iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3718

An Inertial Pen to Recognize Handwriting & Gesture using DTW Algorithm

Dr. Satya Sai Srikant[1], Alok Bhatt[2], Anurag Singh[3], Swapnil Singh[4]
[1]*Professor, Department ECE, SRM Institute of Science and Technology, Ghaziabad*
[2, 3, 4] *Electronics and Communication Department, SRM Institute Of Science And Technology, Ghaziabad*

Abstract: In this paper, we present an inertial pen to recognize handwriting & gesture using dynamic time warping based recognition algorithm. With the rapid development of computer technology, human-computer interaction(HCI) techniques have become an indispensable component in our daily life. Users hold the inertial pen to write numerals and English lowercase with their preferred hand held style and speed. The inertial signals generated by hand motions are wirelessly transmitted to a computer for recognition. The dynamic time warping based recognition algorithm includes the procedure of inertial signal acquisition, signal pre-processing, motion detection, template selection, and recognition.
Keywords: Inertial pen, dynamic time warping, handwriting recognition, gesture recognition, signal acquisition, motion detection, and template selection.

I. INTRODUCTION

Technologies are being developed which are able to intuitively express users' intentions, such as handwriting, gestures, and human body language, to naturally control human computer interaction (HCI) devices. These technologies have many applications in the fields of remote control, virtual reality, sign language, signature authentication, sport science, health care, and medical rehabilitation. In this paper, an inertial-sensor-based digital pen (inertial pen) and a dynamic time warping (DTW)-based recognition algorithm are presented for both handwriting and gesture recognition tasks. The portable inertial pen is composed of a tri axial accelerometer, a tri axial gyroscope, a tri axial magnetometer, a microcontroller, and an RF wireless transmission module. Users can utilize this inertial pen to write numerals and English lowercase letters, and make hand gestures at their preferred speed without any space limitations. Measured accelerations, angular velocities, and magnetic signals are transmitted to a personal computer (PC) via the RF wireless module. The proposed DTW-based recognition algorithm is composed of the procedures of inertial signal acquisition, signal pre- processing, motion detection, template selection, and recognition. In the proposed recognition algorithm, we utilize the zero velocity compensation (ZVC) method and a quaternion-based complementary filter to reduce the integral errors caused by the intrinsic noise/drift of the accelerometer and gyroscope, which worsen the accuracy of the velocity, position, and orientation estimations. Furthermore, we have developed a minimal intra-class to maximal inter-class based template selection method (Min-Max template selection method) for a DTW recognizer to obtain a superior class separation for improved recognition. The advantages of this approach include the following: 1) with the inertial pen, users can deliver diverse commands through hand motions to control electronic devices anywhere without space limitations; 2) the DTW-based recognition algorithm only requires one training sample or class template for each class for highly accurate motion recognition; and 3) the DTW-based recognition algorithm can effectively reduce the integral errors of inertial signals.

II. INERTIAL PEN

The inertial pen consists of a triaxial accelerometer & a triaxial gyroscope(MPU6050), a triaxial magnetometer(HMC5883L), a microcontroller(ATMEGA8) and a zigbee as RF wireless transceiver. The accelerometer, gyroscope, and magnetometer are used to detect accelerations, angular velocities, and magnetic signals generated by hand movements. An accelerometer & gyroscope(MPU6050) can sense the inclination (tilt) of a device even when stationary. Since gravity is an acceleration of 1g, tilt is proportional to the sine of the angle the accelerometer makes with the Earth's gravitational field. Three axis units return sensor information in the X, Y, and Z directions. A Gyroscope is a spinning wheel or disc in which the axis of rotation is free to assume any orientation by itself. When rotating, the orientation of this axis is unaffected by tilting or rotation of the mounting, according to the conservation of angular momentum. Because of this, gyroscopes are useful for measuring or maintaining orientation. Magnetometers are devices that measure magnetic fields. A magnetometer is an instrument with a sensor that measures magnetic flux density B (in units of Tesla orAs/ m^2). Magnetometers refer to sensors used for sensing magnetic fields. ATmega8 microcontroller has 23 programmable input/output (I/O) pins which can be used for interfacing with external world. It is possible to configure them as input or output by setting a particular register value through programming. This IC comes in 3different packages, but we are using the popular 28-Pin PDIP package (Atmega8-16PU). ZigBee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low bandwidth needs, designed for small scale projects which need wireless connection. . Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics. ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. The battery of the inertial pen is replaceable and rechargeable.

