**(9) 整合式模型效能評估**

緊接著下一步我們初步評估整合物件偵測模型與轉向角預測模型的推論速度及精確度。本研究計畫初步試用了YOLOv4-tiny、YOLOv5s、YOLOv5n、YOLOv7及YOLOv7-tiny等物件偵測模型。另外，本研究計畫也初步試用了Nvidia-CNN、CNN及ResNet18等轉向角預測模型。計算出在嵌入式平台Jetson Nano能夠在每幀224× 224的解析度下達多少幀率(FPS)進行系統運作，如Table 2 所示。在相同的方式下所獲得的推論精確度(%)，如Table 3 所示。在Table 2所顯示，整合模型的物件偵測YOLOv4-tiny所獲得的FPS執行的速度為最高。在Table 3所顯示，整合模型的轉向角預測ResNet18所獲得的MSE執行的均方誤差為最低。因此本研究計畫初步採用整合模型為YOLOv4-tiny負責物件偵測和ResNet18執行轉向角預測。

Table 2. FPS of integrated models

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Object Detection  St. Angle Prediction | YOLOv4-tiny | YOLOv5s | YOLOv5n | YOLOv7 | YOLOv7-tiny |
| Nvidia-CNN | 19.5 | 15.6 | 18.1 | 10.8 | 19.0 |
| CNN | 19.6 | 15.8 | 18.2 | 11.0 | 19.1 |
| ResNet18 | 18.4 | 14.5 | 17.1 | 9.7 | 17.8 |
| Average | 19.2 | 15.3 | 17.8 | 10.5 | 18.6 |

p.s. St.: steering

Table 3. Precision of integrated models

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Object Detection  St. Angle Prediction | | Precision (%) | | | | | | | | | | | | | |
| YOLOv4-tiny | | | YOLOv5s | | | YOLOv5n | | | YOLOv7 | | | YOLOv7-tiny | |
| MSE | Nvidia-CNN | 0.0953 | 97.2 | 0.0953 | | 99.1 | 0.0953 | | 97.7 | 0.0953 | | 98.9 | 0.0953 | | 97.0 |
| CNN | 0.0849 | 97.2 | 0.0849 | | 99.1 | 0.0849 | | 97.7 | 0.0849 | | 98.9 | 0.0849 | | 97.0 |
| ResNet18 | 0.0712 | 97.2 | 0.0712 | | 99.1 | 0.0712 | | 97.7 | 0.0712 | | 98.9 | 0.0712 | | 97.0 |

p.s. The cell with/without grey background represents angle prediction loss (MSE) and object detection precision (%), respectively. St. is the abbreviation of steering.