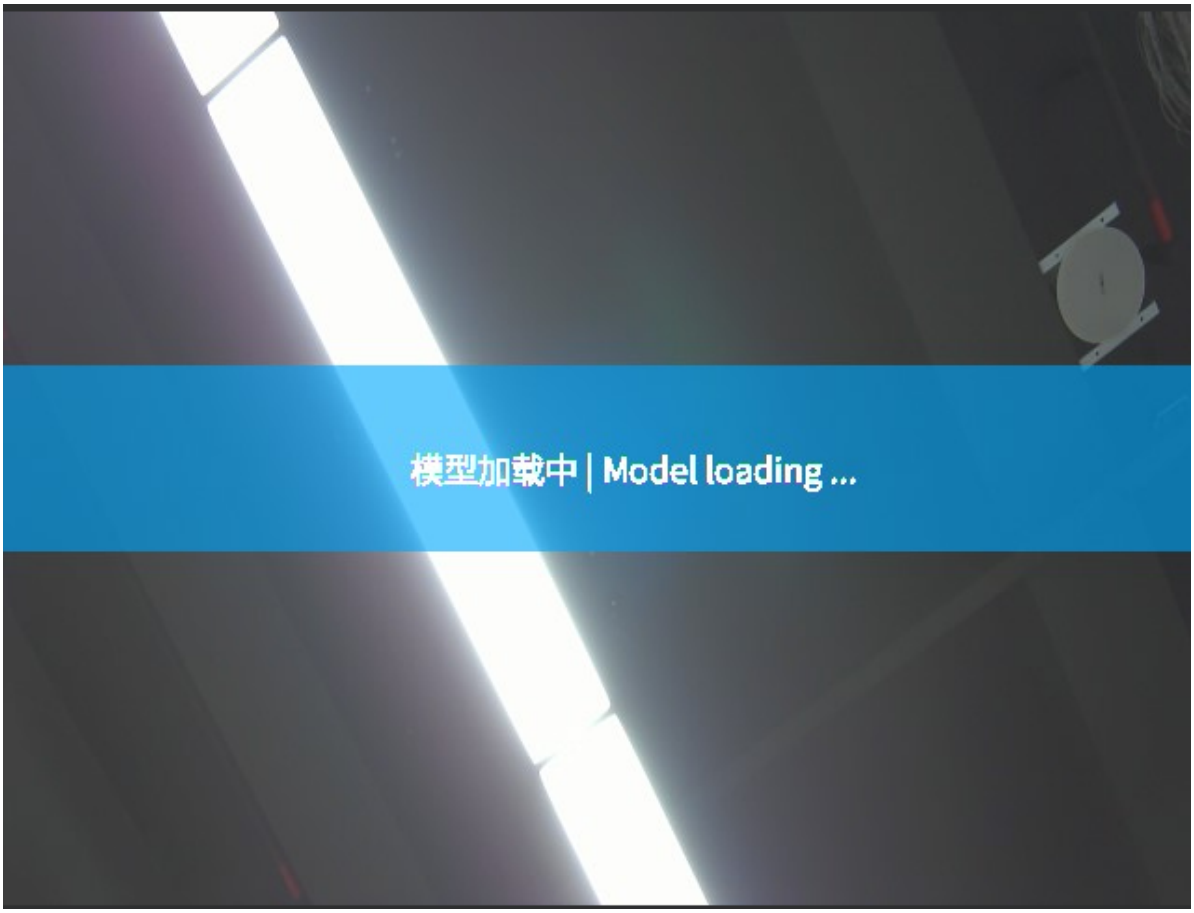
Dynamic gesture recognition

Routine Experiment Effect

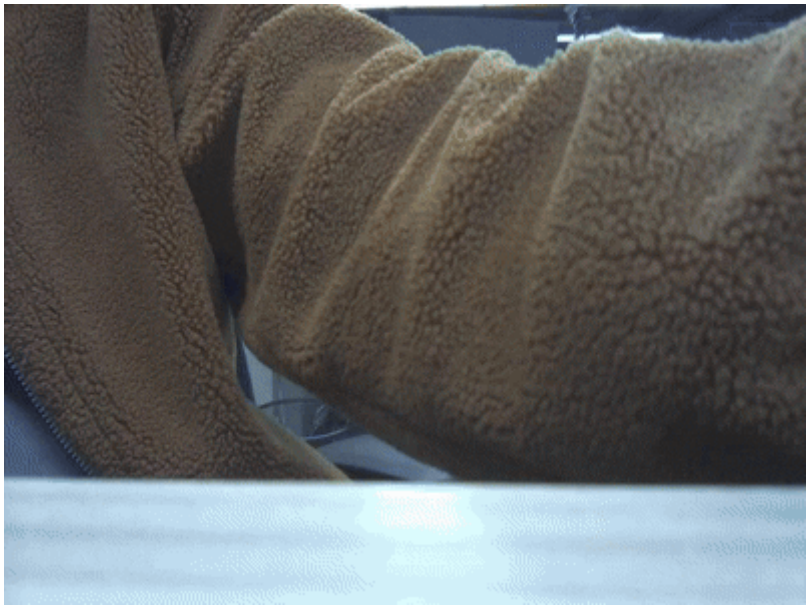
In this section, we will learn how to use K230 to realize the human body detection function.

