Wireless Compact Radar

Researchers at the University of Memphis have developed a compact, wireless, low cost radar and sensor mote system with a suite of integrated capabilities. Commercial Off-The-Shelf (COTS) sensor nodes have been integrated with wireless technology, aiming at surveillance and tracking of moving targets. This work presents a distributed intelligent decision support system and demonstrates its effectiveness in identifying unique but similar events.

Applications

- Surveillance and tracking of moving targets
- Detection, ranging and velocity estimation capabilities integrated with wireless nodes
- Incorporates additional sensors for acoustic, vibration transducers, and infrared sensing
- A long range passive infrared sensor that detects moving vehicles up to a 50 m range
- Detecting moving humans up to a 10 m range
- Effectively classify different types of objects and events

Advantages

- Highly compact wireless design—fits in a pocket.
- Multiple modalities provide improved reliability and classification by cross-correlating and integrating the sensor outputs
- Using multiple sensors we can account for the variable features of the object
- Can identify unique but similar events
- Can be deployed as a key part of a distributed intelligent decision support system
- The acoustic and vibration sensors provide information complementary to the radars

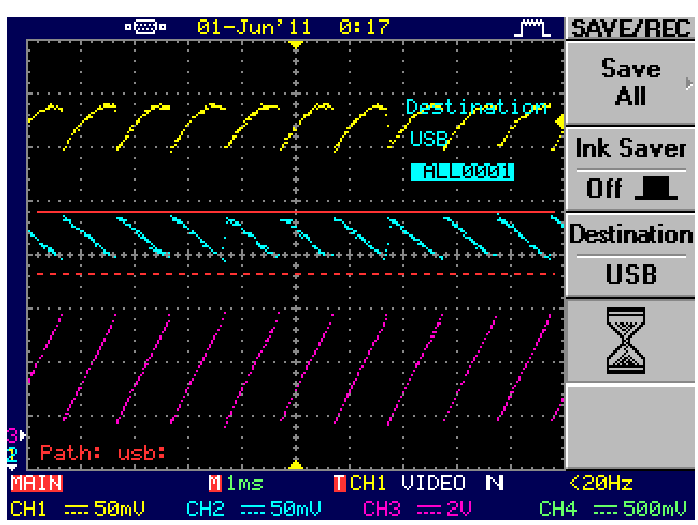


Figure 1: Ramp signals obtained from Target

The wireless device includes a small and inexpensive K band Doppler radar (24 GHz) which uses the Doppler Effect to produce velocity data about objects at a distance. The figure shows the received signal by a transceiver (radar) while the target is moving in the periphery of the radar. The radar has two channels I (yellow) and Q (Blue), second is the 90 degree phase shift of the other. The third ramp signal (Pink) is the input ramp signal.

