Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 7341 - 7347
Received 16 February 2021; Accepted 08 March 2021.

Integration of 3D MEMS Accelerometer Sensor

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Abstract— A methodology which tracks the hand gesture depends on the integration of custom-built Micro Electro Mechanical Systems (MEMS)-based inertial sensor (measurement unit), the low-resolution imaging (i.e., vision) sensor. A 2-D gesture recognition changes in to a motion tracking gesture recognition in three dimensions. Essentially, it will show the inertial data sampled at 100 Hz and vision data sampled at 5frames/s. An Extended Kalman filter, which provides accurate human hand gesture recognition as well as tracking. The novel adaptive algorithm measures noise covariance, acceleration and angular rotational rates. The proposed method may reduce the velocity of error and also position drift by using MEMS Accelerometer sensor. To compensate for the time delay, the moving average filter used to reduce the frequency noise and then propagate the inertia of signal. A dynamic of time wrapping with DCT provides extracted feature and it gives exact value of 92.3% also individual numerical recognition with 100 ms.

Index Terms—fusion sensor, gesture and recognition, MEMS related motion tracking, trajectory algorithm

1. Introduction

The up-gradation of micro electromechanical system (MEMS) technology, leads to various applications with low cost of MEMS-global positioning system (GPS) which is integrated with the navigation system is being popularly researched. The MEMS-based inertial sensor which is integrated with GPS and it also provides a reliable positioning solution in GPS which was commonly occurs in the urban areas [2]. Especially, a low cost of the MEMS-GPS integrated navigated system is used for mobile robot, an unmanned aerial vehicle, a micro-aerial vehicle and also a pedestrian navigated system. Gestures are used for the communication system between the people and also a machine. Then Building the interaction between the human and computers are also required for an accurate hand gesture recognized system also an interface for an easy human computer interaction (HCI) system, a recognized gesture is used for the controlling robot also conveying meaningful information.

The expansion of human machine interaction technologies reduces the size, dimension and weight of the consumer electronic products such as smart phones, handheld computers. It increases the day-to-day convenience. An attractive and alternative, inertial sensor projected body will sense the activities of the human movement, it also captures the motion of trajectory information from the accelerations of recognizing gestures. The main advantage of the inertial sensors for motion sensing that can be operated without any of the external reference and also the limitation in operating the conditions. However, the recognition of motion trajectory is very difficult for the users and also, they have a different speeds or styles to generate a various motion of trajectories. [5] The researchers looking forward to get rid of the issues in increasing the accuracy of the recognition system. By the process of miniaturization, the MEMS accelerometer based recognized system which will acknowledge the gestures in a 3-D is constructed by using this digital format.

Gestures may be static (posture) or dynamic (sequence of more postures). The Static gestures are required less computational, complexity and dynamic gestures which are all complex. It is suitable for the real time environments.

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Acquired data available in the recognition system can be obtained either by using spare devices such as instrument data glove devices, or used the virtual image, and both mentioned methods [18, 19].

which are used to extract the gesture features. The Vision based method will approach easy, natural and a less cost comparing with gloves and the approaches are required by users will wear their special device and it was connected to their computer it will hinder their naturalness of the communication between all users and computers. There are a lot of reviews were discussed in the gesture of recognition system also its application was using different no of tools. This work has been demonstrated their advancement of gesture of recognition systems and was represent the starting point of the investigators in the human gesture recognition field. The readers should note that it will aim to provide a broad and introduction of subjects of the inertial methods of navigation, it will be focused mainly on the strap down type of the inertial method of navigation system using micro-machined electromechanical systems (MEMS) devices. MEMS technology have an interest on this current time. Also it was offered a rugged, low no of cost, small and light weighted inertial sensors and which is relative to their technologies. Also, the performance of the MEMS inertial device is for improvement. Due to their inertial navigation system (INS)it was developed which is based on MEMS device.

2. Gesture Tracking

To propose their automatic systems, we could recognize the isolated gesture in the real-time system from stereo the sequences of motion and trajectory by a single human using HMMs [1]. In a proposed system it was consists of three main stages; automatic method of segmentation process, tracking method, also feature extraction and classification.

(1) Pre-processing; means it localizes and also finds the human to reproduce their motion of trajectory path.
(2) Feature extraction; means the Clustering which is extract and its feature will be generated their discrete no of vectors, which is given as input to the HMMs recognizer.
(3) Classification; means their gesture path and it would be recognized by the discrete vectors and also Left-Right Banded of topology.

The two types of the gesture path recognition methods are vision-based and also accelerometer-based sensor. Due to their some of the limitations which was ambient of noise, slower dynamic responses, also large no of data collections/processing of the vision-based methods. The recognized system will be implemented which was based on the inertial measurement unit of the MEMS accelerometer sensor. If accelerometer sensors are used for the inertial measurements it will cause a heavy computational burden, in our system it is based on the MEMS accelerometers only and gyroscope sensors which was not implemented. Many of the researchers is focus by the developed effective of algorithms for an error compensation of the inertial sensor and will improved their recognition system of accuracy. An effective acceleration and errors of compensative algorithm was based on the zero no of velocity of compensated and it would also develop to decrease their acceleration of the error by acquiring in the reconstructed method of trajectory. A Kalman filter with all of the magnetometers (micro inertial of measurement unit (μIMU) with magnetometers), is employed to the compensate of orientated proposed digital of the instrument.[4] when oriented instrument is estimated, the motion of trajectory and the instruments was also be reconstructed with accurately. An optical method of tracking was calibrated which was based on optical of tracking method system (OTS) it was calibrated by a 3-D of acceleration method, the angular velocity, and spaced attitude of motion. Then OTS is developed by these two goals: 1) Also obtained the acceleration of proposed and ubiquitous of digitized instrument by a calibrated 3-D trajectory and 2) also obtained an accurate of attitude angle by the multiples of calibrated method. In order to recognize and reconstructed their motion of trajectory was accurately mentioned, and approaches to introduce all the sensors which are gyroscopes and magnetometers it was obtained by the précised method of orientations. This will increase their cost of motion of trajectories and recognized system which also a

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commutated of burden.

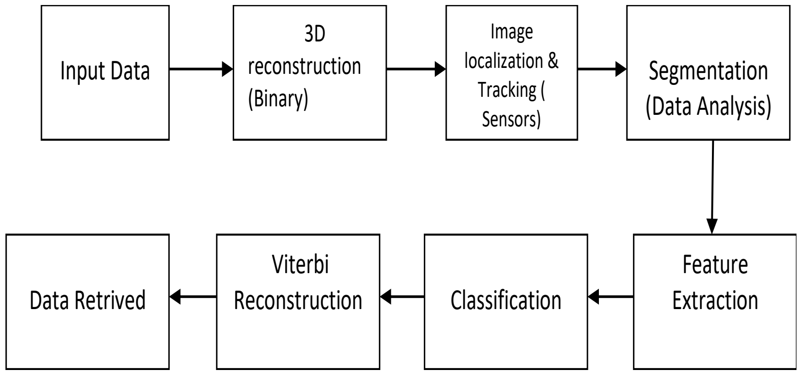

Figure 1: Block diagram

2.1Segmentation and Tracking

A method of detection and segmentation is a complex and its background was described by the motion of segmented and tracking which will took place by using a 3D depth of map of information. Segmentation of regions will becomes a robust and if there was a chrominance is used in all analysis. We should ignore all the channels will reduce all their effects of a bright of variation and will used their chrominance fully and will represented a movement of information. A large database will be used for trained up the Gaussian of models. This Gaussian Mixture of Models will begin with the models of database and where having a variant method of k-means clustering method algorithm which will perform their model of training and will determined an initial of configuration of the GMM of parameters. A depth of an information which will solve all the overlapping problems, then it was obtain by the passive methods of stereo of measuring which is based by the cross correlated of the known calibrated of data's. All the clusters which are composed of resulted a 3D-points.[8] The clustered of algorithm which was considering as a kind of the regions and is grown in a 3D which was used in two methods; skin as well as Euclidean method. Those all methods are very robust to their disadvantage of light and partial occlusions, it was occurred in a real-time of environment. In their analysis which was used to derived their boundary of areas of method, which also bounding boxes of body with centroid point.

After the localization of human target from the segment. We can find their best of matches in a hand of target in a sequential no of frames which was used for measuring their similarity of maximize the Bayes error and arises from their comparisons of targets and also their candidate. Due to their consideration of mean depth of the value which was computed from their frame of the regions to solved their overlapped between their motions. The mean is defined as recursive and will performed their optimization to reduce their strength. This mean-shift optimizations will give their measurement no of locations of hand target method, also uncertain of estimation which was computed and it was follow by the Kalman filter, it will derive their predicted positions of hand target, the hand of gesture path was obtain by took their correspondence of the detect movement and also the successive frames. The frames which are fused together to detect their movement of human body by accelerometer sensor.

2.2. Feature Extraction

To select a nice features and to recognized their hand gestures of path which also played a significant role in the systems performance. The three basic features; are locations, orientated method and velocity. We also analyzed their effective features which are extracted by the trajectories is also combined them to test their recognition rate. A 3D

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dynamic feature will divided into two category that are featured in Cartesian space (x; y) and featured in the Polar space (_; ').

2.2.1 Features in Cartesian Space

A gesture of path is a spatio-temporal pattern which was consists of centroids (x hand and y hand). All there coordinates in the Cartesian space it was extracted by gestures frame. We also considered two types of locations space. First of location space is Lc and it measure the distant from centroid point of all points in the gesture of path because there are different types of location space was generated by same gesture (Eq 1). Second of location feature is Lsc, which was from start point to current point of gesture of path (Eq 3)

$$Lc=\sqrt{}(x_{t+1}-c_x)^2+(y_{t+1}-c_y)^2$$

$$(cx,cy)=1/n\ (\textstyle\sum_{t=1}^{n} xt, \sum_{t=1}^{n} yt) \qquad (2)$$

$$Lsct=\sqrt{}(x_{t+1}-x_1)^2+(y_{t+1}-y_1)^2 \qquad (3)$$

A second time basic feature was orientation, it will gives the direction of the hand when it traverses along their space during their gesture process. This orientation feature was based on the calculation method of human displacement vector and in every point it was represented by orientated according to the centroid path of gesture.

A third basic feature was velocity, and it plays more important role in gesture recognition phase which was particularly at the most of the situation. The velocity which was based on their fact in each of the gesture was made by different speeds and the velocity of gesture will decreases by the point of gesture path.The velocity will be calculated at Euclidean distance from two successive points and was divided by all time the number of frames as follows;

$$Vt=\sqrt{}(x_{t+1}-x_t)^2+(y_{t+1}-y_t)^2 \qquad (4)$$

In the Cartesian coordinate of system, we also use their different combination of variety of featured vectors. For example, all featured vector is at the frame t + 1 is also provided by the union of locations and features (Lct; Lsct), the location features with the velocity of feature (Lct; Lsct; Vt).Each of the frame will contains a set of vectored at the time t and all dimensions space was proportional to their size of feature vector method. In their manner, a gestures will represent as ordered sequences of featured vectors, it is projected by clusters in the space dimensions to obtain their discrete code word which is used by input to HMMs. It was done by using their k-means clustered algorithm.

2.2.2 Features of Polar Space

The Polar of coordinate system is directly find out by the Cartesian coordinates which is generated from the gesture of images. It also obtained a normalized polar coordinate, which will used a radius from their center point of the gesture path, the radius of start and current point. In Polar space, a different no of combinations of features will obtained a variety of featured vectors.[6] For example, the featured vectors at the frame t + 1 was obtained by the union of location features from centroid point with velocity of feature (ρct; φct; Vt), the locations feature will started and the current points with their velocity feature (ρsct; φsct; Vt), and the combination of all vectors (ρct; φct; ρsct; φsct; Vt).