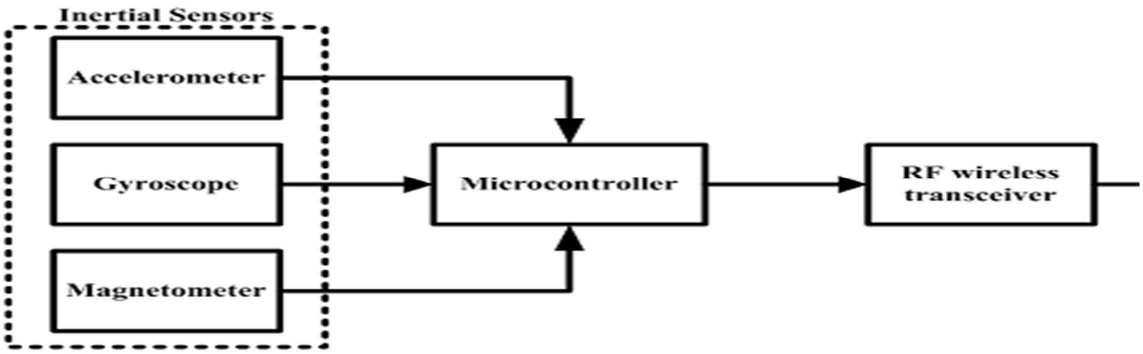


Fig.1 Schematic diagram of inertial pen

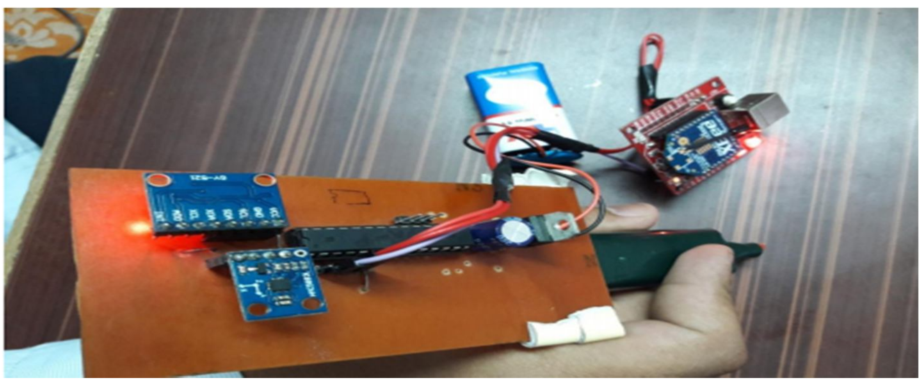


Fig.2 Top view of inertial pen module

III. DYNAMIC TIME WARPING ALGORITHM

Dynamic time warping (DTW) is a time series alignment algorithm developed originally for comparing two (time-dependent) sequences and mapping similarity between them. It aims at aligning two sequences of feature vectors by warping the time axis iteratively until an optimal match (according to a suitable matrices) between the two sequences is found. Dynamic time warping (DTW) algorithm is developed to ensure a minimal cumulative distance between the aligned sequences, and to find the similarity for the optimal alignment between two temporal sequences. The DTW algorithm in the current paper is used to classify time sequences (movement signals) of different digits, letters, or gestures based on the nature of the movement signals generated from the handwriting and gesture trajectories. Most importantly, the training procedure of the DTW recognizer only needs one class template for each class.The DTW process is described as follows: Let M and N be two similar temporal sequences with the same sampling rate and different lengths, where M = [m1, m2, . . . ,mp] and N = [n1, n2, . . . , nq]. First, a cumulative distance matrix D ∈ Rp×q , in which each element represents a mapping and alignment between M(i) and N(j), is constructed for measuring the similarity between the sequences M and N. Subsequently, a warping path W = {w1,w2, . . . ,wK } can be calculated from the cumulative distance matrix (D), which is composed of the local cumulative distances D(i , j), by the following equation W = with i(k) ∈ {1,………,p} and j(k) ∈ {1,……….,q}.The optimal warping path can be found effectively based on dynamic programming through the local cumulative distance D(i , j) defined as: D(i , j) = d(mi ,nj) + min.

