

Detecting moving objects with passive bistatic radar

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With two regular TV antennas connected to general receiving devices, an adaptive and expandable system can be built to detect targets. Such a system utilizes the transmitted signal from commercial broadcasting antennas and applied techniques for displaying a bistatic range and bistatic velocity of a moving object.

A thesis work has been carried at FOI, the Swedish Defence Research Agency in Linköping, where the final system was tested on a landing airplane and an unmanned aerial vehicle (UAV). Through these tests, each target's bistatic range and velocity were detected and presented in a 2D colorplot. These results provide a proof of concept, that a passive bistatic radar (PBR) system can be constructed with a low cost, and be able to detect both large aircrafts and small UAVs.

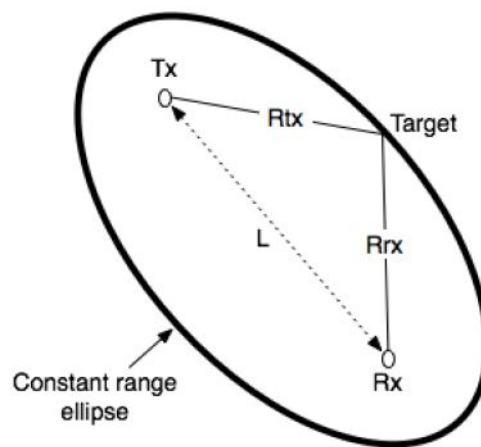


Figure 1: *Geometry of a PBR system.*

Figure 1 shows the geometry of a PBR system. Here T_x is the location of the transmitter, R_x the location of the receiver, R_{tx} the distance from the transmitter to the target and R_{rx} the distance from the receiver to the target. L is called the baseline and is the distance between the transmitter and the receiver. The bistatic range is usually defined as $R_{tx} + R_{rx} - L$, representing the difference (in distance) between a received direct path signal traveling along the baseline and an echo from a target. The detected (bistatic) velocity of a moving target is determined by how the target changes the frequency of the echo signal as it is moving towards or away

from the baseline. The amount that is detected depends wholly on the target's location and bearing compared to the antennas, as well as the target's true velocity.

A PBR system able to detect UAVs offers many possibilities, both military and civilian. Since there is no need for a dedicated transmitting antenna, that also needs a lot of power, this kind of radar system would suit perfectly in an urban environment. Imagine a small sized, highly mobile, and cheap radar system that easily could be deployed to monitor the air space at sports or political events, or whenever there is a large gathering of people. This would allow for small objects, such as UAVs, to be detected and dealt with before they could potentially cause any damage. At the very least, there would be an increased chance to mitigate any potential damage by alerting security forces with its presence.

For military applications, a PBR system inherently offers beneficial effects. Since the system does not transmit anything, its location is virtually undetectable except by the naked eye. As the transmitter and receiver are separated, it also increases the chance for the radar to detect stealth targets as they pass between the antennas due to the forward-scattering effect. When this happens, the shape of the aircraft or any coating with radiation-absorbent material used to achieve stealth, will not make any difference for the detectability. Even though the constructed system, at this stage, is not fully capable to be implemented in the scenarios mentioned above, it would be most likely possible after further development.

One disadvantage with a PBR system compared to a conventional radar, is that the interpretation of the collected data becomes a little bit more complicated. When the transmitter and receiver is collocated, or if it is the same antenna, the detected distance is the true distance to the target (divided by two). When they are separated, in the bistatic case, both the distance from the transmitter to the target and from the target to the receiver must be taken into consideration. Due to this, the detected distance shows a target that could be located anywhere on an ellipse (encapsulating the transmitter and the receiver), as shown in figure 1. To achieve a better approximation of the distance, additional receiving devices has to be used.