SMART PARKING SYSTEM ON UF CAMPUS

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Smart Parking System on UF Campus

Background and Significance. Parking on the UF campus can often be very difficult, due to insufficient parking supply versus the demand (faculty, staff, students, and visitors). The situation is particularly acute when there are special events on campus such as Gator sports activities, job fairs, concerts, etc., which occur frequently. Searching for a parking space causes extra travel time, consumes road capacity, burns extra fuel, and produces extra toxic emissions. The parking issue jeopardizes the efficiency of campus functions, including academic meetings, teaching, research activities, etc. Moreover, it significantly affects the traffic efficiency and associated livability in Gainesville.

Challenge, Opportunities. UF currently provides 23,000-24,000 parking spaces, and there has been no substantial change to this number for the past 20 years. A Campus Development Agreement caps campus parking spaces at 25,377. In the meantime, campus parking demand (requests from students, staff and faculty members) continues to increase along with the growth of the university. The imbalance between supply and demand indicates the apparent deficiency of parking spaces, which represents the root of the parking difficulty on campus. However, it is also noticed that students, staff and faculty members in universities usually have relatively flexible and diverse schedules and request parking spots at different times of the day. This feature provides us the opportunities to coordinate the requests so that we can use the parking facilities more efficiently.

Solution and Project tasks. To address the parking issue on the UF campus, multiple solutions from both supply and demand sides are needed. This project seeks to establish a smart online parking service system, which enables real-time parking decision assistance. Specifically, this smart system—which considers both the working/class schedule of users and parking occupancy availability—provides real-time parking occupancy information to users that allows smarter trip scheduling to campus to be made. This solution will take advantage of advanced sensing, communication and information technologies. To achieve this goal, we propose the following research tasks, which represent the kick-off efforts for this project.

Task 1: Monitoring parking supply. To facilitate improving the service level of UF campus parking, the first project task is to implement smart parking facilities monitoring the utilization of the system, which help detect and collect the following information for future analysis.

1) Parking space utilization of surface lot or garage at any given time.
2) Vehicle entrance and exit data at all parking surface lot/garage entrances/exits
3) Vehicle identification data, which will not only help with parking duration (assuming we do not have space-level sensors), but also the apportionment of space sizes within any given lot (e.g., much higher percentage of small cars vs large cars, or vice versa)
4) Scooter and motorcycle parking data

This requires either space-specific technology or vehicle identification technology at entrance/exit points. RFID and video cameras could be the potential techniques we use. The commercial company WGI (https://wginc.com/about-us/) has shown interest to support this project. We may explore multiple vendors to join and contribute to this initiative.

Another option to be considered is providing a webpage (or mobile app) where users could report their schedules for coming to and leaving campus. This information will help reduce the uncertainty for predicting the usage of parking spaces. The contribution of such information can be encouraged by providing incentives.

Task 2: Understanding parking demand. Once the parking facility monitoring system is implemented, we are able to collect parking data regarding the usage of parking spaces over the entire day. Preferably we could also obtain statistics on parking durations, space turnover rate, etc. Built upon this capability, we will conduct data analysis and use machine learning approaches to discover more comprehensive

information/patterns about the utilization of parking facilities, such as the variation of the availability over a day and weekdays, predicting open parking spots for short-term parking duration, etc.

This knowledge will enable us to build up real-time parking facility service on campus. Moreover, this knowledge can also provide more advance services including other potential solutions to address the campus parking difficulty, including (i) how to optimize course schedules considering parking capacity, (ii) what is the best rate of overselling, (iii) how to provide incentives for parking in less utilized lots or taking public transit, etc, (iv) more options for parking of certain durations (2-hr, 4-hr, etc.) or certain weekdays.

Task 3: UF Smart Parking APPs. This project task is dedicated to develop a website and/or mobile app so that we can provide the real-time parking space availability, prediction, suggestions, etc. we can also improve the current parking map by involving real-time parking information, dynamic hours of enforcement, etc. With all of these capabilities, we can help UF faculty, students and staff make smarter scheduling decisions and help relieve the 'parking anxiety' that many travelers to campus feel on a daily basis. There are also some available commercial technologies/apps we can refer such as BestParking (https://www.bestparking.com/parking-app/).

