An Efficient and Simple Approach for Indoor Navigation Using Smart Phone and QR Code

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***Abstract*— This paper presents an effective way for indoor navigation using inertial measurement unit (IMU) in conjunction with a quick response (QR) code. Usage of QR codes helps to compensate the errors from the IMU thereby providing accurate navigation. This technique involves very less cost and can be implemented in a straight forward manner.**

Keywords*— *inertial measurement unit; quick response (QR) code; indoor navigation

I. INTRODUCTION

The present day indoor navigation techniques includes wireless technologies like WIFI [1][2], GSM [3], FM [4] *etc.* and other technologies, including infrared (IR), RFID [5][6] *etc*. These technologies are expensive in nature as these technologies demands for the installation of additional infrastructure and sensors thereby leading to high budget and high labor cost. As a solution to the above problem this paper considers indoor navigation using IMU in conjunction with QR code. IMU, which includes sensors like accelerometer and gyroscope accumulates error which becomes a main factor for the deviation from the original path [7]. Therefore, this paper proposes a QR code technique that aids IMU by compensating the error from the IMU hence, giving a better accuracy.

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II. PEDESTRIAN DEAD RECKONING

A Pedestrian Dead Reckoning (PDR) is a pedestrian positioning method which is based on additive distance travelled given the initial position. The distance traversed can be tracked by the method of step detection [8] using an accelerometer and the orientation calculated using a gyroscope.

We go through a series of steps as shown in Fig. 1 before performing the step detection. The raw values obtained from a three axis accelerometer of a smartphone are first converted to absolute acceleration. These are then fed through filters so as to eliminate the influence of gravity and offset and also to get a smooth signal with attenuated noise. In this paper, the step detection is carried out using peak detection. The peak detection is carried out using a variable threshold method, thereby detecting its maxima and minima of the signal in an interval. To ensure a valid step, a time interval of 150 ms between maxima and minima is considered. The path traversed can be calculated using the estimated step length. This paper uses a dynamic approach called scarlet method [8] to estimate the step length.

In the Scarlet approach, the accuracy problem caused by the variation in spring in the steps of different people is solved. This approach shows a relation between maximum acceleration $a_{\max}$, minimum acceleration $a_{\min}$ and average acceleration a_{avg} of the step length s_s as

$$s_s = k\frac{a_{avg} - a_{\min}}{a_{\max} - a_{\min}} \tag{6}$$

$$a_{avg} = \sum_{m=1}^{N} |a_m| / N \tag{7}$$

where k is a constant multiplier taken as 0.81 and moving average size N is taken as 16. The measured acceleration values are denoted by a_m.

The raw three axis gyroscopic values obtained from the smart phone in radians per second are first converted to degree per second so as to get the rotated angle. The rotated angle thus obtained is merged with the step detection to get step rotated angle. The result obtained is finally combined with the scarlet method to obtain stride length with the orientation of the user as shown in Fig. 1.

One of the major drawbacks of using PDR alone for the navigation purpose is the accumulation of errors [7] over a time span as the current location estimate is based on the prior estimate of the last step. Hence the errors related to the stride length and the orientation, which is unavoidable with the present commercial grade sensors, makes the PDR unreliable if used for a long period of time or distance as shown in Fig.2. Therefore, this technique is merged with other techniques for a better positioning.

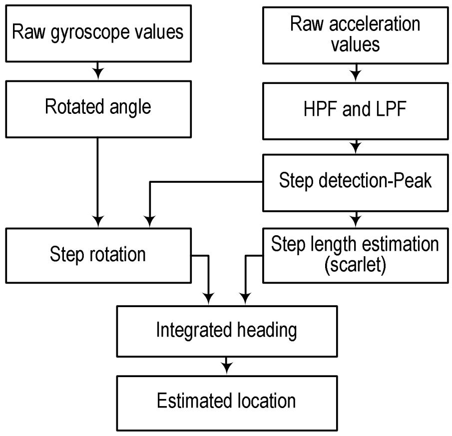

Fig.1. Block diagram for PDR implementation.

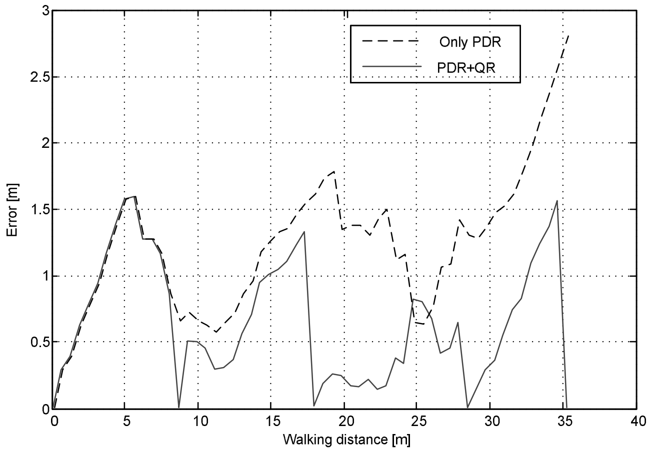

Fig. 2. Comparison between conventional PDR and proposed method.

III. PDR In Conjunction With QR Code

As seen above the drawbacks of using only IMU leads us to combine PDR technique with the QR code which helps to compensate the errors from IMU thereby providing a better and accurate navigation. This technique first requires the placement of the QR code at intersections and along the path with a separation distance of 10m as the PDR algorithm gives an accurate information within a range of 10m. These locations of QR code augmented with the blueprint as shown in Fig. 3 are made available to the user.

The unique algorithm used in this paper restricts the values of the accelerometer and gyroscope from deviating by using QR codes. i.e. once a QR code is read, the location determined by the values of the accelerometer and gyroscope converges to the location of QR code thereby, restricting the errors from the accelerometer and gyroscope. The result is as shown in Fig.2. When compared to the conventional algorithm of using PDR solely in Fig. 2, the proposed method provides a better and accurate information with an average error of 0.64 m. The implementation of the conventional and proposed algorithm on a blue print in shown in Fig. 3. Table I gives a comparison of some methods used for indoor navigation on the basis of average error and infrastructural cost.

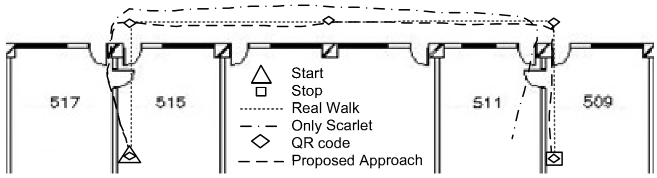

Fig. 3. PDR with QR Code assistance for navigation in a real time scenario.

TABLE I. Comparison Of Different Techniques

Technologies	*Average Error (m)*	*Infrastructure cost*
WIFI [2]	2~5	>150$
FM [4]	3~5	>300$
RFID [5]	2~4	>800$
PDR	1~5	0$
Proposed PDR with QR code	0.64	<20$

IV. Conclusion

The indoor navigation technique using PDR with QR code provides an efficient technique in comparison with other existing technologies in terms of infrastructural cost, accuracy, being independent of wireless technology, less memory utilization and lesser consumption of the battery.

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