US ARMY RDECOM

U.S. Army Research, Development and Engineering Command

Malcolm Baldrige National Quality Award 2007 Award Recipient

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Use of Magnetic North Finding Technology in Magnetically Unstable Environments in FC Application

Michael Wright & Ralph Tillinghast

May 2012

Current State (Fire Control)

- M150/M151 120mm Mortar Fire Control
  - Laser Ring Gyro Based system (+/- 1 mil)
- Direct Lay Pointing (DLP)
  - 60mm Mortar (Charges 0 and 1)
  - Round Selection, Elevation and Time of Flight
- M2 Compass
  - Accuracy, +/- 10 mils
  - Handheld, Magnetic
- M2A2 Aiming Circle
  - Accuracy, +/- 2 mil
  - Large, Magnetic, Labor intensive

Current Technology for True North Reference

- GPS Interferometry
  - Accurate, Slow, Requires GPS signal
- Laser Ring Gyro
  - Accurate, Expensive, Power Hungry, Heavy
- Dynamically Tuned Gyro
  - Accurate, Slow
- Fiber Optic Gyro
  - Less Accurate, Expensive, Slow
- Hemispherical Resonator Gyro, Fluid Gyro, MEMs Gyro
  - Not Accurate, Slow
- Celestial System
  - Accurate, Fast, Degraded at Dusk/Dawn and with Clouds/Fog

Current Applications, Pointing (60 & 81mm Mortar Systems)

- Magnetic compass north finding easily affected by interference and incorrect declination
  - Error is not always evident
  - Azimuth value “hunts” because of changes in the magnetic field
- MEM’s gyro north finding not accurate or fast enough for Digital Fire Control
- Optical tracking cannot handle large shifts in azimuth and elevation
- Laser and Fiber Optic Gyros too heavy, expensive, and inefficient for use as a pointing device on man portable mortars

Combination of Technologies

- Combination of technologies required to accurately detect and hold north reference through magnetic interference and firing events
  - Magnetic north reference used to establish direction
  - Accelerometers and gyros used to detect motion to verify that change in magnetic reference is due to motion
  - Optical tracking used to eliminate “noise” in both the magnetic and inertial tracking as well establish known markers for referencing the system back to a known location
  - Software Algorithms to filter the data

Current Pointing Device OptoWOM

Key Specifications:

- Azimuth accuracy: 0.2˚RMS
- Pitch/Roll accuracy: 0.1˚RMS
- Max update rate:100 Hz
- Gyro dynamic range:±1800˚/sec
- Accel dynamic range: ±2 g

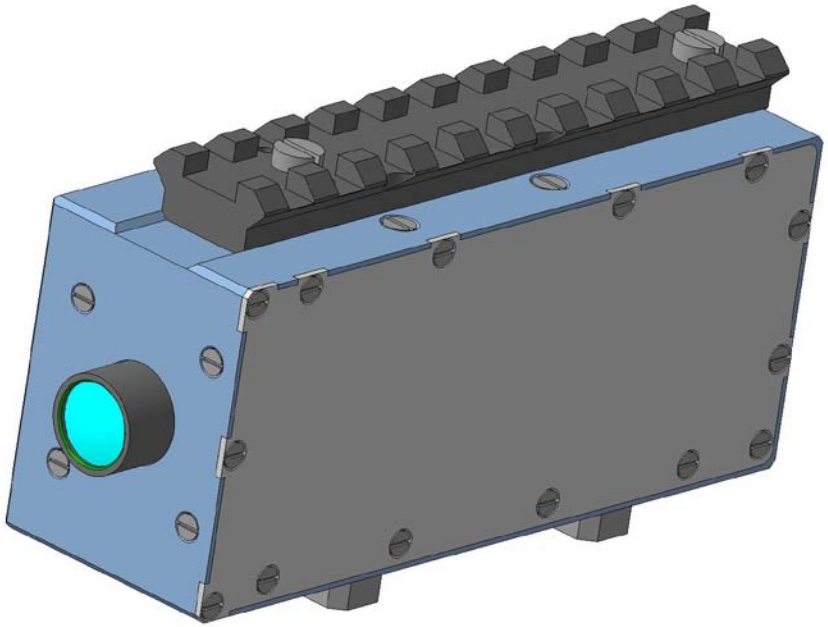
- Optical Weapon Orientation Module (OptoWOM) employs the use of gyroscopes, accelerometers, and magnetometers to track both slow and fast movements of weapons in real-time. The OptoWOM determines if the magnetic change is caused by motion by comparing to the motion indicated by the rest of the sensors.

