

## Augmented Navigation

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### Augmented Navigation



### Augmented Navigation



### Two Domains

- Augmented Driving (and walking)
- Augmented Surgery

### Augmented Driving Problem

- Augment what we can see while driving with additional information
  - Traffic Information
  - Up-coming turns
  - Sources of possible collisions
  - Car status information
- Non-distracting, non-dangerous way!

### Current Features

- Vehicle Cameras
- Blind spot alerts
- Other vehicle alerts
- Forced Braking

## Car Systems

- “Head’s up” displays
- Speed
- Alert Lights
  - Cars cutting you off
  - Breaking in front of you
  - Slipping out of your lane
  - Pedestrian detection



## Garmin: NuviCam

- Dash Camera
- Watching the cars ahead and the lane markers
  - provide audible and visual warnings
    - forward pre-collision
    - lane-departure
- “Real Vision” feature displays an augmented reality view of the road ahead when approaching a destination
  - overlays house numbers along with arrow-shaped indicators to let drivers know precisely where to go when the actual house numbers may be obscured or missing.
- [https://www.youtube.com/watch?feature=player\\_detailpage&v=oTSofFE6t-E#t=19](https://www.youtube.com/watch?feature=player_detailpage&v=oTSofFE6t-E#t=19)

## BMW 2004

- In 2004, BMW was the first automotive manufacturer to use a color Head-Up Display which projected driving-related information directly in the driver’s line of sight.



## BMW 2011

- The next generation Head-Up display arrived in 2011 and featured this time even more full-color graphics, a significant improvement over the first generation.
- virtual “markings” are superimposed on real objects in the external environment,
  - so that navigation information or information from the driver assistance systems can be displayed at exactly the right points on the driver’s view of the road scene.
- Navigation instructions can be blended into the road, and vehicles or safety-relevant objects can be highlighted or marked in context.

## BMW 2011



## Mazda 2014



## Lighting Changes

- Some newer displays can adjust the brightness of the HUD lights depending on the lighting conditions
- Many offer "Night Vision"
  - Extra detection for objects at night
  - Animals
  - Pedestrians



## Hyundai 2015

- [https://www.youtube.com/watch?feature=player\\_detailpage&v=iZg89ov75QQ#t=34](https://www.youtube.com/watch?feature=player_detailpage&v=iZg89ov75QQ#t=34)
- Speed
- Cut-off warning
- Maneuvers super-imposed on the road
- Bio-medical interface

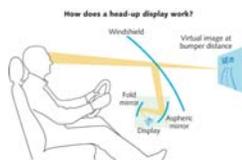
## How It Works: Displays

- Some cars use transparent phosphors on the windshield that reacts when a laser shines on it. When the laser is off, you don't see anything, but when the light is on the information is projected on the glass.
  - Others use a similar system but incorporate mirrors to project the images on the windshield.
- Generate the image so it appears at the desired focal length
  - Hovering over a particular car or turn

## Mazda 2014 v Toyota 2013



## Display



## How It Works: Detection

- Cameras around the vehicle
  - Can detect lane markers, other vehicles
- In conjunction with GPS information
  - If the vehicle is not in the correct lane for an upcoming maneuver, the system computes a 3D model of the road situation ahead using the signals from the camera system
  - superimposes the instructions congruently on the external scene.

## How It Works: Night Vision

- Infrared Cameras
  - Can see heat
  - Work in fog or darkness
- Generally these are displayed on better screens than HUDs



## Concluding Remarks

- Motorcycle HUD
- Audi's working on gesture controlled HUD (as of 2012)
- Widely used in airplanes
- Actual images of displays show they're still not great, but getting better

## Remote Assistance over Google Glass

- Sep, 2013, orthopedic surgeon Brent Ponce, MD from University of Alabama Birmingham
- Live video streamed to colleague Dr. Dantuluri in Atlanta
- Dr. Dantuluri was able to superimpose a projection of his hands onto the Google Glass display via VIPAAR (Virtual Interactive Presence and Augmented Reality)
- Educate hospital residents
- Instruct surgeons at small hospitals
- Results and detail of an early trial in *MB Shenai et al., 2011*