Broader Impacts of this Project. The success of this project will significantly improve the service level of the parking facilities on the UF campus. More importantly, incrementally building up such a smart parking system, involving advanced sensing, communication, information, and data analytics technologies, provides a good testbed to promote cutting-edge research as well as high-tech education. Students will have the hands-on experience on how new technology will affect and improve the quality of people's daily life. Last but with the same importance, solving the parking difficulty on UF campus will also help traffic congestion reduction and establish an eco-friendly transportation system in the city of Gainesville. For example, the study may use the O'Connell lot as a testbed to start this Pilot project. The City of Gainesville is supportive of this idea because better information on parking demand in UF, such as the O'Connell lot, particularly for major events (e.g., Sesame Street Live, Career Fair, sporting events, etc.) might help them with the development of signal timing plans to better handle these peak traffic demands. Furthermore, providing parking availability information to travelers might help reduce the number of vehicles on the roadway (2nd, University, Gale Lemerand) that are in parking space search mode.

Pilot Project Budget Estimation

The budget estimation is closely linked to the number of access points and lanes in the testbed. We propose to use the O'Connell Center parking surface lot and garage as initial the initial test bed site. Provided below is such information for the testbed and discussion about the budget estimation according to the options provided by the vendors.

Testbed: It includes 2 primary access points, encompassing 5 total lanes (2 in, 3 out), and 2 secondary access points that is used very infrequently (usually just football games), encompassing 4 total lanes (2 in, 2 out). The garage is accessed from within the surface lot and includes a total of 3 access points (2 in, 1 out) with 3 lanes. Figure 1 at the end of the doc shows an aerial photo of the proposed test site and the access points.

