EMBEDDED SYSTEMS PROGRAMMING 2015-16

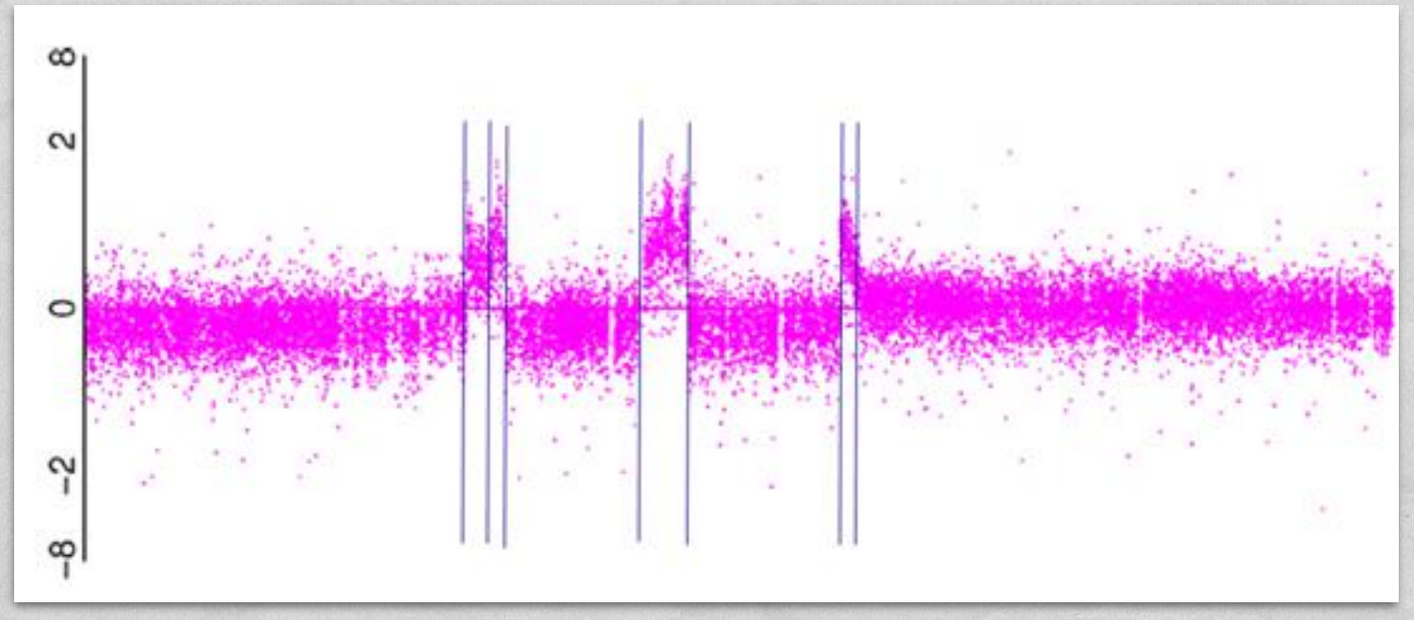
Apps and Algorithms

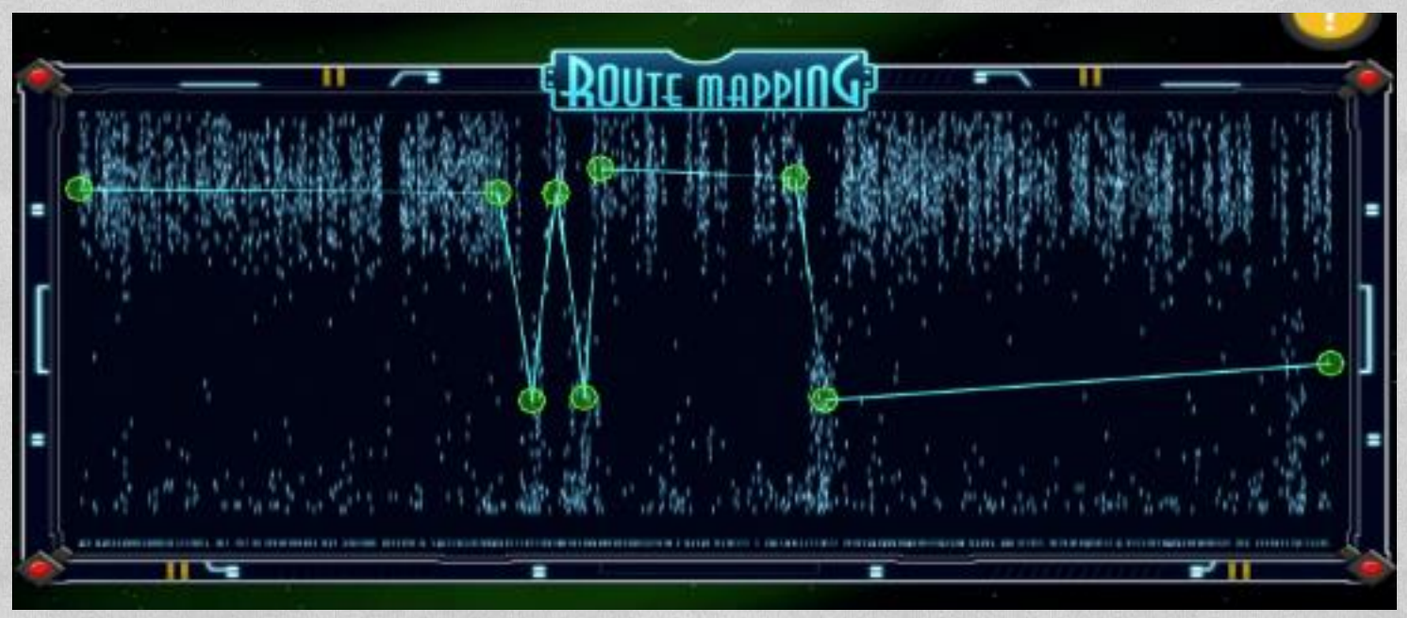
PLAY TO CURE (1/2)

- Developed at Cancer Research UK
- Looks like a space-themed arcade game, but **helps identify defects in real-world DNA microarray data**

- In just 1 month, data from gamers **saved 6 months** of manual data analysis by cancer researchers

PLAY TO CURE (2/2)





Source: Cancer Research UK

DUOLINGO (1/3)

- Started at Carnegie Mellon U. (Prof. Luis von Ahn)
- "Free" language learning

- Adaptive, data-driven approach: very effective
- Low-cost English proficiency exams

DUOLINGO (2/3)

Quit

Translate this text to Spanish

I am a man.

Yo | soy | un | hombre

Mujer | una | niño

Niña | el

Check

Quit

Select "the woman"

la niña

la leche

el pan

la mujer

Check

Quit

Speak this sentence

Él come una manzana.

Translation:
He eats an apple.

I can't use a microphone right now

Continue

DUOLINGO (3/3)

- The company's business model relies on **converting user's answers to exercises into paid translations**
- These translations are of better quality than automated translations, and are much cheaper than professional ones
- Duolingo has already been generating revenue from translations provided by 10% of its user base

ACCELWORD

AccelWord: Energy Efficient Hotword Detection through Accelerometer

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ABSTRACT

Voice control has emerged as a popular method for interacting with smart-devices such as smartphones, smartwatches etc. Popular voice control applications like Siri and Google Now are already used by a large number of smartphone and tablet users. A major challenge in designing a voice control application is that it requires continuous monitoring of user's voice input through the microphone. Such applications utilize *hotwords* such as "Okay Google" or "Hi Galaxy" allowing them to distinguish user's voice command and her other conversations. A voice control application has to continuously listen for hotwords which significantly increases the energy consumption of the smart-devices.