The example code is in [Source code/08.Body/09.dynamic_gesture.py]

After connecting to the IDE, run the code and wait for the routine to run and load the model. (It takes about 8 to 10 seconds)



After waiting for the routine to run and load the model, we put our hand in front of the camera and wait for the gesture icon to appear in the upper left corner. The appearance of this icon means that K230 is ready to recognize gestures, and we can perform the corresponding gesture waving behavior. The specific operation can be seen in the following animation:



> Serial port output function has been added
>
> After detecting the gesture, the following serial output format will be sent
>
> $dir#
>
> The '$' represents the beginning of the data, and the '#' represents the end of the data.
>
> dir is the direction, 0 is up, 1 is left, 2 is down, 3 is right, 4 is unchanged
>
> *Note: The current code will send multiple serial port data when a gesture is recognized. You can filter it on the receiving end.

Code Explanation

> **There is too much complete code in this section, so only the key parts of the code are explained here**

Gesture recognition key code

```
    def run(self, input_np):

        """
        运行手势识别 / Run gesture recognition

        参数 / Parameter:
        input_np: 输入图像 / Input image

        返回 / Returns:
        根据当前状态返回检测结果或识别结果 / Returns detection or recognition results
based on current state
        """
        if self.cur_state == self.TRIGGER:
            # 手掌检测模式 / Hand detection mode
            det_boxes = self.hand_det.run(input_np)
            boxes = []
            gesture_res = []
```

```
            for det_box in det_boxes:
                # 获取检测框坐标 / Get detection box coordinates
                x1, y1, x2, y2 = det_box[2], det_box[3], det_box[4], det_box[5]
                w, h = int(x2 - x1), int(y2 - y1)

                # 过滤无效检测框 / Filter invalid detection boxes
                if (h < (0.1 * self.rgb888p_size[1])):
                    continue
                if (w < (0.25 * self.rgb888p_size[0]) and
                    ((x1 < (0.03 * self.rgb888p_size[0])) or
                     (x2 > (0.97 * self.rgb888p_size[0])))):
                    continue
                if (w < (0.15 * self.rgb888p_size[0]) and
                    ((x1 < (0.01 * self.rgb888p_size[0])) or
                     (x2 > (0.99 * self.rgb888p_size[0])))):
                    continue

                # 执行关键点检测 / Perform keypoint detection
                self.hand_kp.config_preprocess(det_box)
                hk_results, gesture_str = self.hand_kp.run(input_np)
                boxes.append(det_box)
                gesture_res.append((hk_results, gesture_str))

            return boxes, gesture_res
        else:
            # 动态手势识别模式 / Dynamic gesture recognition mode
            idx, avg_logit = self.dg.run(input_np, self.his_logit, self.history)
            return idx, avg_logit

    def draw_result(self, pl, output1, output2):
        """
        绘制识别结果 / Draw recognition results

        参数 / Parameters:
        pl: 绘图层对象 / Drawing layer object
        output1: 第一阶段输出(检测框) / First stage output (detection boxes)
        output2: 第二阶段输出(关键点和手势) / Second stage output (keypoints and
gestures)
        """
        # 清空绘图缓存 / Clear drawing cache
        pl.osd_img.clear()
        draw_img_np = np.zeros((self.display_size[1], self.display_size[0], 4),
dtype=np.uint8)
        draw_img = image.Image(self.display_size[0], self.display_size[1],
                               image.ARGB8888, alloc=image.ALLOC_REF,
data=draw_img_np)

        if self.cur_state == self.TRIGGER:
            # 触发状态下的处理 / Processing in trigger state
            for i in range(len(output1)):
                hk_results, gesture = output2[i][0], output2[i][1]

                # 检测到"five"或"yeah"手势 / Detect "five" or "yeah" gesture
                if ((gesture == "five") or (gesture == "yeah")):
                    # 计算手势方向向量 / Calculate gesture direction vector
                    v_x = hk_results[24] - hk_results[0]
                    v_y = hk_results[25] - hk_results[1]
```