<http://www.beckershospitalreview.com/healthcare-information-technology/the-potential-in-augmented-reality-surgery.html>

## Remote Assistance over Google Glass

- How it works:
  - <https://youtu.be/aTOoBwfgBe0>
  - Simple model: hands above workplace
  - Camera registration to give remote user first person experience
  - Segment hands + tools from background
- Limitation:
  - Remote user's view is dynamic, while he/she may want it to be static so he/she can make marks or highlights in the view
  - Augmented information is always relative to local user's view, while it should be relative to the workplace
- Commercialized as VIPAAR <https://www.vipaar.com/home>



<http://www.uab.edu/news/feature/10m/3886-uab-docs-virtual-surgery-with-vipaar-and-google-glass>

## Immersive Medical Training with Oculus Rift

- 30 Jun, 2014, Dr. Thomas Gregory performed the first surgery filmed specifically for the Oculus Rift
- Two Go-pro cameras to capture stereoscopic video
- Students watch the video on Oculus Rift
- Place students in the view of the primary surgeon. Observe not only the procedure, but also everything that is going on around



<http://mashable.com/2014/06/14/watch-surgery-on-the-oculus-rift-but-maybe-do-it-after-lunch/>

## Immersive Medical Training with Oculus Rift

- How it works:
  - <https://youtu.be/pKT7zZ7Lo6w>



## iPad App Aided Tumor Excise

- An iPad app from Fraunhofer Institute of Medical Image Computing MEVIS
- Help surgeons excise liver tumors without damaging critical vessels within the organ
- Tested successfully in a liver tumor removal in 2013 in Germany
- Features:
  - Overlay vessels on the organ image
  - Measure vessel length
  - Update removed tissue
  - Medical analysis



<http://www.medipadapp.com/v13/03augmentedreality-ipad-app-guides-surgeons-during-liver-removal.html>

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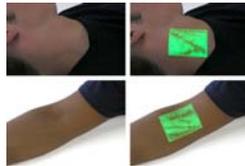
- How it works
  - <https://youtu.be/nKPWNQ71bkE>
  - Overlay medical model from medical software onto the real organ



<http://www.mevis.fraunhofer.de/en/solutions/mobile-liver-explorer.html>

## VeinViewer

- A Projector system that acquire an image of an object and project an enhanced version of it back onto the object
- Idea from University of Tennessee Health Science Center
- Commercial product by Luminetx Corp
- Non-invasive vein imaging device for phlebotomy and other vein treatment



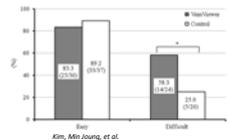
<http://www.realtobture.net/2007/01/veinviewer/>

## VeinViewer

- How it works:
  - NIR light is absorbed or scattered in the forward direction of blood – blood reproduces as dark
  - Scattered in all directions in skin and subcutaneous fat – skin and fat appear light
  - Needs calibration between camera and projector
- Can find smaller and shallower veins than U-S (Miyake, Roberto Kasuo, et al. 2006)
- Increases success rate on difficult vein finding tasks on children (Kim, Min Joung, et al. 2012)



[www.christimed.com](http://www.christimed.com)



## Robotics in Surgery

- Presented by Prof. Luc Soler, MD, from University of Strasbourg IRCAD
- Overlay hidden tissue and blood vessels
- Enlarge view in endoscopy
- Match moving organs
- Future steps:
  - Patient specific biology modelling
  - Robust real-time organ deformation tracking
  - Automation of complete medical procedure
- <https://youtu.be/uVDxMr-47kU>



Courtesy of Society of American Gastrointestinal and Endoscopic Surgeons

## References

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- Miyake, Roberto Kasuo, et al. "Vein imaging: a new method of near infrared imaging, where a processed image is projected onto the skin for the enhancement of vein treatment." *Dermatologic surgery* 32.8 (2006): 1031-1038.
- <http://www.ircad.fr/>