State of Research

A lot has changed since then
- Motorcycle capabilities
- Roadway environment and traffic
- Research methods

Until recently the last large scale investigation of issues facing motorcyclists was conducted over 30 years ago (Hurt et al, 1981).
Research Methods

Experimental
- Controlled experiments
- Lab, Test Track, Simulator
- Manipulate an independent variable
- Measure a dependent variable

Naturalistic
- Some of both

Epidemiological
- Passive collection
- Naturally occurring events
- Sampling strategies
- Health sciences
The Equipment

- GPS
- Machine vision lane tracker
- Accelerometers (3 axes)
- Gyro (3 axes)
- Forward radar
- Turn Signals
- Brake lever inputs
- Continuous collection
- 8-12 mo capacity
- Cellular communication from bikes back to VTTI

- Five color cameras
  - forward
  - rear
  - left
  - right
  - rider
Video
MSF 100

- 100 Participants (72 male)
- 38,000 trips, 350,000 mi
- Personal Motorcycles instrumented for between two months and two years.
- August 2011 through December 2013
- Personal motorcycles fell into one of three classes
- Participants ranged in age from 21 – 79 years old at time of install

![Motorcycle Class by Age Grouping](chart.png)
MSF 100 Analysis

• Various exploratory analyses have been performed including
  – Identifying high and low frequency riders
  – Weather and riding
  – Early crash Identifications
  – Speeds and accelerations of the sample
  – Early analysis of risk and personality survey data
• Crash and near-crash investigation currently underway.
NHTSA 160

- All 160 Motorcycles have been instrumented in Southern California
- 60 Full Size DAS
- 100 MiniDas Units
- Recruiting emphasis on sport and cruiser type motorcycles
- Increased variety of makes and models represented
- Partial data in-house for 140 motorcycles so far
MiniDAS Instrumentation

- Accelerometers (3 axes)
- Gyro (3 axes)
- GPS
- Two color cameras
  - forward
  - Rider face
- Continuous collection
- 4-6 mo capacity
- Cellular communication
- Rapid install process

Sample of MiniDas IMU Data
CONNECTED MOTORCYCLE WORK AT VTTI
VTTI approaching connected vehicles from two directions

- Leading the charge for the involvement of motorcycles in the connected vehicle network

- Human Factors of connected motorcycle interfaces.
Motorcycle Crash Warning System
Prototype Interfaces

Auditory – Helmet Speakers
Visual – Visor/Mirror LEDs
Haptic – Wristbands

*Tested individually and as a combination of four.

Alerts
– Caution alert/Warning

3/4/2016
Advancing Transportation Through Innovation

Virginia Tech Transportation Institute
Motorcycle Crash Warning System Test Scenarios

- Closed Track Testing - Smart Road
  - Intersection Movement Assist
  - Lane Change Warning
  - Forward Collision Warning
Sorry about the teaser…

• Results by Dr. Miao Song of VTTI expected to be part of TRB 2016
Motorcycle System Performance Background

- Ability of CVS to detect and classify vehicles are based on:
  - Wireless Communication Robustness
  - GPS Position Accuracy
- Unlike Light Vehicles, the CVS antenna is blocked by the Motorcycle Rider and other components on the MC
- Rider occlusion may degrade signal levels, therefore negatively impact CVS alert applications
- Certain roadway environments may exasperate this degradation (e.g. frequent curves requiring considerable lean angle)
Motorcycle Systems Performance Objectives

• Characterize communications (DSRC) and positioning performance (GPS) based on:
  – Antenna Configuration
  – Terrain and Roadway Geometries
  – Roadway Environments

• Compare motorcycle vs. automobile performance

• Report observations and provide recommendations
Motorcycle System Performance Test Scenarios

- **Closed Track - Smart Road Testing**
  - Static Dwell Tests
  - Dynamic Ranging
  - Dynamic Platooning

- **Real World Testing – Platooned Performance Drives**
  - 2-Hour Platooned drives across diverse roadway environments (i.e. Interstates, Local Roads, Urban Thruways)
  - Locations
    - New River Valley, VA
    - Charleston, SC to Savannah, GA (Planned)
Motorcycle System Performance Assessment

Utilizing data collected during test scenarios, statistics describing Performance Measures such as:

- **Communications:**
  - Received Signal Strength Indicator
  - Packet Error Rate
  - Inter-Packet Gap

- **Position:**
  - # of Satellites Used
  - Dilution of Precision
  - Fix Quality

800 m
Loss of Signal
Testing Occurring in the…..

Virginia Connected Corridors

- Two Corridors for Testing
  - Smart Road, Blacksburg VA
    - Controlled access
    - Development
  - Fairfax County, Northern VA
    - Real work challenges
    - Early Deployment
- Array of Infrastructure
  - Connected Vehicle fleet
    - Motorcycle
    - Cars
    - Truck & Buss
  - Roadside equipment
  - Backed network and processing
  - DSRC and cellular capabilities
As of this week...

- Prototype DSRC Helmet developed by VTTI
- Supports any V2X (or shall we say M2X) protocol
- Basic equipment of our connected vehicles, packaged in a helmet

- Provides both Visual and Auditory warnings
- 10 hour battery life
- Can take from bike to bike
- Leverages technology already available in helmets (Bluetooth)
- Can readily be miniaturized
X2M Helmet

Tablet PC

RSE Transmitter

Dedicated short range radio (DSRC)
VTTI Motorcycle Program

Direction

• Continue to analyze existing and upcoming naturalistic collections in order to understand how exactly riders ride.

• Continue to push the envelope regarding the inclusion of motorcycles in the development of vehicle communication technologies including V2I, I2V, and V2V applications

• Support riders, manufacturers, roadway designers, and policy makers by utilizing data-driven approaches, backed by cutting edge research.
Questions and Contact Information

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