strongly protected IEUM holds the entire private information and sends them to devices based on their usage. For instance, the autonomous car drives based on the user’s routine that IEUM provides. In this way, users no longer store their sensitive data to the device which can be easily exposed to danger. Therefore, IEUM enables humans to control which, where, and when their personal data is used and enhances data privacy.

In addition, the data transmission supports sustainability. We let every car be a public autonomous driving unit whoever can use it. Although cars are no longer a personal asset, IEUM makes the car personal through data transmission. This reduces the energy expenditure since it reduces the time that car is in use.

Moreover, IEUM connects with other IEUM for sustainability and road efficiency. Human drivers conduct human error and misuse the fuel. However, connected IEUMs let the car drive in the most fuel-efficient way. The traffic congestion is removed and energy usage and pollution are reduced. Therefore, communication among IEUMs supports sustainability and enhances road efficiency. The poster that covers CAD rendering of IEUM, car, manufacturing process of the prototype can be found here: link.

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