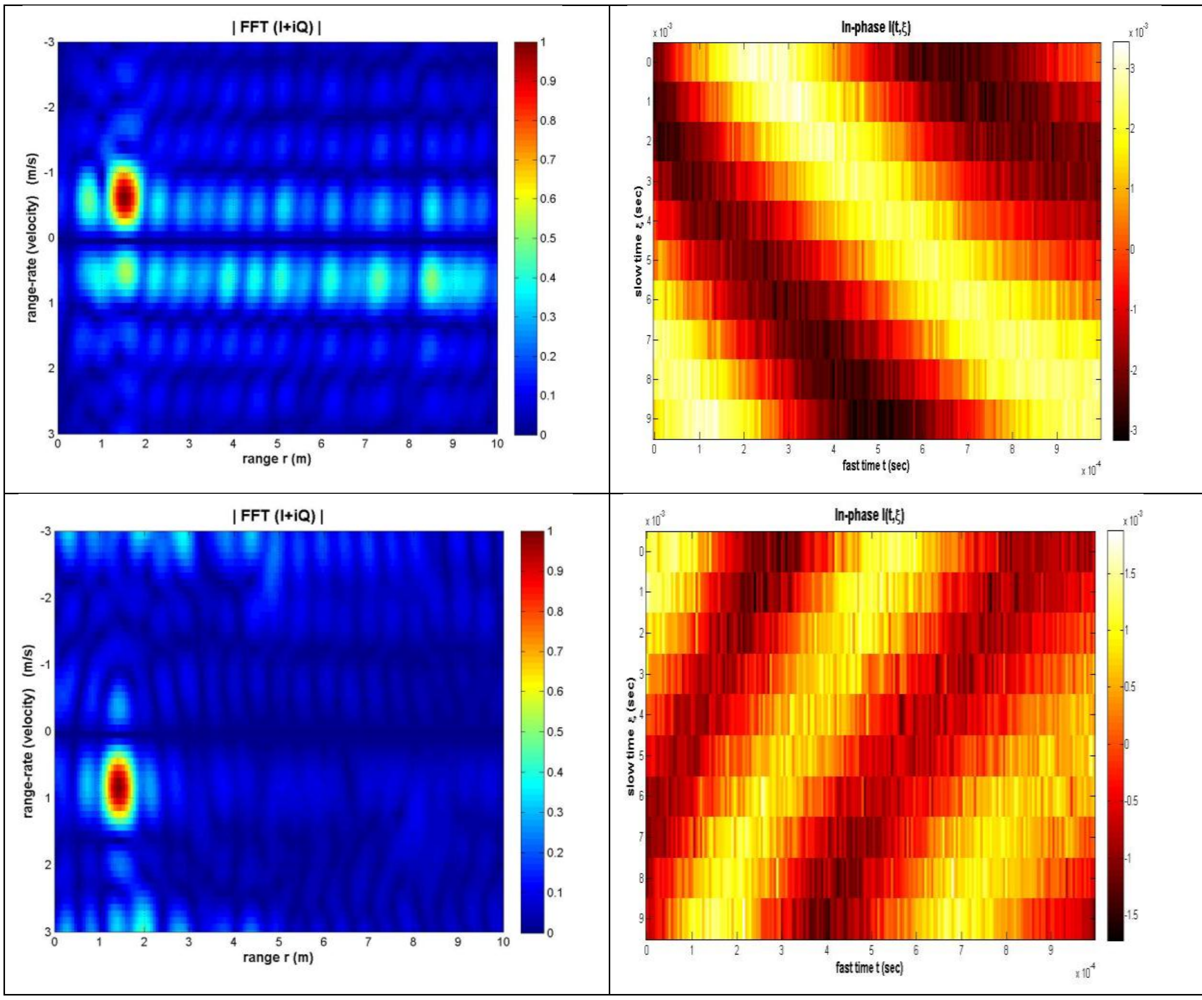


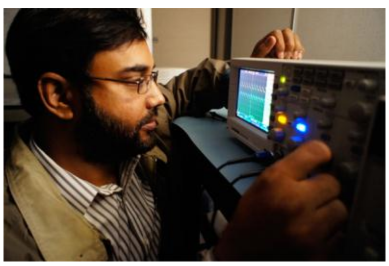
Figure 2: Detection of object moving with the velocity of 0.695 m/s towards (top two panels) or away from (lower two) the radar. The distance of the target was 1.2m

Signals at certain time stamp are captured using different sensors and then they are transferred to the base-station by wireless motes. The data in these figures is from detection of Acoustic, Vibration and Radar (I and Q channel) signals for the detection and tracking of the target. Processing of the signals is then performed offline. This processing provides velocity, range and direction of the target. The data in these figures are examples showing the detection of target which is moving towards and away from the radar at a speed of 0.695 m/s and the range of target from the radar at that time stamp is 1.242 m.

Technical Description

Data acquisition is conducted by the low-cost (< $50 US) miniature radar. Detection, ranging and velocity estimation capabilities of the mini-radar are uniquely integrated with wireless nodes. Each sensor board sits atop a TelosB mote capable of storing, processing, and transmitting sensor data. Multiple modalities provide improved reliability and classification by cross-correlating and integrating the sensor outputs. The SBT sensor mote continuously monitors the environment and provides an initial detection capability. It uses a long range passive infrared sensor that detects moving vehicles, and people in motion. Using the invention, the researchers have successfully classified the shape of moving objects as well as whether they are made of paper or metal with more than 90% of accuracy. Current studies are focused on multi-object detection and tracking using single and multiple radar devices.

Inventors



Dr. Iftekharuddin is an associate professor in the department of electrical and computer engineering. He was an assistant professor of computer science and electrical and computer engineering at North Dakota State University (NDSU) before joining to the U of M in the fall of 2000. Dr. Iftekharuddin was a principal research engineer at Timken Research, Canton, OH before joining to NDSU. There he was involved in research in signal and image processing, neural networks applications, time-frequency analysis, sensors and embedded system design.

He obtained his B.Sc. degree from Bangladesh Institute of Technology in 1989. He received an M.S. and a Ph.D. both in electrical engineering from the University of Dayton in 1991 and 1995 respectively.

Dr. Wang is associate professor of Computer Science. She is an IEEE senior member. In 1997 Dr. Wang received her BS degree in Computer Science from Peking University and in 2004 she received the Ph.D. in Computer Science from University of California, Los Angeles. She is a member of a team comprising ten institutions that received a $7.9 million grant (2010 - 2013) from the NSF for the Future Internet Architecture (FIA) program.

Inventors

Dr. Kozma is a William Dunavant University Professor of Mathematics and director for the Center for Large-Scale Integration and Optimization Networks (CLION) in the FedEx Institute of Technology at the University of Memphis. He has published papers in the several fields including signal processing as well as design, analysis, and control of intelligent systems. His current research interests include spatio-temporal dynamics of neural processes, random graph approaches to large-scale networks, such as neural networks, computational intelligence methods for knowledge acquisition and autonomous decision making in biological and artificial systems. He has published over 100 scholarly papers and 3 books. Dr. Kozma earned his PhD in Applied Physics from Delft University of Technology, the MS in Mathematics, Eötvös Loránd University and the MS in Power Engineering, Moscow Power Engineering Institute.