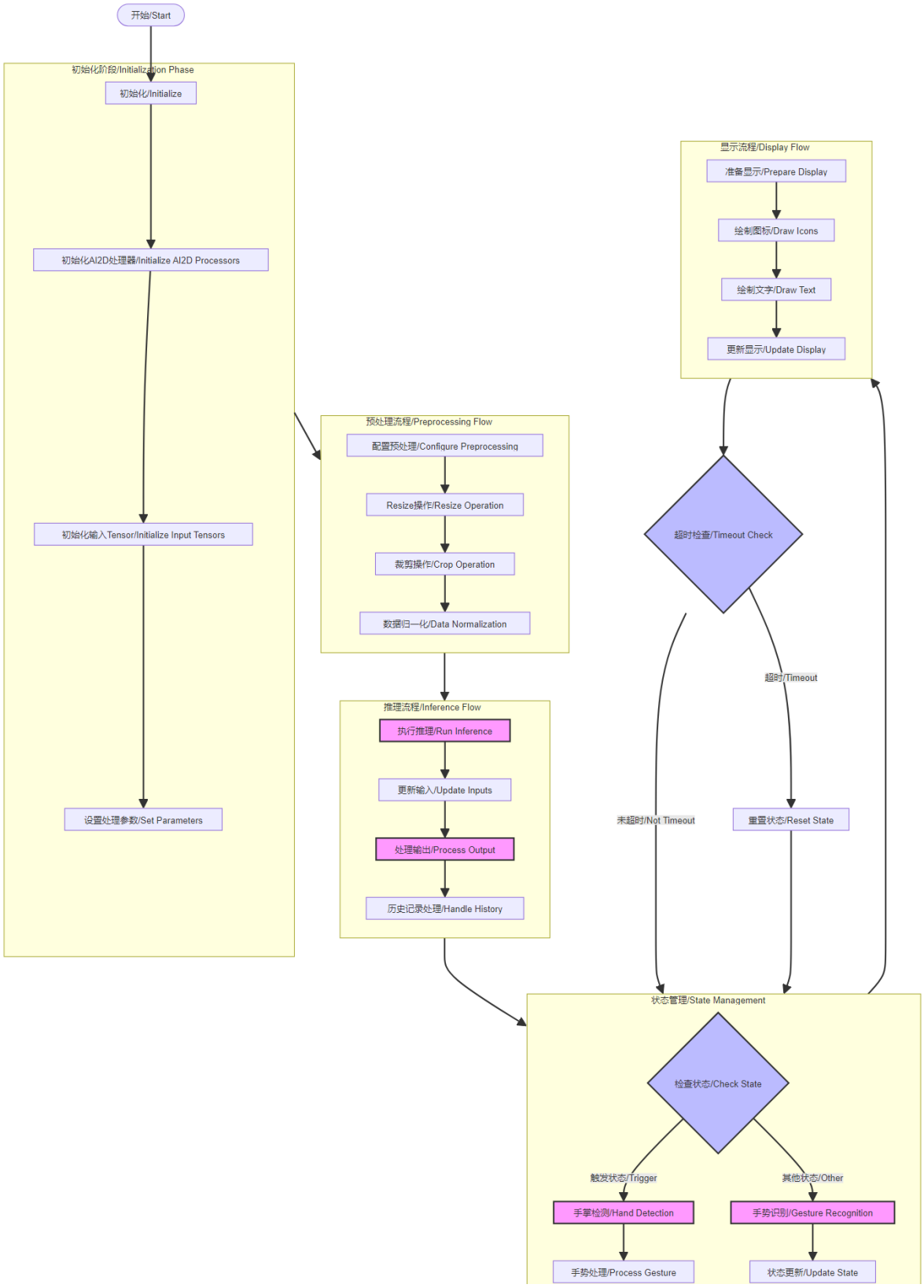
```
                    angle = self.hand_kp.hk_vector_2d_angle([v_x,v_y],
[1.0,0.0])
                    if (v_y > 0):
                        angle = 360 - angle

                    # 根据角度判断手势方向 / Determine gesture direction based on
angle
                    if ((70.0 <= angle) and (angle < 110.0)):  # 向上 / Upward
                        if ((self.pre_state != self.UP) or (self.pre_state !=
self.MIDDLE)):
                            self.vec_flag.append(self.pre_state)
                        if ((len(self.vec_flag) > 10) or (self.pre_state ==
self.UP) or
                            (self.pre_state == self.MIDDLE) or (self.pre_state
== self.TRIGGER)):
                            draw_img_np[:self.bin_height,:self.bin_width,:] =
self.shang_argb
                            self.cur_state = self.UP

                    elif ((110.0 <= angle) and (angle < 225.0)):  # 向右 /
Rightward
                        if (self.pre_state != self.RIGHT):
                            self.vec_flag.append(self.pre_state)
                        if ((len(self.vec_flag) > 10) or (self.pre_state ==
self.RIGHT) or
                            (self.pre_state == self.TRIGGER)):
                            draw_img_np[:self.bin_width,:self.bin_height,:] =
self.you_argb
                            self.cur_state = self.RIGHT

                    elif((225.0 <= angle) and (angle < 315.0)):  # 向下 /
Downward
                        if (self.pre_state != self.DOWN):
                            self.vec_flag.append(self.pre_state)
                        if ((len(self.vec_flag) > 10) or (self.pre_state ==
self.DOWN) or
                            (self.pre_state == self.TRIGGER)):
                            draw_img_np[:self.bin_height,:self.bin_width,:] =
self.xia_argb
                            self.cur_state = self.DOWN

                    else:  # 向左 / Leftward
                        if (self.pre_state != self.LEFT):
                            self.vec_flag.append(self.pre_state)
                        if ((len(self.vec_flag) > 10) or (self.pre_state ==
self.LEFT) or
                            (self.pre_state == self.TRIGGER)):
                            draw_img_np[:self.bin_width,:self.bin_height,:] =
self.zuo_argb
                            self.cur_state = self.LEFT

                    self.m_start = time.time_ns()
                self.his_logit = []

            else:
                # 非触发状态下的处理 / Processing in non-trigger state
                idx, avg_logit = output1, output2[0]
```

```
            # 处理不同状态下的手势动作 / Handle gesture actions in different states
            if (self.cur_state == self.UP):
                draw_img_np[:self.bin_height,:self.bin_width,:] =
self.shang_argb
                if ((idx == 15) or (idx == 10)):  # 向上挥动确认 / Upward wave
confirmation
                    self.vec_flag.clear()
                    if (((avg_logit[idx] >= 0.7) and (len(self.his_logit) >= 2))
or
                        ((avg_logit[idx] >= 0.3) and (len(self.his_logit) >=
4))):
                        self.s_start = time.time_ns()
