Automatic Parking Monitoring and Assistance for city of Champaign

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Team 17

ILLINOIS
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No one would be happy with a ticket
Problems of existing parking system

1. Inflexible parking length choice
2. Inefficient supervision
3. Not convenient to pay
Objective

1. No operation needed on phone or meter while parking

2. Reasonable parking fee calculation

3. Timely notification to parking department about any kind of violation.
Then we come up with...
Internal Block Diagram

- Pi Module
  - Raspberry Pi
  - UART
  - 5V
- Hardware Modules
  - Analog out
- PCB Module
  - LED
  - Digital I/O
  - PIC MCU
  - Digital I/O
  - Ultrasonic Motion Sensor
  - Power Management Module
- Camera Module
- Image Data in
- 120V AC
- Wall Power

Network:
- WLAN
- Remote Server (PC)
- Remote Database
- Push / Pull
- Frontend Interface
- Webserver
- Mobile Applications
Hardware components

- LCD screen
- Ultrasonic sensor
- Pi camera
Hardware components

PCB & MCU

Raspberry Pi
Workflow of smart parking meter

Car arrive
- Car detection
- Raspberry Pi wake up
- Plate recognition
- MCU time counting
- Raspberry Pi sleep
- Data transmission
- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep

Car leave
Design details

Car arrive:
- Car detection
- Raspberry Pi wake up
- Plate recognition
- MCU time counting
- Raspberry Pi sleep
- Data transmission
- Car leave:
- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep
Ultrasonic sensor

Distance = Signal interval / sound speed

Car parking criteria:

Ultrasonic sensor detected an object stay in the range of 0.2m to 0.6m.
**Design details**

Car arrive:
- Car detection
- Raspberry Pi wake up
- Plate recognition
- MCU time counting
- Raspberry Pi sleep
- Data transmission
- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep

Car leave:
- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep
Raspberry Pi control
Design details

Car arrive
- Car detection
- Raspberry Pi wake up
- Plate recognition
- MCU time counting
- Raspberry Pi sleep
- Data transmission

Car leave
- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep
Plate Number Recognition
Algorithm workflow

1. Plate segmentation
2. Character segmentation
3. Character recognition
Plate segmentation

- preprocessed binary image
- contour image
- candidate plates
- possible characters
Character segmentation
Character recognition

M

C

L

ECE ILLINOIS
Filter candidate plates
Client-Server Communication

Car arrive

- Car detect
- Raspberry Pi wake up
- Plate recognition
- MCU time counting
- Raspberry Pi sleep
- Data transmission

Car leave

- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep
Software design

*Top-level data flow of the entire data transmission system.*
Software design

Flow of data on the server side

1. Await new driver arrival/departure
2. Log time/license plate
3. Is license plate registered?
   - No: Create new database entry with 0 balance
   - Yes:
     - Driver arriving or departing?
       - Departing: Request updated balance from the smart meter
       - Arriving: Fetch driver balance, and send it to the smart meter
4. Upon receiving the new balance, update the database info
Web Server design

Software logic flow on the meter/client side
Design details

Car arrive:
- Car detection
- Raspberry Pi wake up
- Plate recognition
- MCU time counting
- Raspberry Pi sleep
- Data transmission
- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep

Car leave:
- Raspberry Pi wake up
- Data transmission
- Raspberry Pi sleep
Micro-controller & LCD

ATMEGA328P

External Interrupt Line & Digital I/O

Ultrasonic Motion Sensor

Digital I/O Signal

Parallel Slave Port Data I/O

Digital Feedback Signal

Digital R/W Cmd

LCD Module
Power Analysis

Power Consumption in One Working Loop of smart meter

- Time (s) axis
- Current (A) axis

Points labeled 1, 2, 3, 4, 5 indicate different phases or events in the power consumption pattern.
Cost

Points scored

- Raspberry Pi Model 3 B+: 34.1%
- Camera Module: 27.3%
- LCD Screen (EADIP162-...): 19.3%
- SanDisk 16GB MicroSD: 8.0%
- Others...: 11.4%

Total: $88
Future Work

- Integrate sensor to measure the position of the car in the spot to determine whether it parks outside the spot.

- Integrate flash light to enable taking photos during the night.

- Integrate methods to inform the driver if any violations happen.

- Add stage where one car immediately park in before raspberry pi goes to sleep.
References

1. https://github.com/openalpr/openalpr
2. https://github.com/MicrocontrollersAndMore/OpenCV_3_License_Plate_Recognition_Python
Thanks for watching !!!!

Any Questions?