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Hand Gesture Based Robot Control using MEMS and ARM-9

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Abstract: Gestures thought of because the most natural communicatory manner for communications between human and computers in virtual system. Hand gesture may be a methodology of non-verbal communication for personalities for its freer expressions rather more aside from body components. Hand gesture recognition has bigger importance in coming up with associate economical human pc interaction system. Victimization gestures as a natural interface advantages as a motivation for analyzing, modeling, simulation, and recognition of gestures. .In this paper, we tend to introduce a hand-gesture-based management interface for navigating a car-robot. A 3-axis measuring system is adopted to record a user's hand trajectories. The flight knowledge is transmitted wirelessly via associate RF module to a pc. The received trajectories square measure then classified to at least one of six management commands for navigating a car-robot. The classifier adopts the dynamic time warping (DTW) algorithmic program to classify hand trajectories. Simulation results show that the classifier may deliver the goods ninety two.2% correct rate.

Keywords: Hand gesture, tracking, recognition, Robot, dynamic time warping (DTW).

I. INTRODUCTION

In today's age, the robotic business has been developing several new trends to extend the potency, accessibility and accuracy of the systems. Basic tasks may well be jobs that square measure harmful to the human, repetitive jobs that square measure boring, disagreeable etc. the robots are a replacement to humans; they still ought to be controlled by humans itself. Robots are wired or wireless, each having a controller device. Each has professionals and cons related to them. On the far side dominant the robotic system through physical devices, recent technique of gesture management has become very hip. The most purpose of exploitation gestures is that it provides a a lot of natural approach of dominant and provides an upscale and intuitive type of interaction with the robotic system. The sensory system interaction is one in all the foremost easy interactive interfaces for dominant objects. Intended by the concept of a Wiimote, we have a tendency to attempt to implement a interface that permits a user to navigate a car-robot during a sensory system interactive approach. a simple approach is to directly use a Wiimote to regulate a car-robot; but, the worth a Wiimote isn't terribly low and Wiimote's size isn't terribly tiny either. Therefore, the interface developed by USA adopts atiny low sized measuring instrument module rather than the standard Wiimote. To navigate a car-robot, we'd like a minimum of six totally different hand gestures shown in Fig. 1. a direct downside to be solved is that the hand gesture recognition downside.

Recently, there are many alternative hand gesture recognition systems, like vision-based mechanical phenomenon recognition systems, and inertial-based mechanical phenomenon recognition systems. Notwithstanding cameras or accelerators square measure employed in the hand gesture systems; the core module may be a hand gesture recognition algorithmic program. The dynamic time dynamic time warping (DTW) and also the Hidden Andre Markoff model (HMM) square measure 2 preferred algorithms utilized to acknowledge hand gestures. as an example, Niezen and Hancke adopts the DTW to acknowledge hand gestures for a portable and Shiqi et al. uses the HMM to acknowledge written characters. The HMM may be a terribly economical algorithmic program for gesture recognition; but, the worth bought the high potency is that the length coaching time and an oversized quantity of coaching knowledge. As for the DTW algorithmic program, it's economical for recognizing a tiny low quantity of hand gestures since it doesn't have the HMM's drawbacks. Since solely six totally different hand gestures ought to be classified, we have a tendency to determined to adopt the DTW algorithmic program because the core recognition module.

II. GESTURE RECOGNITION

To take advantage of the temporal component of gestures, we chose to use an HMM-based recognizer. An HMM recognizer classifies time sequences of features. For each new data point in a continuous stream of measurements, our HMM recognizer determines which gesture is currently being executed. In this section, we will present the process of data reduction and gesture spotting, as is illustrated in Figure 1. For readers unfamiliar with HMMs, we refer to Rabiner and Juang for an excellent tutorial on evaluation, estimation, and decoding using HMMs as applied to the problem of speech recognition.

A. Hand Gestures Used To Navigate a Car-Robot

Gesture recognition allows humans to speak with the machine (HMI) and act naturally with none mechanical

devices. Victimization the construct of gesture recognition, it's attainable to purpose a finger at the pc screen in order that the indicator can move consequently. This might probably build standard input devices like mouse, keyboards and even touch-screens redundant. These are the different types of Hand Gestures Used to Navigate a Car-Robot (fig 2).

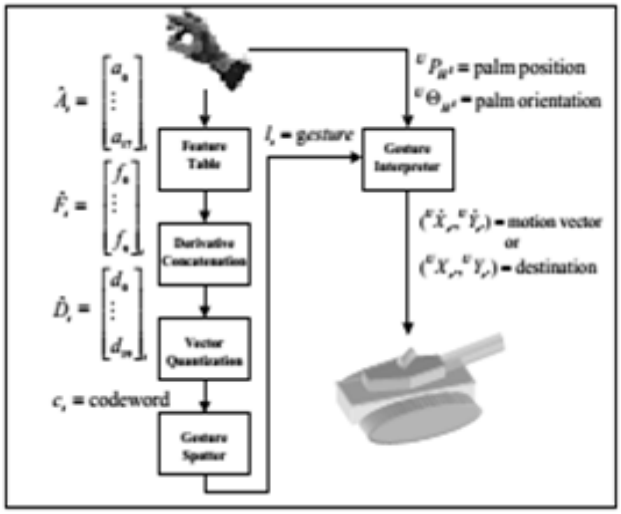

Figure1. The data flow from the glove to the robot.

Gesture	command
→	turn right
←	Turn left
↑	Go straight
↓	Go Back
↻	rotate
↑M	STOP

Figure2. Different types of Hand Gestures.

Gesture spotting using an HMM After preprocessing the data, the gesture spotter takes a sequence of codewords and determines which of the six gestures the user is performing, or \none of the above" if no gesture is being executed. The six gestures we chose to recognize consist of:

- OPENING: Moving from a closed fist to a flat open hand
- OPENED: Flat open hand
- CLOSING: Moving from a at open hand to a closed fist
- POINTING: Moving from a first open hand to index finger pointing, or from a closed fist to index finger pointing
- WAVING LEFT: Fingers extended, waving to the left, as if directing someone to the left
- WAVING RIGHT: Fingers extended, waving to the right

Being able to reject motions that do not correspond to any of these six gestures is very important. If every stream of motion data would be classified as one of the six gestures listed above, almost any motion of the fingers would result in inadvertent robot actions. Including the classification \none of the above" allows the user to perform other tasks while wearing the data glove, without the HMM interpreting the hand motions as robot commands. The algorithm described in this paper differs from the standard forward-backward technique described in Rabiner and Juang's tutorial [10] in two important respects. A first modification allows us to classify continuous streams of measurements. The correspondence of an HMM, λ, to an observation sequence O= $O_1, O_2, \ldots O_T$ can be quantified as $P_r(O/\lambda)$, which is the probability that the observation sequence is produced by the model. However, as the length of the sequence grows, $Pr(O_1, O_2, \ldots O/\lambda)$ decreases to zero. A solution to this problem is to limit the observation sequence to then most recent observations, $O=O_{t-n} \ldots O_t$. The length of this sequence needs to be determined by the user.

The second modification allows us to reject hand motions that do not match any of the six modeled gestures. In the standard HMM recognition algorithm, the gestural with the largest confidence level $Pr(O/\lambda_l)$ is selected, where λ_l is the model corresponding to the gestural. This means that one of six gestures will always be selected, unless a threshold is set to reject all six. However, a threshold that is large enough to reject all non-gestures, may also exclude gestures that are performed slightly differently from the training gestures. This is unacceptable, because different users tend to execute gestures differently. To overcome these problems, we used the HMM gesture spotter illustrated in figure 3. It contains a \wait state" as the first node that transitions to all the gesture models and it with equal probability. All these transition probabilities are all equal to make the transition independent of the observation. When a new observation is applied to the gesture spotter, the probability of being in the state is updated for all existing states. In other words, we update all the $Pr(I_t = q_i /O, \lambda_l)$, the probability of being in state q I at time to f the state sequence $I(=I_1 \; I_2 \ldots I_t)$,given the observation sequence O and the model λl of gestural. Next, the state probabilities are normalized so that they sum to one. If the observation sequence corresponds to any of the gestures, the probability of being in the final state of the model for this gesture will be higher than that for the other gestures. On the other hand, if the observation sequence does not belong to any gestures, the probability of being in the “wait state" will be the highest due to the normalization.

If the recent sequence of observations represents a gesture, the earlier part of the sequence is trapped in the \wait state" while subsequent observations raise the correct gesture's probability. Therefore, the gesture spotter selects the gesture that corresponds to the last state with the highest score, or no gesture if the \wait state" has the highest score.

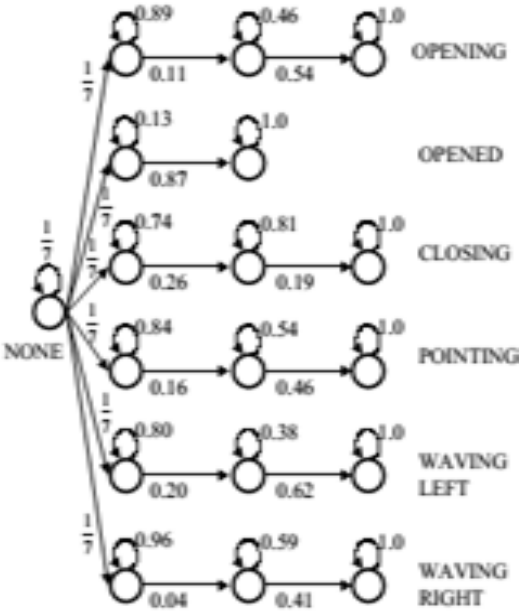

Figure3. An HMM with a shared initial state.

III. IMPLEMENTATION

On the computer facet, the interface consists of a 3-axis measuring device (x-axis = frontal, y-axes = mesial, z-axes =vertical) ADXL330 measuring device (range: ±3g, sensitivity: 300mV/g, typical bandwidth: 1600Hz , noise density: 280μg/√Hz rms, operational voltage range: one.8~3.6 V), a ATMEGA168V microcontroller (tiny size , high performance , low power, 6-channel 10-bit ADC, 16k bytes of in-system self-programmable flash program memory), associated an AM24L01BS-U-based RF (2.4G Hz wireless link) module. On the car-robot facet, every car-robot additionally has associate ATMEGA168V microcontroller associated an RF module. The RF module receives commands from the pc and also the microcontroller ATMEA168V on the automaton coverts the received command to a PWM signal to regulate robot's motors. Then the car-robot navigates in line with the corresponding received command.

IV. CONCLUSION AND FUTURE WORK

In this paper, we have a tendency to introduce a hand-gesture-based interface for navigating a car-robot. A user will management a car-robot directly by victimization his or her hand trajectories. Within the future, we will directly use a portable with associate degree measuring system to control a car-robot. We have a tendency to conjointly wish to feature a lot of hand gestures (such because the curve and slash) into the interface to manage the car in a very a lot of natural and effectively method.

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