                        self.cur_state = self.TRIGGER
                        self.draw_state = self.DOWN
                        self.history = [2]
                    self.pre_state = self.UP
                elif ((idx == 25) or (idx == 26)):  # 中间位置确认 / Middle
position confirmation
                    self.vec_flag.clear()
                    if (((avg_logit[idx] >= 0.4) and (len(self.his_logit) >= 2))
or
                        ((avg_logit[idx] >= 0.3) and (len(self.his_logit) >=
3))):
                        self.s_start = time.time_ns()
                        self.cur_state = self.TRIGGER
                        self.draw_state = self.MIDDLE
                        self.history = [2]
                    self.pre_state = self.MIDDLE
                else:
                    self.his_logit.clear()

            # 处理其他方向的状态(RIGHT/DOWN/LEFT)的逻辑类似
            # Similar logic for other directional states (RIGHT/DOWN/LEFT)
            elif (self.cur_state == self.RIGHT):
                draw_img_np[:self.bin_width,:self.bin_height,:] = self.you_argb
                if  ((idx==16)or(idx==11)) :
                    self.vec_flag.clear()
                    if (((avg_logit[idx] >= 0.4) and (len(self.his_logit) >= 2))
or ((avg_logit[idx] >= 0.3) and (len(self.his_logit) >= 3))):
                        self.s_start = time.time_ns()
                        self.cur_state = self.TRIGGER
                        self.draw_state = self.RIGHT
                        self.history = [2]
                    self.pre_state = self.RIGHT
                else:
                    self.his_logit.clear()
            elif (self.cur_state == self.DOWN):
                draw_img_np[:self.bin_height,:self.bin_width,:] = self.xia_argb
                if  ((idx==18)or(idx==13)):
                    self.vec_flag.clear()
                    if (((avg_logit[idx] >= 0.4) and (len(self.his_logit) >= 2))
or ((avg_logit[idx] >= 0.3) and (len(self.his_logit) >= 3))):
                        self.s_start = time.time_ns()
                        self.cur_state = self.TRIGGER
                        self.draw_state = self.UP
                        self.history = [2]
                    self.pre_state = self.DOWN
                else:
```

```
                    self.his_logit.clear()
            elif (self.cur_state == self.LEFT):
                draw_img_np[:self.bin_width,:self.bin_height,:] = self.zuo_argb
                if ((idx==17)or(idx==12)):
                    self.vec_flag.clear()
                    if (((avg_logit[idx] >= 0.4) and (len(self.his_logit) >= 2))
or ((avg_logit[idx] >= 0.3) and (len(self.his_logit) >= 3))):
                        self.s_start = time.time_ns()
                        self.cur_state = self.TRIGGER
                        self.draw_state = self.LEFT
                        self.history = [2]
                    self.pre_state = self.LEFT
                else:
                    self.his_logit.clear()

            self.elapsed_time = round((time.time_ns() - self.m_start)/1000000)

            # 超时处理 / Timeout handling
            if ((self.cur_state != self.TRIGGER) and (self.elapsed_time >