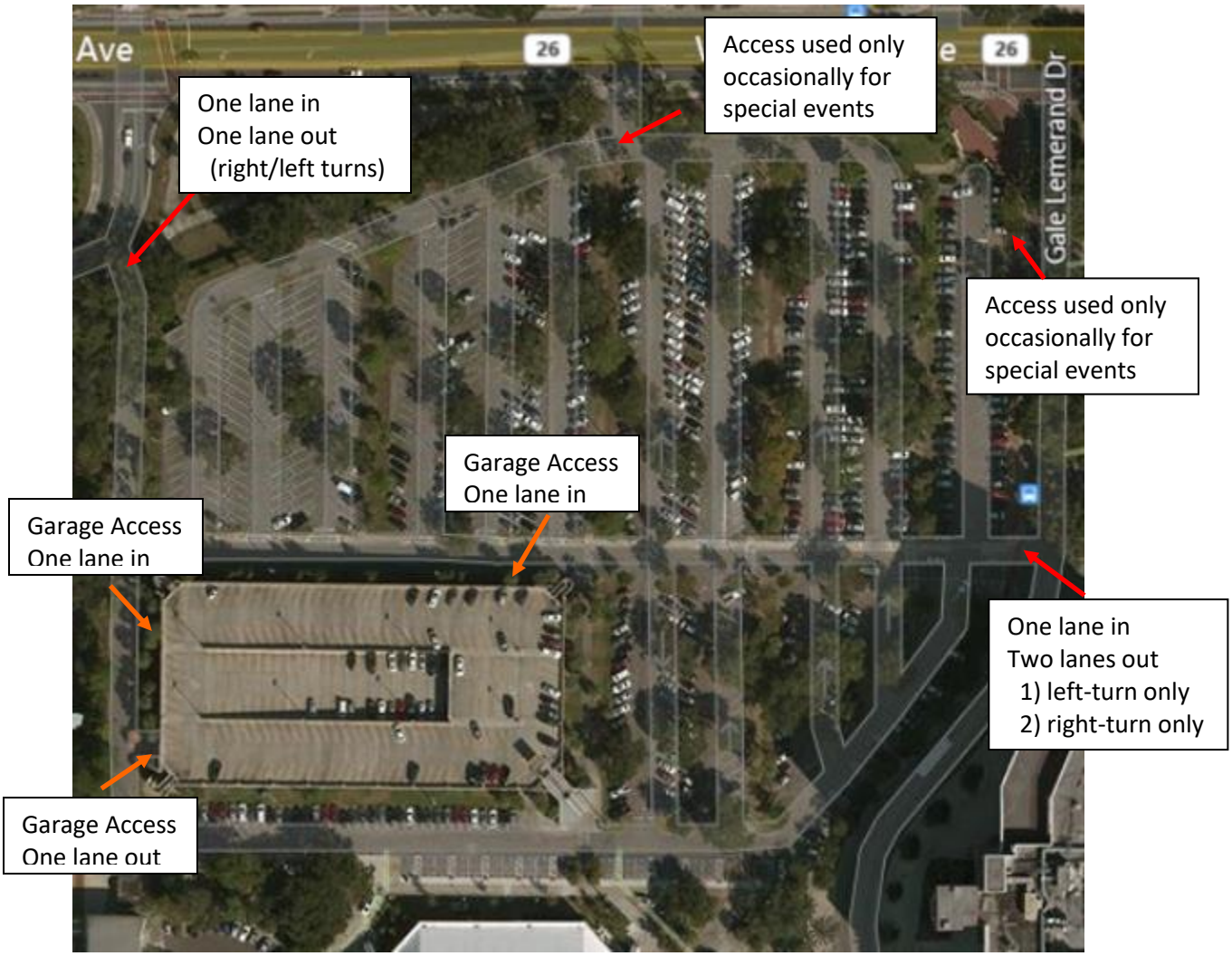

Figure 1. O'Connell Center surface parking lot and garage

The intent for this pilot project is to identify the potential benefits of parking data, both real-time and archived, such as real-time parking availability, areas for optimizing parking lot permit allocation, etc. In order to keep costs relatively lower for this pilot project, it is not proposed to instrument each parking space with sensor technology. Rather, the approach will be to monitor each entrance/exit point to the surface lot and parking garage. The technologies being considered for this purpose include:

- License Plate Recognition (LPR): A video-based system that extracts the license plate number from the vehicle. As such, each vehicle is uniquely identified and thus parking duration can be measured from entrance and exit times. https://resources.genetec.com/youtube-all-videos/gateless-off-streetparking-enforcement-with-autovu-free-flow-2
- Video Image Processing (VIP): A video-based system that recognizes the passage of a vehicle, but does not uniquely identify it. Thus, entry/exit counts, but not parking duration, data are obtained.
- Vehicle counting sensors: Inductive loops in the ground detect vehicles and their direction of travel to provide a count of every entry and exit into your parking facility. https://www.t2systems.com/solutions/vehicle-counting/count-vehicles-anywhere
- In-pavement magnetometer sensors: passive devices that indicate the presence of a metallic object by detecting the perturbation (known as a magnetic anomaly) in the Earth's magnetic field created by the object. https://www.fhwa.dot.gov/policyinformation/pubs/vdstits2007/04pt2.cfm

The pilot project costs consist of three components: capital costs, recurring maintenance costs, and personnel costs. Based upon discussions with three parking technology vendors, we have identified several potential options, enumerated as follows, in order of most to least desirable.

1. LPR at each access point provided by Genetic
   Total Initial Cost = $214k = $78k~132k (Initial) + $82k (Personnel)
   Recurring annual cost = $6k (for LPR Software)
2. In-ground sensors for vehicle count provide by Temple, Inc
   Total Initial cost = $30.065k~$38.565k + $82k (Personnel)
   Recurring annual cost = 0 (hosting data by campus) ~ $3k (hosting by Temple)
3. Video count provided by T2
   Total Initial cost = $257k = $175k (Initial) + $82k (Personnel)
   Recurring annual cost =$36k

Three items to take note of are:

- Given the cost of Temple, Inc's solution is very low, we propose to implement the O'Connell parking center by both Option 1 and Option 2 if the budget is permitted. This enables us to exam and compare the benefit-cost efficiency for two different types of solutions, doing LPR and vehicle count respectively. They may give us thoughts to choose different technologies under different level of service requirement in the future.
- If a permanent service will be provided, we may consider implementing monument signage, which will initially cost $4k to $11.5k and a $300 recurring fee.
- The detailed cost breakdown for these options is provided in the table below. The personnel costs do not vary by option.

