UNIVERSITY OF SOUTH FLORIDA

Defense of a Doctoral Dissertation

Design, Deployment, and Validation of Computer Vision Techniques for Societal Scale Applications

by

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For the Ph.D. degree in Computer Science and Engineering

Artificial Intelligence techniques have ensued a significant impact on our daily lives. Numerous applications in so many diverse fields have been made possible by AI algorithms today, and there are many more yet to come. In this dissertation, we design, deploy and validate computer vision algorithms for innovative and high-impact societal scale applications. We specifically focus on two applications in this dissertation: Detection of distracted driving and Detection of breeding habitats of mosquito vectors. Distracted driving on roads is a major problem around the world. Distracted driving is the case where a driver diverts his/her focus from the road and engages in other activities (e.g., texting, calling, drinking, etc.), which will cause visual, manual, and cognitive distraction. In this dissertation, we design a computer vision technique that processes images captured inside of cars to detect instances of distracted driving automatically. Furthermore, our innovation lies in adding contextual feedback with the classification of distracted driving. We present our contributions in two chapters. First, we considered six classes of driving activities; five classes are distracted driving and one safe driving class. These distracted classes are texting right hand, texting left hand, talking left hand, talking right hand, and drinking. We first detect objects in a car that can contribute to distracted driving. These are left and right hand, steering wheel, smartphone, and bottle. To do so, we design an object detection model based on Faster R-CNN architecture. Once the object is detected, we designed a simple machine learning technique to classify activities as distracted or safe, based on the relative locations of these objects. Next, using the same dataset, we increased the total number of driving classes to ten, where nine of them are distracted driving class and one safe driving class. Along with the previous five distracted driving classes, the four newly added distracted driving classes are operating the car radio, looking back, doing makeup, and talking to side passengers. The number of objects that cause distracted driving also increased, and we have considered a total of nine objects this time, namely, left and right hand, steering wheel, smartphone, bottle, radio, face look straight, face look back, and face look right. Finally, we have also investigated another significant societal scale problem - namely combating mosquito vectors in nature. To do so, we designed computer vision techniques to detect mosquito breeding habitats from Unmanned Aerial vehicles (UAV) videos. We designed a Mask Region-based Convolutional Neural Network (Mask R-CNN) on the video/image data to automatically detect and geo-locate potential mosquito breeding habitats and determine habitat sizes. We believe that our research in this dissertation enables creating innovation applications for the greater good using AI and can generate future work in this space to serve humanity.

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Publications

1) **Dey, A. K.,** Goel, B., & Chellappan, S. (2020, October). Detecting Distracted Driving from Images by Processing Relative Locations of Objects of Interest Inside Vehicles. In International Conference on Broadband and Wireless Computing, Communication and Applications (pp. 76-86). Springer, Cham.
2) **Dey, A. K.,** Goel, B., & Chellappan, S. (2021). Context-driven detection of distracted driving using images from in-car cameras. Internet of Things, 14, 100380.
3) Goel, B., **Dey, A. K.,** & Chellappan, S. (2017, October). Detecting routes taken by users on public vehicles from their wearables. In 2017 8th IEEE Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON) (pp. 451-457). IEEE.
4) Goel, B., **Dey, A. K.,** Bharti, P., Ahmed, K. B., & Chellappan, S. (2018, March). Detecting distracted driving using a wrist-worn wearable. In 2018 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops) (pp. 233-238). IEEE.
5) Bharti, P., **Dey, A. K.,** Chellappan, S., & Beckie, T. (2019). An Experimental Investigation Comparing Age-Specific and Mixed-Age Models for Wearable Assisted Activity Recognition in Women. In HEALTHINF (pp. 367-374).
6) Sengupta, A., Beckie, T., Dutta, **K., Dey, A.,** & Chellappan, S. (2020). A Mobile Health Intervention System for Women with Coronary Heart Disease: Usability Study. JMIR Formative Research, 4(6), e16420.

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