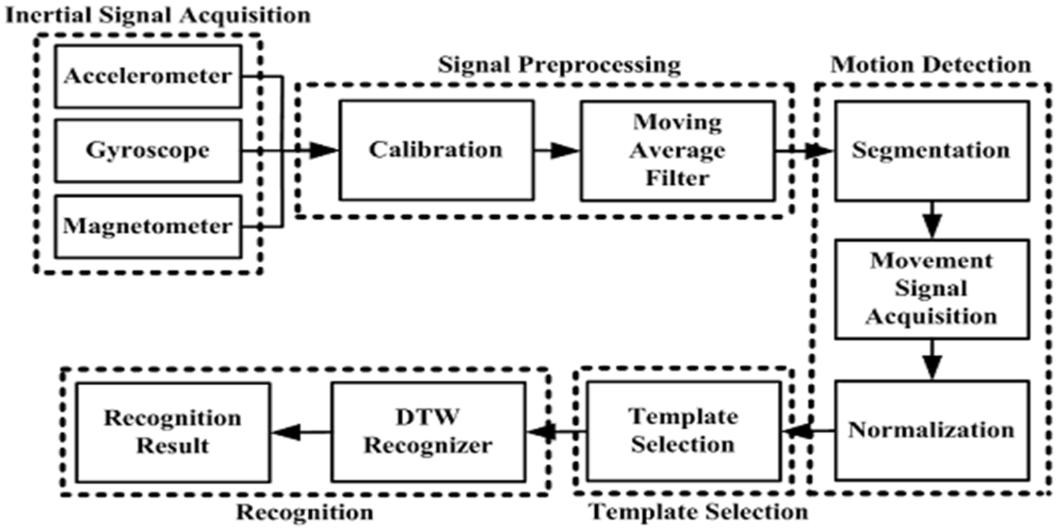
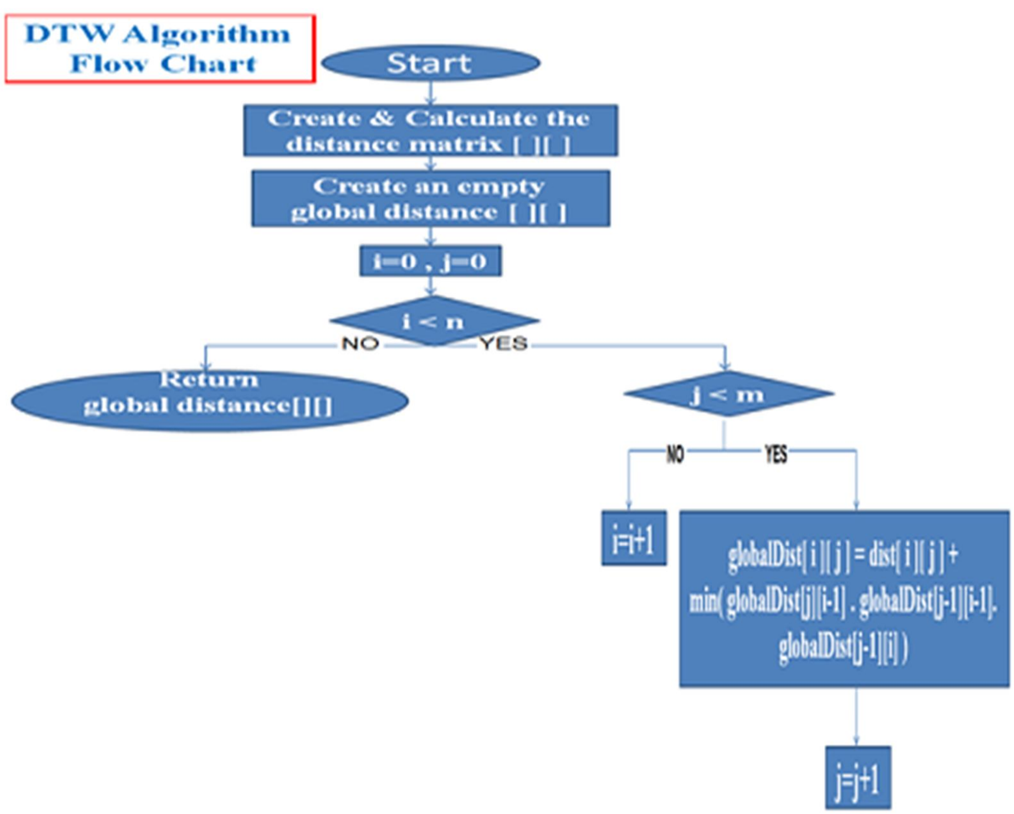


Fig.3 Block Diagram Of The Dtw Based Recognition

Signal Pre-processing: Since the measured signals are always contaminated not only by the sensors' error sources but also with users' unconscious trembles, signal pre-processing composed of calibration and a moving average filter is an essential procedure after inertial signal acquisition .Calibration,the accelerations, angular velocities, and magnetic signals are calibrated to reduce sensitivity and offset errors from the raw signals. When the inertial pen is stationary, the triaxial accelerometer measures the gravitational acceleration only. On the basis of this fact, we align each axis of the triaxial accelerometer with the Earth's gravity to calibrate the accelerometer. To execute the calibration, we first place the triaxial accelerometer on a level surface and then point each axis alternately upward and downward.