I: Monitoring System (6 accesses and 12 lanes)

Vendor(s)	**Technologies**	**Initial Cost**		**Recurring annual cost**		**Annual Maintenance costs**
		per access	**per lot**	**per unit**	**per lot**	
T2: Option 1	LPR* and video (1 video/lane)	$40k	$40k*7 access =$280k	$5.5k per camera	$5.5k*12 cameras =66k	$300/per year/per camera
T2: Option 2	Video (1 video/lane)	$25k	$25k*7 gates =$175k	$3k per camera	$3k*12 cameras =$36k	n/a
T2: Option 2	Flat mats with counting sensor	$11k	$11k*7 access =$77k	$750 per access	$750*7 access =$5.25k	n/a
Ballpark budget of T2		$77k – $280k		$5.3k– $66k		0~$3600
Genetec	LPR	$11k/lane	$11k*12 lanes	$500/month * 12 = $6k		n/a
Ballpark budget		**$78k-132k for O'Connell**		**$6k**		**n/a**
Temple, Inc.	In-ground sensors	$30065.00 (12 lanes) (Installation/Support/Mounting Structure not included)		$3000		**n/a**
Ballpark budget		$30.365k – $38.565k (12 lanes)		0-$3000		**n/a**

Comments:
- An access: a single access point to a facility with one (1) entry and one (1) exit
- The accesses for the garage have only one lane; thus, this may reduce the cost
- Genetec indicates that initial costs are probably closer to $8,000 per lane, because the six lanes identified with the O'Connell Center lot are relatively close together
- Genetec proposes $6,500 per lane if the infrastructure work is done by the university
- Website for T2: https://www.t2systems.com/home
- Website for Genetec: https://www.genetec.com/solutions/industries/parking-enforcement
- Temple's recurring annual cost reduced to zero if campus hosts purchase server and software (extra $8500) to host the service

II Personnel costs

2 Faculty (Drs. Du and Washburn), 2% effort over 18 months

1 PhD student, 50% effort over 18 months

≅ $80k

III: Monument signage

Venders	**Techniques**	**Initial cost**	**recurring annual cost**

WGI	Large LED sign with a 4’ x 3’ LED board	$11,500	$300
	Small LED sign with a 1’ x 3’ LED board	$4,000	$300
	Fabricated aluminum monument sign with individual LED display inserts	$9,500	$300

UF | Transportation Institute
UNIVERSITY of FLORIDA

Smart Parking System on the University of Florida Campus

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University of Florida, Feb. 22, 2019

Background and Significance

Campus parking inventory

- 23,000-24,000 parking spaces, largely unchanged for 20 years
- New buildings often take away parking spaces-will continue
- Campus Development Agreement caps campus parking spaces at 25,377

Parking service

- Peak occupancies for all types of Decal is about 93% on average
- Parking permit oversell rate of UF is 1.4 decals per parking space; much higher than peer comparisons, average oversell rate = 1.27

Significance

- Parking on the UF campus can be very difficult at times (sporting events, special events), giving rise to 'parking anxiety'
- It significantly affects the efficiency of campus activities and city traffic

Challenge, Opportunities

- **Supply: Parking Facility**
  - Need parking lot monitoring system
  - Need space availability information and service
- **Customers: visitors, students, staff, and faculty**
  - Flexible and diverse schedules
  - Can potentially be coordinated
  - Need such service
- **There is still room to improve the usage of the spaces**
- **Advanced sensing, information, and data analysis will help**

Solution and Project Tasks

Establish a smart online parking service system, which

- Provides real-time parking occupancy information
- Suggests smart trip plan to campus
- Coordinates the usage of different types of decals

Tasks

- Task 1: Monitoring parking supply
- Task 2: Understanding parking demand
- Task 3: UF Smart Parking APPs and Testbed

Task 1 Monitoring Supply

- Implement smart parking facilities monitoring the utilization of the system
- Detect and collect the following information for future analysis
  - Vehicle entrance and exit data at all parking surface lot/garage entrances/exits
  - Vehicle identification data, which help with parking duration and the apportionment of space sizes within any given lot (e.g., much higher percentage of small cars vs large cars, or vice versa)
  - Parking space utilization of surface lot or garage at any given time
  - Scooter and motorcycle parking data
- Facilities
  - Vehicle identification technology at entrance/exit points (License Plate Recognition)
  - RFID or Cameras
  - WGI (https://wginc.com/about-us/) has expressed interest to support

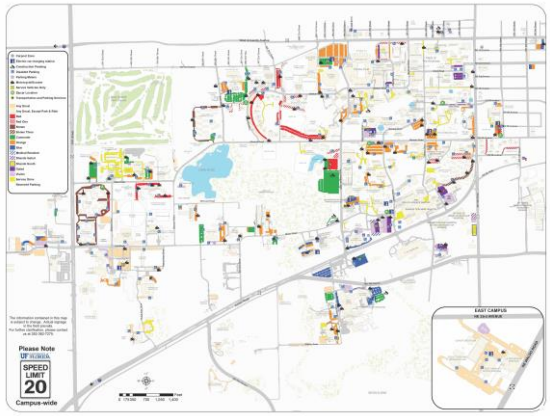
Task 2 Understanding and Managing Demand

