Proposal

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#197 Perception for Transportation Service Robots

Principal Investigator
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Status
Incomplete Proposal

Research Type
Applied
Grant Type
Research
Grant Program
Private Funding
Grant Cycle
2018 Traffic21
Visibility
Public

Abstract

Transportation hubs, both large and small, serve as critical points in the travel chain. Due to their role as multi-modal nexus points, mobility breakdowns at hubs can impact large numbers of people across a wide range of disabilities. Hub-based service robots have the potential to assist people with and without disabilities through these complex and confusing facilities. This vision of the future is the focus of the Disability Rehabilitation Research Project on Robotics and Automation for Inclusive Transportation, which is part of the Accessible Transportation Technologies Research Initiative (ATTRI).

A key building block to support transportation hub assistance robots is the ability to perceive human torso orientation. This allows projections of where a person is walking, where they intend to move, and the regions of space they are attending to. The team has made initial progress on using low-cost stereo camera sensing to rapidly extract the torso plane of humans in 3D space. We seek to refine this capability to support use in future robots and deployments. Parts of this effort will include collection and preparation of such data for development and evaluation of service robot perception.

Description

In coordination with the USDOT’s Accessible Transportation Technologies Research Initiative (ATTRI), the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR) awarded the Disability Rehabilitation Research Project on Robotics and Automation for Inclusive Transportation (aka ATTRI DRRP) to Carnegie Mellon in 2017. The mission of this five-year ATTRI DRRP is to research and develop seamless transportation assistance from cloud-based autonomy and shared robots located in and around transportation hubs.

Transportation hubs, both large and small, serve as critical points in the travel chain. Due to their role as multi-modal nexus points, mobility breakdowns at hubs can impact large numbers of people across a wide range of disabilities. Hub-based service robots have the potential to assist people with and without disabilities through these complex and confusing facilities. Future ATTRI DRRP efforts will include a publicly deployed, hub-based, mobile robot for on-demand assistance. Example functionality in this deployment includes navigation assistance, robot guidance through a station, information retrieval (e.g., “is the elevator working?”), and rendezvous with services (e.g., station staff) and other unmanned systems (e.g., robots, etc.).

A key building block for such functionality is the ability to perceive human torso orientation. This allows projections of where a person is walking, where they intend to move, and the regions of space they are attending to. The team has made initial progress on using low-cost stereo camera sensing to rapidly extract the torso plane of humans in 3D space. We seek to refine this capability to support use in future ATTRI robots and deployments.

Our initial methods merge the popular OpenPose human perception algorithms and depth data to support rapid perception of torso body elements. This is then used to estimate torso plane. Our simple forecasting algorithm outperforms complicated recurrent neural network methods, while being faster on the torso pose forecasting task. In initial lab-based comparisons, our method outperforms complex recurrent neural network methods while being approximately 45 times faster on a torso plane forecasting task.

Under Traffic21 funds, we seek to extend this to a more full-fledged perception system and apply it to service robots and tasks like socially appropriate navigation. This will require multi-person perception and improvements in robustness to more naturalistic data. The team currently has access to data collected from a static sensor in the Steel Plaza light rail station, but we believe additional data is needed from the perspective of a moving mobile robot in support of more realistic evaluation. Parts of this effort will include collection and preparation of such data for development and evaluation of service robot perception.

Timeline

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Start - July 2018: Refine and enhance torso plane perception algorithm

August - December 2018: Collect natural transportation hub data and prepare for analys
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January - June 2019: Evaluate torso plane perception algorithm on naturalistic data
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Deployment Plan

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Future ATTRI DRRP efforts will include a publicly deployed, hub-based, mobile robot fo
r on-demand assistance. Technology developed under this project will be integrated int
o this robot during deployment. Local government agencies have made commitments to neg
otiate with the team on the specifics of where and when this deployment will occur.

This same technology may also be relevant in other deployments. For example, torso pla
ne perception is also useful for other robots, autonomous cars, and other domains wher
e inferring human intent and attention is useful.
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Expected Accomplishments and Metrics

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Open source torso plane perception software.

Improvements over the state of the art on torso plane estimation, both in speed and ac
curacy.

We may generate naturalistic human motion data sets, pending IRB approval and negotiat
ions with local sites.
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Individuals Involved

Email	Name	Affiliation	Role	Position
henny@cmu.edu	Admoni, Henny	Robotics Institute	Co-PI	Faculty - Untenured, Tenure Track
abhijatb@andrew.cmu.edu	Biswas, Abhijat	Robotics Institute	Other	Student - Masters
steinfeld@cmu.edu	Steinfeld, Aaron	Robotics Institute	PI	Faculty - Researcher/Post-Doc

Budget

Request

$30000.00

Funding

$0.00

Documents

Type	Name	Uploaded
Proposal Budget	2018_Traffic21_Budget_Steinfeld.xlsx (/media/project_files/2018_Traffic21_Budget_Steinfeld.xlsx)	May 25, 2018, 7:24 a.m.

Match Sources

No match sources!

Partners

Name	Type
Port Authority of Allegheny County	1