A. Flow Chart For Dtw Algorithm



International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

IV. CIRCUIT DIAGRAM

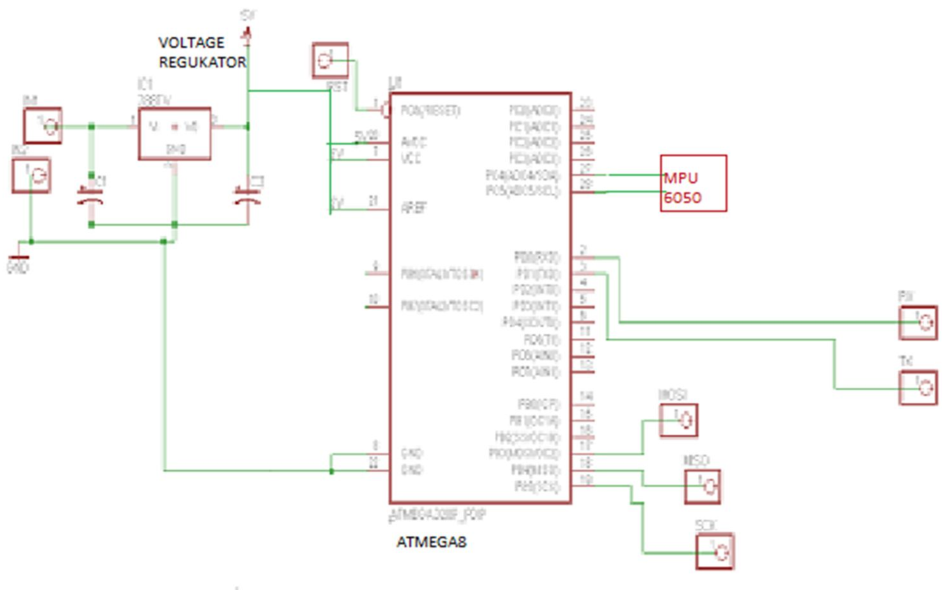


Fig.6 CIRCUIT DIAGRAM

V. CONCLUSION

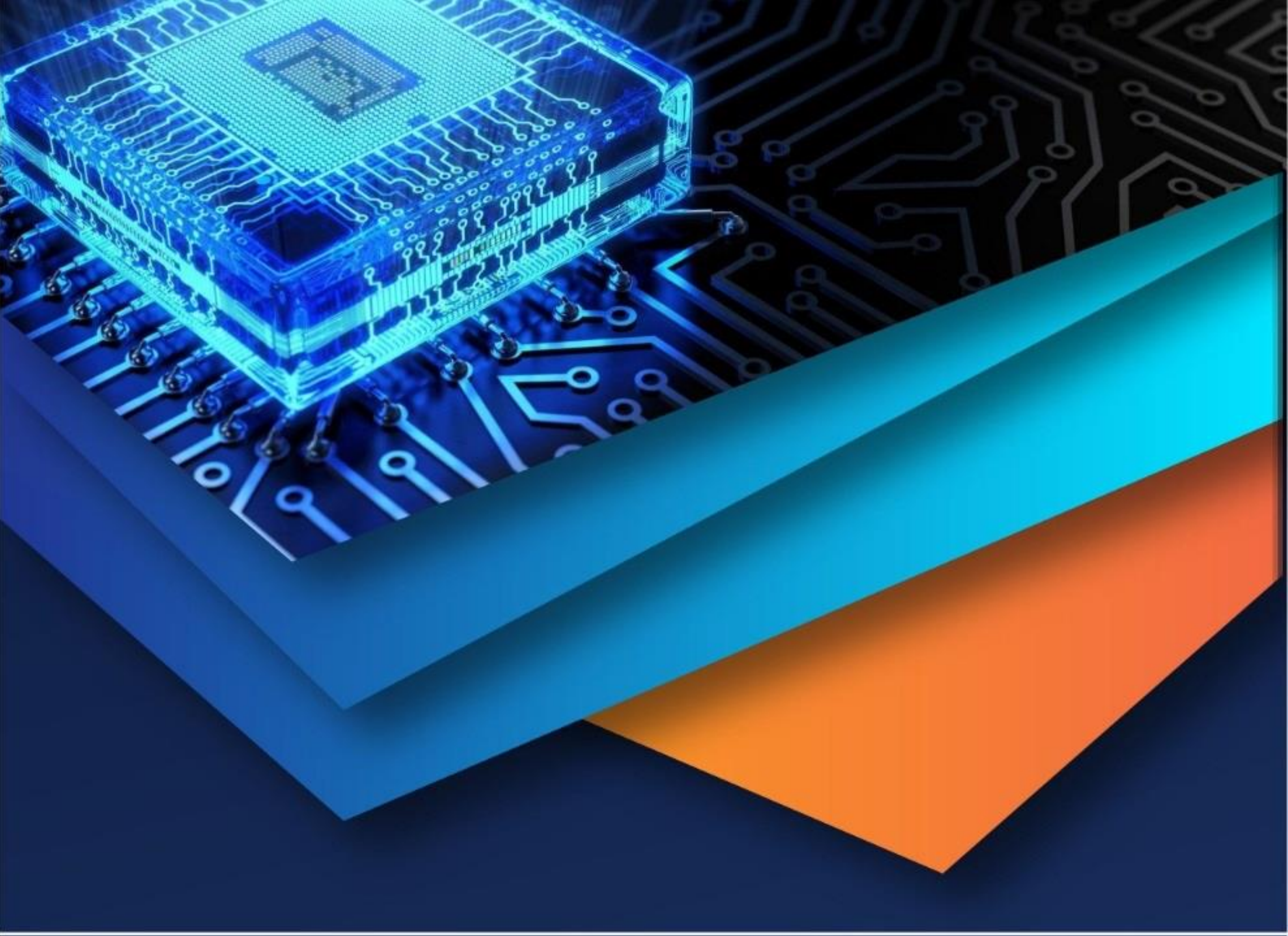
This paper has presented an inertial pen for handwriting and gesture recognition using ATMEGA8, Accelerometer, Gyroscope, magnetometer, and zigbee. The proposed inertial pen is based on recognition algorithm which consists of inertial signal acquisition, signal processing, motion detection and recognition. To obtain better movement signals, we have utilized a quaternion-based complementary filter to reduce orientation errors and the ZVC method so as to minimize the undesirable error accumulation of velocity signals. Subsequently, to improve the performance of the DTW recognizer, all movement signals are normalized via the Z-score method and the class template is selected via the proposed Min-Max template selection method. Based on model presented in paper, we believe that the inertial pen and its associated DTW-based recognition algorithm can be considered an innovative and effective Human Computer Interaction device.

VI. ACKNOWLEDGEMENT

We are very grateful to our college and the faculties for their cooperation and support. We are thankful to Dr. SATYA SAI SRIKANT (Professor ECE, SRM), our project guide for his invaluable and help.

