

Investigation on Traffic Flow Control by Using a Millimeter Wave Radiometric Imaging System

Shengchang Lan⁽¹⁾ *, Haoyu Tang⁽¹⁾, Caitian Yang⁽¹⁾, Jinghui Qiu⁽¹⁾, Nannan Wang⁽¹⁾, Hua Zong⁽¹⁾ and Alexander Denisov⁽²⁾

(1) Department of Microwave Engineering, Harbin Institute of Technology, China 150080

(2) Iceberg research center Kiev, Ukraine

This paper aims to present this method of using millimeter wave radiometer imaging system (RIS) to monitor the traffic flow in all whether conditions. As the sensors, radiometers will show a radiometric image of the proximity of the crossroad in a certain frequency band. By analyzing the radiometric image, automobiles can be detected and recognized. That is to say, traffic flow condition in this area can be also solved by recognizing automobiles and calculating the automobile numbers in the radiometric image.

Each radiometer is identical with an antenna beam spot on the underlying road. The antenna beam spot on road has a geometric area, the radius of which is approximated by Rayleigh diffraction as, $A = R(1.22\lambda/D)$, at a distance R with the antenna diameter D and the wavelength λ . The automobile area is S_{auto} . Hence the area of this beam spot is $S_{back} = \pi A^2 = 1.44\pi(\lambda R/D)^2$. More specifically, if we define the antenna efficiency as η , the location factor of the object as σ , attenuations and losses from the antenna to the radiometer input as α , as well as the detection probability as K , the contrast ΔT_{dif} will be,

$$\Delta T_{dif} = S_{auto} \cdot \frac{[\eta\sigma\Delta T_{contrast}]}{[K\alpha \cdot 1.44\pi(\lambda R/D)^2]} \quad (1)$$

It is reasonable to evaluate needed radiometer sensitivity to find automobiles on the streets or to detect the difference between two spots with automobiles and without automobiles. The fact of detecting the automobiles is dependent on the condition whether the radiometers sensitivity ΔT_s is less than the difference detected. If ΔT_s is less than the difference above, automobiles can be detected against the road background.

$$\Delta T_s \leq \frac{S_{auto}\eta\sigma\Delta T_{contrast}}{1.44K\alpha\pi(\lambda R/D)^2} \quad (2)$$

Using the proposed RIS, we have tested 3 mm RIS application in a scenario shown in Fig. 1(left) and its recognition result in Fig. 1(right). The image show the feasibility of using this system for future traffic flow controls. It is also recommended to design the system by means of 8 mm band radiometers for economic benefits in future development.



Figure 1. Radiometric image and its recognition result.