- Understanding the utilization of parking facilities
  - Parking durations, space turnover rate
  - Variation of the availability over a day and weekdays,
  - Predicting open parking spots for short-term parking duration
- This knowledge enables to serve/manage parking demand on-campus better
  - Provide real-time parking facility service on campus
  - Optimize course schedules considering parking capacity
  - Determining the best oversell rate
  - Provide incentives for parking in less utilized lots or taking public transit, etc
  - Suggest more options for parking of certain durations (2-hr, 4-hr, etc.) or certain weekdays with unique characteristics

Task 3: Building UF Smart Parking APP and Testbed

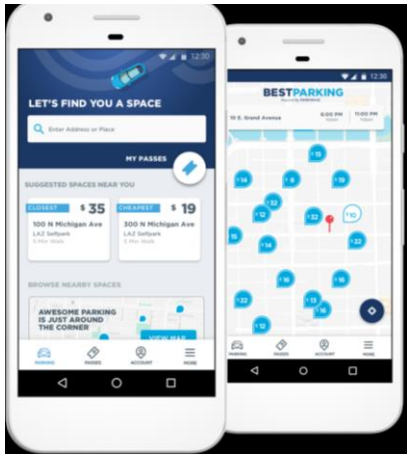
- **Improve Parking Map**

1) Real-time usage information
2) Prediction



- **A Mobile APP or Website**

1) Provide parking and trip suggestions



- **Testbed (O'Connell lot)**

1) Major events: Sesame Street Live, Career Fair, sporting events
2) Help develop signal timing plans for peak demands
3) Affected roadways: 2nd, University, Gale Lemerand.

Broader Impacts of this Project

The success of this project will

- **Improve the service level of the parking facilities on the UF campus.**
- **Provides a good testbed to promote cutting-edge research as well as high-tech education.**
  - **Incrementally build up such a smart parking system, involving advanced sensing, communication, information, and data analytics technologies**
- **Students will have the hands-on experience on how new technology will affect and improve the quality of people's daily life.**
- **Help traffic congestion reduction and establish an eco-friendly transportation system in the city of Gainesville.**

Venders in Contacts

- **WGI (involves another two parking technology vendors)**
  - **T2: For a single access point to a facility with one (1) entry and one (1) exit**
    - Option 1: Fixed LPR system with a video camera for each lane ($40,000 for Year 1 and then $5,500 recurring annual charge per camera)
    - Option 2: Similar to Option 1 only using video counts ($25,000 for Year 1, and the recurring annual charges would be $3,000 per camera)
    - Option 3: Use surface mounted industrialized flat mats with counting sensors ($11,000 for Year 1 and the recurring annual charges would be $750 for the two lanes).
  - **Genetec**
    - Offer a LPR product called "Free Flow"
    - $8,000 to $11,000 per lane including infrastructure improvements (curbing, channelization if needed, power, poles for mounting, Wi-Fi).
    - $6,500 per lane if the infrastructure work is done by the university.
    - The Genetec hosted software solution is $300/month. Each "lot" is an additional $100
    - For the O'Connell test location it would be considered two lots and the hosted software would total $500/month, which could be discontinued at any time
  - **Temple. Inc**
    - Offer in-ground sensor for vehicle count; $30.365k – $38.565k for initial cost and ($3000) for recurring annual cost if the vender host the service.

Stakeholders Involved

- UF Chief Operating Officer (Charlie Lane)
- UF Herbert Wertheim College of Engineering (Dean Cammy Abernathy)
- UF Transportation and Parking Service Office (Scott Fox and Ron Fuller)
- UF Infrastructure Council (Bernard A Hauser)
- UF Faculty Senate (Katherine Vogel Anderson)
- UF Director of the Office of Sustainability (Matt Williams)
- UF Business Affairs (Craig Hill, Associate VP)
- Florida Department of Transportation (Tom Byron)
- Assistant City Manager, Gainesville (Dan Hoffman)
- RTS director (Jesus Gomez)
- University of Florida Health, Shands Hospital (Edward Jimenez)
- Others

Thank you and Discussion

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