RFERENCES

[1] Akl, C. Feng, and S. Valaee, “A novel accelerometer-based gesture recognition system,” IEEE Trans. Signal Process., vol. 59, no. 12,pp. 6197–6205, Dec. 2011.
[2] C. M. N. Brigante, N. Abbate, A. Basile, A. C. Faulisi, and S. Sessa,“Towards miniaturization of a MEMS-based wearable motion capture system,” IEEE Trans. Ind. Electron., vol. 58, no. 8, pp. 3234–3241,Aug. 2011.
[3] R. Xu, S. Zhou, and W. J. Li, “MEMS accelerometer based non-specific user hand gesture recognition,” IEEE Sensors J., vol. 12, no. 5,pp. 1166–1173, May 2012.
[4] S. Kallio, J. Kela, P. Korpipää, and J. Mäntyjärvi, “User independent gesture interaction for small handheld devices,” Int. J. Pattern Recognit.Artif. Intell., vol. 20, no. 4, pp. 505–524, 2006.
[5] J.-S. Wang and F.-C. Chuang, “An accelerometer-based digital pen with a trajectory recognition algorithm for handwritten digit and gesture recognition,” IEEE Trans. Ind. Electron., vol. 59, no. 7, pp. 2998–3007,Jul. 2012.
[6] I. Frosio, F. Pedersini, and N. A. Borghese, “Auto calibration of triaxial MEMS accelerometers with automatic sensor model selection,” IEEE Sensors J., vol. 12, no. 6, pp. 2100–2108, Jun. 2012.
[7] M. Šipoš, P. Paces, J. Rohác, and P. Novácek, “Analyses of triaxial accelerometer calibration algorithms,” IEEE Sensors J., vol. 12, no. 5,pp. 1157–1165, May 2012.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY