Arduino Interaction in Beck Identity for Inclusive Purposes using MEMS Acceleration

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***Abstract*:- This paper proposes a method to recognize human gestures using MEMS (Micro Electro Mechanical Systems) accelerometer and convert it into voice signals. An efficient recognition algorithm, µWave algorithm, is used for the process of interaction using a single three-axis accelerometer. Unlike statistical methods, µWave requires a single training sample for each gesture pattern and allows users to employ personalized gestures and physical manipulations. µWave achieves maximum accuracy, competitive with statistical methods that require significantly more training samples. The main theme of this work is to make a system which can act as an artificial vocal tract for speech impaired people without use of complex form of inputs. Using algorithm, seven basic hand gestures i.e., up, down, left, right, tick, circle, and cross are recognized based on the input signals from MEMS accelerometer. The gesture is recognized by comparing the accelerating values with stored templates. The respective commands are transmitted to the receiver with the help of wireless sensor networks. The corresponding commands are played through vocal tract in the receiver end.**

Keyterms: MEMS accelerometer, Gesture Recognition, µwave algorithm.

I. INTRODUCTION

Now a days people use gestures for spontaneous interaction with consumer electronics and mobile devices in the field of pervasive computing. Yet these types of gesture-based interactions face many challenges. Pattern recognition like speech, gestures etc undergoes serious issues when it comes to personalized gestures or customer-desired own gestures.

Interaction by means of physical gestures enables a better understanding between the user and the machine. For example, in telerobotics, slave robots have been demonstrated to follow the master's hand motions remotely. Another type of this application includes character recognition which provides the interaction in TV set using inertial sensors in 3D space .It can also be used for the improvement of interaction between two humans.

Miniaturization reduces cost by decreasing material consumption. It also increases applicability by reducing mass and size by placing the MEMS, instead of traditional systems like connecting series of external components by wire or soldered to printed circuit board, the MEMS on silicon can be integrated directly with the electronics. These are called smart integrated MEMS already include data acquisition, filtering, data storage, communication interfacing and networking. MEMS technology not only makes the things smaller but often makes them better.

MEMS are termed as micro electro mechanical system where mechanical parts like cantilevers or membranes have been manufactured at microelectronics circuits. It uses the technology known as micro-fabrication technology.

We present µWave, an efficient recognition algorithm for interaction using a single three-axis accelerometer. Unlike the previous statistical methods, µWave requires a single training sample for each gesture pattern and allows users to employ personalized gestures and physical manipulations.

Most of the existing systems in the gesture recognition follow image-based approaches. It requires sophisticated image processing platforms .Mostly cameras were used as input devices. Object needs to be present in front of the cameras for capturing gestures, which limits the mobility. Power consumption is a challenging one. Several other existing devices can capture gestures, such as a "Wiimote," joystick, trackball and touch tablet. Some of them can also be employed to provide input to a gesture recognizer.

Vision-based and accelerometer and/or gyroscope based are the most commonly used recognition based methods. Vision-based method results in a blur because of the limitations such as unexpected ambient optical noise, slower dynamic response, and relatively large data collections/ processing of.. Since heavy computation burden will be brought if gyroscopes are used for inertial measurement.

The proposed recognition system is implemented based on MEMS acceleration sensors. Since heavy computation burden will be brought if gyroscopes are used for inertial measurement, our current system is based on MEMS accelerometers only and gyroscopes are not implemented for motion sensing.

The sensing device senses acceleration in three axes .Those sensed signals are conditioned and given to the controller circuit. The controller compares the incoming signal values with the pre-stored values. Commands for each gesture were separately allotted to each channel in the voice chip.

When the incoming acceleration value matches with pre-stored one corresponding channels will be enabled and the command be displayed .The same be played through the speaker after amplification since the signal from voice chip is very low.

II. µWAVE ALGORITHM INTRODUCTION

Firstly, unlike many pattern recognition problems, e.g. speech recognition, gesture recognition lacks a standardized or widely accepted "vocabulary". It is often desirable and necessary for users to create their own gestures, or personalized gestures. The main aim of this algorithm is to support efficient personalized gesture recognition on a wide range of devices, in particular, on resource-constrained systems.

The strength of uWave in user-dependent gesture recognition makes it ideal for personalized gesture-based interaction. With uWave, users can create simple personal gestures for frequent interaction. Its simplicity, efficiency, and minimal hardware requirement (a single accelerometer) make uWave have the potential to enable personalized gesture based interaction with a broad range of devices.

a) DTW (DYNAMIC TIME WARPING)

µWave matches the accelerometer readings for an unknown gesture with those for a vocabulary of known gestures, or templates, based on dynamic time warping (DTW). Dynamic time warping (DTW) is the core of µWave.

HMM-based methods became the mainstream because they are more scalable toward a large vocabulary and can better benefit from a large set of training data. However, DTW is still very effective in coping with limited training data and a small vocabulary, which matches up well with personalized gesture- based interaction with consumer electronics and mobile devices.

b) ALGORITHM DESIGN

The premise of µWave is that human gestures can be characterized by the time series of forces applied to the handheld device. Therefore, µWave bases the recognition on the matching of two time series of forces, measured by a single three-axis accelerometer.

For recognition, µWave leverages a *template library* that stores one or more time series of known identities for every vocabulary gesture, often input by the user. The input to µWave is a time series of acceleration provided by a three-axis accelerometer. Each time sample is a vector of three elements, corresponding to the acceleration along the three axes. µWave first quantizes acceleration data into a time series of discrete values. The same quantization applies to the templates too. It then employs DTW to match the input time series against the templates of the gesture vocabulary. It recognizes the gesture as the template that provides the best matching. The recognition results, confirmed by the user as correct or incorrect, can be used to adapt the existing templates to accommodate gesture variations over the time.

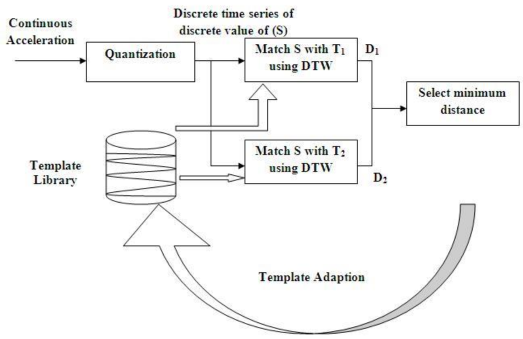

Figure 1: µWAVE based on design

c) µWAVE ALGORITHM PROCESS

The Key technical components of µWave:

- Acceleration quantization,
- Dynamic time warping (DTW), and
- Template adaptation.

i) ACCELERATION QUANTIZATION

µWave quantizes the acceleration data before template matching. Quantization reduces the length of input time series for DTW in order to improve computation efficiency. It also converts the accelerometer reading into a discrete value thus reduces floating point computation. Both are desirable for implementation in resource-constrained embedded systems.

uWave quantization consists of two steps. In the first step, the time series of acceleration is temporally compressed by an averaging window of 50ms that moves at a 30ms step. In the second step, the acceleration data is converted into one of 33 levels. Non-linear quantization is employed because we find that most samples are between –g and +g and very few go beyond +2g or below –2g.

Acceleration Data (a)	Converted Value
a > 2g	16
g < a < 2g	11~15 (five levels linearly)
0 < a < g	1~10 (ten levels linearly)
a = 0	0
-g < a < 0	-1~-10 (ten levels linearly)
-2g < a < -g	-11~-15 (five levels linearly)
a < -2g	-16

TABLE 1: µWAVE based on acceleration quantation

ii) DTW (DYNAMIC TIME WRAPING)

Dynamic time warping is a classical algorithm based on dynamic programming to match two time series with temporal dynamics, given the function for calculating the distance between two time samples. DTW employs dynamic programming to calculate the matching cost and find the corresponding optimal path.

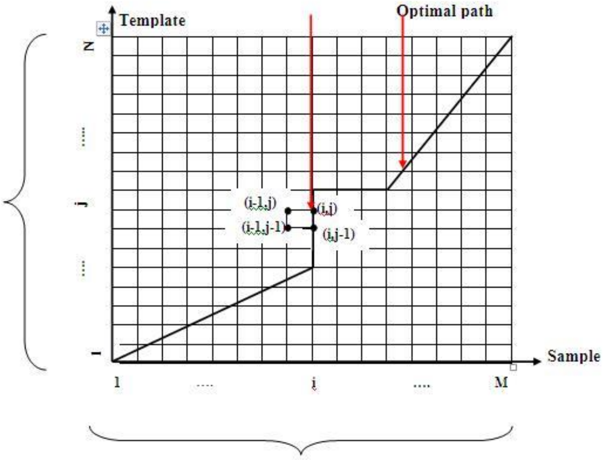

Figure 2: Graphical illustration of DTW algorithm

The matching between S and T with time warping can be represented as a monotonic path from the starting point (1, 1) to the end point (M, N) on the M by N grid. A point along the path, say (i, j), indicates that S[i] is matched with T[j]. The matching cost at this point is calculated as the distance between S[i] and T[j]. The path must be monotonic because the matching can only move forward. The similarity between S and T is evaluated by the minimum accumulative distance of all possible paths, or matching cost.

iii) TEMPLATE ADAPTATION

µWave keeps two templates generated in two different days for each vocabulary gesture. It matches a gesture input with both templates of each vocabulary gesture and take the smaller matching cost of the two as the matching cost between the input and vocabulary gesture.

III. HARDWARE DESIGN AND SOFTWARE DESIGN

The design of entire system consists of two parts which are hardware and software. The hardware is designated by the rule of embedded system and the step of software consisted of several parts.

1) HARDWARE DESIGN

A) TRANSMITTER

The main aim of the transmitter is to sense the gesture, convert it into a recognized signal and transmit through the wireless sensor networks. The input is taken from the MEMS accelerometer. Since the output of the MEMS accelerometer is an analog signal, microcontroller cannot operates it. So the in built ADC in the controller is used to convert the signals into digital form.

The converted signals are recognized using µWave algorithm. µWave is an efficient recognition algorithm used for interaction using a single three-axis accelerometer The outcome of the algorithm is displayed in the LCD and transmitted using Zigbee protocol through MAX 232. MAX 232 is a voltage converting IC which converts TTL logic into RS-232 logic.

In the receiver end, the recognized signals are received and sent via controller to the voice board. The voice board converts the recognized discrete signals into speech signals and is played by the speaker.

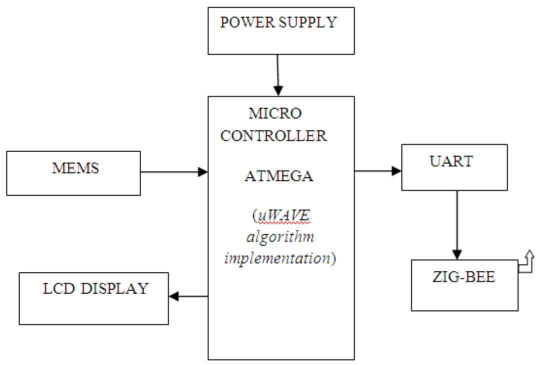

Figure 3: Transmitter

B)RECEIVER

Our sensing device produces the analog values corresponding to the acceleration of three axes. Acceleration values for the eight gestures were placed in the lookup table in controller. Each incoming gestures values for all three axes be compared with every axis value in the table. .The tolerance level for each axis is ±5.When the detected gesture is same as that of stored one, one channel among eight in the voice chip will be automatically enabled and the command for that gesture will be displayed.

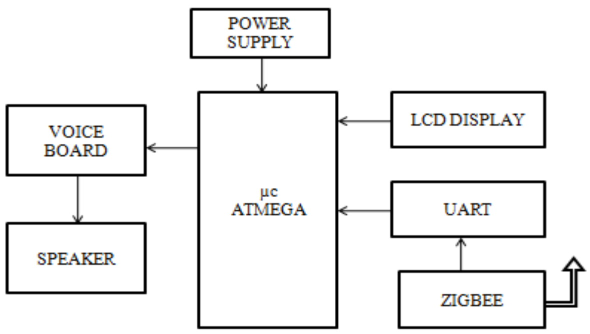

Figure 4: Receiver

The same be also played through speaker using APR9600 voice chip. It is 8 channel voice chip. Since the algorithm is based on the acceleration values which is generalized from gesture motion analysis, it is not limited to specific users. Therefore, there is no requirement to train users before using it.

2) SOFTWARE DESIGN

The input gesture is received from MEMS in the form of analog signals. Using the algorithm the pattern is recognized. After the process of template matching the pattern is checked whether it is valid or not. If it is valid, the pattern is displayed in LCD followed by converting the analog signals into speech signals which is played through the speaker.

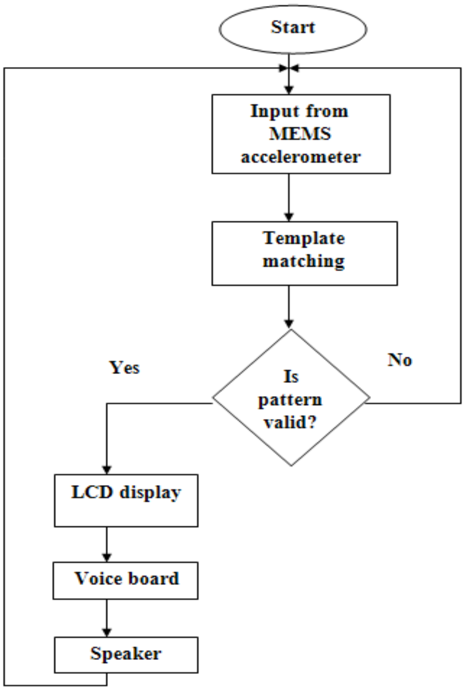

Figure 5: Flow chart

IV. SIMULATION

Figure 6: Display of a recognized pattern “Right”

Figure 7: Display of a recognized pattern “middle”

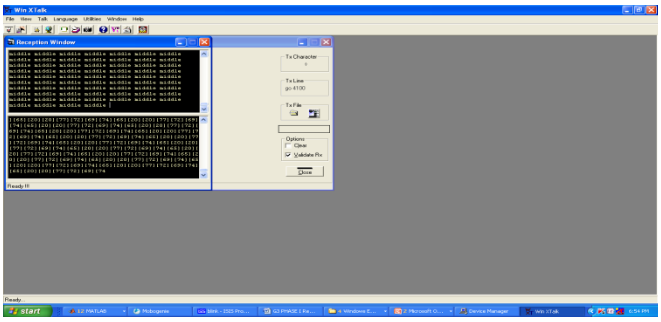

Figure 8:

V. CONCLUSION

The accelerometer used for this project is ADXL330.It is a thin, low power, small, complete 3-axis accelerometer with signal conditioned voltage outputs. It measures acceleration with a minimum full-scale range of ±3 g. It can measure both static as well as dynamic acceleration .The ADXL335 uses a single structure for sensing the three(X, Y, Z) axes. Three axes are highly orthogonal to each other and have little cross-axis sensitivity.

VI. REFERENCES

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