To address this energy efficiency problem of voice control, we present AccelWord in this paper. AccelWord is based on the empirical evidence that accelerometer sensors found in today's mobile devices are sensitive to user's voice. We also demonstrate that the effect of user's voice on accelerometer data is rich enough so that it can be used to detect the hotwords spoken by the user. To achieve the goal of low energy cost but high detection accuracy, we combat multiple

General Terms

Mobile, System, Energy, Efficiency

Keywords

AccelWord, hotword detection, accelerometer, energy, measurement

1. INTRODUCTION

With remarkable advancement in smartphone technology and increasing popularity of upcoming wearable devices, voice control is emerging as an attractive method of interaction with smart-devices. Voice control applications like Siri [1] on iOS devices and Google Now [2] on Android devices are already used by many smartphone and tablet users. Voice control is especially an attractive choice for wearable devices like smartglass and smartwatch. Such devices have a very small touch-enabled screen which restricts the applicability of touch-based control beyond a few primitive touch gestures. For this reason, voice control is commonly used in

PASSIVE ROUTE SENSING

Mining Users' Significant Driving Routes with Low-power Sensors

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Abstract

While there is significant work on sensing and recognition of significant places for users, little attention has been given to users' *significant routes*. Recognizing these routine journeys, can open doors for the development of novel applications, like personalized travel alerts, and enhancement of user's travel experience. However, the high energy consumption of traditional location sensing technologies, such as GPS or WiFi based localization, is a barrier to passive and ubiquitous route sensing through smartphones.