2.2.3 Vectored Quantization

The extract of features will quantized by obtaining a discrete no of symbols. If the featured locations or velocity which is used as separate, all the features will normalized which was multiplied by different scalars ranged by 10 to 30. The normalization of orientated features was divided by 10, 20, 30 and 40 to obtain a code word. In addition to their combination of features by both Cartesian and Polar coordinate system, it also used the k-mean clustered algorithm to divide their gesture features in K clusters on all featured space. The algorithm was based on the minimum no of distance between their center of clusters and featured points. We would divide all their set featured

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vectors into set clusters. It will allowed the human trajectories in featured space by clusters. This was find out by clustered index and was used as input to the HMMs. [11]

2.3. Classification

Markov model is one of the mathematical model of stochastically process, it will generated a random no of sequences and outcomes for certain probabilities. A stochastically process was the sequence of feature code words, all outcome will being the classification of their gesture of path. The Evaluated, Decoded and Trained are the main problem of HMMs and it also being solved by using their Forward- Backward, Viterbi and Baum-Welch (BW) algorithms respectively.

3. MEMS based Accelerometer

Micro-machined of silicon accelerometers also used their principle of mechanical and also a solid state of sensors. If the two classes of MEMS accelerometer. First class will consisted of mechanical accelerometers (i.e: devices which is used to measured their displacement of mass) [3]and it is manufactured by using their MEMS technique. A second time the class will consisted of devices which will measure their change in their frequency of vibration and it is caused the change in tension, it is in the accelerometers.[12] . An advantage of the MEMS devices is listed which was small, very light and having low powered consumption, start-up times have their performance of MEMS device which was improved rapidly.

3.1. MEMS Accelerometer of Error Characteristics

We should also examined their errors and it is a raised in the MEMS type accelerometers. These types of errors are mentioned below in the analogous form of sensor feature, and also therefore represented by the less details .An important difference was the errors which is arises from the accelerometers which was integrated with twice their order to track a position[9], i.e the rate-gyro signals which was only their integrated with once to tracked their orientation.

3.1.1 Constant of Bias

The biases of an accelerometer were offset and it also provides the output of signal from the true value, which is m/s^2. A constant bias of error is ϵ, it was two times integrated, and caused by an error in the position it will grow by a quadratic in all time. The accumulated error was available at that point was

$$s(t)= \epsilon \, (t^2/2) \qquad (1)$$

Where tis time of integration.

3.1.2 Flicker Noises / Bias Stability

MEMS accelerometer sensor was subjected to flickered noise, it was caused by a bias to wonder over their time. The fluctuation was modeled as biases random walk. The flickered of noise and it will be created by a second order random walk in the velocity which was uncertain and it will grow proportionally by t3/2, which also a third ordered random walk on the positions was grow proportionally by t5/2.

3.1.3 Temperature Effects

The temperature change will be caused the fluctuations on the bias without put of signal. The relation between bias, temperatures will also depend on their specific of the devices, which is also a very highest nonlinear method. A residual bias system will be caused by an error in their position it was grow very quadratically with in a time [7]. An IMU contained the temperature of sensor and it was possible for applying the correction of output of the signal which was ordered and compensate the temperatures of the dependent of effects.

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3.1.4 Calibration Errors

The Calibrated errors will appear on the bias of errors it was only a visible to all devices which was undergone by the accelerated method. It shown that the 'temporary' bias error was observed and it was even though fall devices was stationary, it was due to their gravitational of acceleration.

4. Conclusion and future work

The main goal which is demonstrating successfully tracking the body motions and extract an accuracy of 92.3%. The system can recognize the body movement components and the program tracks the motion of human and whatever the left hand moves over a predefined area, it recognizes the motion and receives the next predefined area. The main focus is creating a modern device that can record and recognize the human gestures. Our system provides sufficient data and accurate feedback to the user. The algorithm was developed by the tracks and real-time of positions. Application of all systems can use an education tool for learner as well as facilitate communication.

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