2000)):
                self.cur_state = self.TRIGGER
                self.pre_state = self.TRIGGER

        # 绘制结果显示 / Draw result display
        self.elapsed_ms_show = round((time.time_ns()-self.s_start)/1000000)
        if (self.elapsed_ms_show < 1000):
            # 根据不同状态绘制不同的箭头和文字 / Draw different arrows and text based
on state
            if (self.draw_state == self.UP):
                draw_img.draw_arrow(self.display_size[0]//2,
self.display_size[1]//2,
                                    self.display_size[0]//2,
self.display_size[1]//2-100,
                                    (155,170,190,230), thickness=13)
                draw_img.draw_string_advanced(self.display_size[0]//2-50,
                                              self.display_size[1]//2-50, 32, "向上
UP")
            elif (self.draw_state == self.LEFT):
                draw_img.draw_arrow(self.display_size[0]//2,
self.display_size[1]//2,
                                    self.display_size[0]//2-100,
self.display_size[1]//2,
                                    (155,170,190,230), thickness=13)
                draw_img.draw_string_advanced(self.display_size[0]//2-50,
                                              self.display_size[1]//2-50, 32, "向左
LEFT")
            elif (self.draw_state == self.DOWN):

 draw_img.draw_arrow(self.display_size[0]//2,self.display_size[1]//2,self.displa
y_size[0]//2,self.display_size[1]//2+100, (155,170,190,230), thickness=13)
                        # 判断为向下挥动时，画一个向下的箭头
                draw_img.draw_string_advanced(self.display_size[0]//2-
50,self.display_size[1]//2-50,32,"向下 DOWN")
            elif (self.draw_state == self.RIGHT):

 draw_img.draw_arrow(self.display_size[0]//2,self.display_size[1]//2,self.displa
y_size[0]//2+100,self.display_size[1]//2, (155,170,190,230), thickness=13)
                        # 判断为向左挥动时，画一个向左的箭头
```

```
                draw_img.draw_string_advanced(self.display_size[0]//2-
50,self.display_size[1]//2-50,32,"向右 RIGHT")
            elif (self.draw_state == self.MIDDLE):

 draw_img.draw_circle(self.display_size[0]//2,self.display_size[1]//2,100,
(255,170,190,230), thickness=2, fill=True)                          # 判断为五指捏合手
势时，画一个实心圆
                draw_img.draw_string_advanced(self.display_size[0]//2-
50,self.display_size[1]//2-50,32,"中间 MIDDLE")
        else:
            self.draw_state = self.TRIGGER

        # 更新显示 / Update display
        pl.osd_img.copy_from(draw_img)
```

flow chart


开始/Start
初始化阶段/Initialization Phase
初始化/Initialize
初始化AI2D处理器/Initialize AI2D Processors
初始化输入Tensor/Initialize Input Tensors
设置处理参数/Set Parameters
预处理流程/Preprocessing Flow
配置预处理/Configure Preprocessing
Resize操作/Resize Operation
裁剪操作/Crop Operation
数据归一化/Data Normalization
推理流程/Inference Flow
执行推理/Run Inference
更新输入/Update Inputs
处理输出/Process Output
历史记录处理/Handle History
显示流程/Display Flow
准备显示/Prepare Display
绘制图标/Draw Icons
绘制文字/Draw Text
更新显示/Update Display
超时检查/Timeout Check
超时/Timeout
未超时/Not Timeout
重置状态/Reset State
状态管理/State Management
检查状态/Check State
触发状态/Trigger
其他状态/Other
手掌检测/Hand Detection
手势识别/Gesture Recognition
手势处理/Process Gesture
状态更新/Update State