WOM and OptoWOM developed by Inertial Labs.

Malcolm Baldrige National Quality Award 2007 Award Recipient

Optical Reference Tracking

- The OptoWOM's optical tracking works through the use of reference images. Within the reference image the system identifies a constellation of identifiable features. For any subsequent image collected by the camera, heading is determined by comparing those images back to the most appropriate reference.



**Ruggedized Prototype unit currently in development*

Setting Optical Reference

- Optical Reference for pointing device is initially set through magnetic reference
  - Pointing device is then rotated mechanically to -45 and +45 degrees from initial reference and optical references are stored with their angular offsets
  - This allows 180 degree field using optical and inertial reference without the aid of the magnetometers

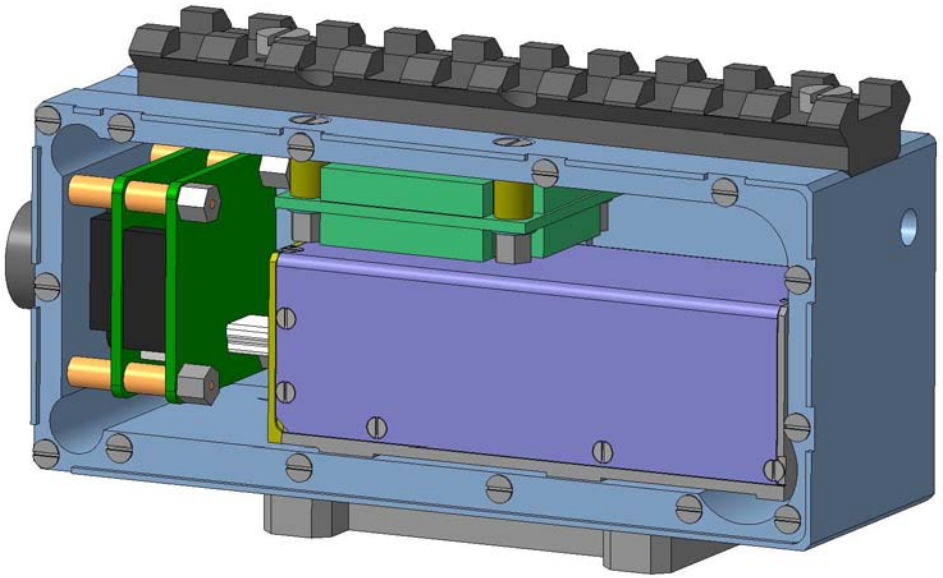
True North Finding Component

- If position is under going position improvement or has down time a true north finder can be used for optical reference
  - Allows for in field, on gun, magnetic declination
  - Allows for non-magnetically biased initial optical reference

Future State of 60 & 81mm
Wireless Universal Lightweight Fire Control

WULF provides weapon pointing data from the LHMBC wirelessly to the gunner. The gun unit displays the required adjustment in azimuth and elevation as well as the required mission data.

- Embedded Computer
- 3-4 mil Accuracy
- Target Battery Life: 24+ hours
- Displays required adjustment in Azimuth and Elevation
- Adaptable to different wireless standards
- 60, 81 and 120mm compatible



Malcolm Baldrige National Quality Award 2007 Award Recipient

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Questions

Contact Info:

Michael Wright

Wireless Universal Lightweight Fire-Control
ARDEC Project Officer
Fire Control Systems & Technology
US Army ARDEC, RDAR-WSF-M
973.724.8614
michael.wright26@us.army.mil

Ralph Tillinghast

Collaboration Innovation Lab
Lab Director
Fire Control Systems & Technology
US Army ARDEC, RDAR-WSF-M
973.724.2095
ralph.tillinghast@us.army.mil

Please visit the ARDEC Booth in the Exhibit Hall