In this paper, we present a passive route sensing framework that continuously monitors a vehicle user *solely through a phone's gyroscope and accelerometer*. This approach can differentiate and recognize various routes taken by the user by time warping angular speeds experienced by

1 Introduction

Modern smartphones have a wide range of embedded sensors and are increasingly being used as a novel sensing platform to sense all aspects of a user's life ranging from health and well-being to driving style. They are a perfect tool for sensing user's context and proactively providing information to the user that he or she will find useful like a virtual personal assistant [2]. One form of this context sensing is *place learning* that identifies significant places where a user usually spends some of his or her time regularly, for example, home, work or lets say a gym. While there is significant amount of work on learning these significant places [22, 17, 6], little attention has been given to *significant journeys*, i.e., journeys that users regularly make during their daily routines.

CARSAFE

CarSafe App: Alerting Drowsy and Distracted Drivers using Dual Cameras on Smartphones

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ABSTRACT

We present CarSafe, a new driver safety app for Android phones that detects and alerts drivers to dangerous driving conditions and behavior. It uses computer vision and machine learning algorithms on the phone to monitor and detect whether the driver is tired or distracted using the front-facing camera while at the same time tracking road conditions using the rear-facing camera. Today's smartphones do not, however, have the capability to process video streams from both the front and rear cameras simultaneously. In response, CarSafe uses a context-aware algorithm that switches between the two cameras while processing the data in real-time with the goal of minimizing missed events inside (e.g., drowsy driving) and outside of the car (e.g., tailgating). Camera switching means that CarSafe technically has a "blind spot" in the front or rear at any given time. To address this, CarSafe uses other embedded sensors on the phone (i.e., inertial sensors) to generate soft hints regard-

1. INTRODUCTION

Driving while being tired or distracted is dangerous. In 2010, 3,092 people were killed and 416,000 injured in the United States alone during accidents directly attributed to distracted drivers [37]. Surprisingly, many people drive while being tired or drowsy [35] and according to experts, many drivers fail to recognize they are in a fatigued state. Tracking dangerous driving behavior can help raise drivers' awareness of their driving habits and associated risks, thus, helping reduce careless driving and promoting safe driving practices. Today's top-end cars come with a wealth of new safety features built-in. These include collision-avoidance, drowsy driver feedback (e.g., vibrating steering wheel), lane departure warning, lane weaving and pedestrian detection. By fitting advanced sensors into the vehicle (e.g., night cameras, radars, ultrasonic sensors), the car can infer dangerous driving behavior, such as drowsiness or distracted driving; some cars even trigger automatic steering when

REFLECTION REMOVAL

Reflection Removal using Ghosting Cues

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Abstract

Photographs taken through glass windows often contain both the desired scene and undesired reflections. Separating the reflection and transmission layers is an important but ill-posed problem that has both aesthetic and practical applications. In this work, we introduce the use of ghosting cues that exploit asymmetry between the layers, thereby helping to reduce the ill-posedness of the problem. These cues arise from shifted double reflections of the reflected scene off the glass surface. In double-pane windows, each pane reflects shifted and attenuated versions of objects on the same side of the glass as the camera. For single-pane windows, ghosting cues arise from shifted reflections on the two surfaces of the glass pane. Even though the ghosting is sometimes barely perceptible by humans, we can still exploit the cue for layer separation. In this work, we model the ghosted reflection using a double-impulse convolution kernel, and

(a) *Input* **(b)** *Close-up of ghosting*

(c) *Recovered Transmission* **(d)** *Recovered Reflection*

GOOGLE'S PROJECT TANGO

- "Project Tango technology gives a mobile device the ability to navigate the physical world similar to how we do as humans"

FIREFLY

- Jeff Bezos introduces Fire Phone
  https://youtu.be/w95kwXy_MOY?t=26m

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UBIQUITOUS AS TOUCH INTERFACES

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queue.acm.org

Mobile computer-vision technology will soon become as ubiquitous as touch interfaces.

BY KARI PULLI, ANATOLY BAKSHEEV, KIRILL KORNYAKOV, AND VICTOR ERUHIMOV

Real-Time Computer Vision with OpenCV

COMPUTER VISION IS a rapidly growing field devoted to analyzing, modifying, and high-level understanding of

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Spring 2015

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Office Hours:

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Office Hours:

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