Automatic Mapping and Localization in Large-Scale Cycle Using K-NN

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Abstract

Most of the functions imbedded on robotic systems are highly dependent on positioning algorithm. system need to be designed in such way that accurate positioning can be ensured while object movements. Indoor positioning system is imposing great challenge since it cannot be linked to GPS system. Hence, location optimization and positioning process at indoor systems need to be performed using own (internal) positioning algorithms that depends on local sensors integrated with the mobile object itself. The results shown that total consumption time (which was used as performance metric to judge the used algorithms) is maximum with Spearman method which was equal to 0.00661 seconds whereas it is far less when Correlation method is used (equal to 000234 second).

Keywords: Robotics, KNN, Correlation, Positioning, GPS, Time Delay.

1 INTRODUCTION

The technology development led to new approaches that facilitates human life such as robots where machines are depended to solve daily problems of human. The revolution of information technology and computer programming is greatly expanded especially when internet and mobile networks evolved. The number of internet user is largely increased which makes knowledge granting is easier than anytime. Hence, technology of localizing was amongst the concerns of robotic engineering where robot need to move as accurate as possible reaching the destination point.

Robotic technology is utilized the machines alike Direct Current (DC) motors in order to perform automatic tasks that difficult to be performed by human. Robotic were used in very accurate industries such as electronics and chip manufacturing as well as in heavy industries alike automobiles. Most of the functions imbedded on robotic systems are highly dependent on positioning algorithm. system need to be designed in such way that accurate positioning can be ensured while object movements.

Geographical location and positioning signaling (GPS) is one of the leading technologies for positioning in the outdoor environments. This system is determining the object location by sending the signal from the GPS handset/sensor to the satellite or even using the mobile/cellular towers in the vicinity. In this chapter, problem statement about indoor positioning system where the challenges facing the indoor positioning system are listed. The objectives and thesis organization are also listed.

Indoor positioning system is imposing great challenge since it cannot be linked to GPS system. Hence, location optimization and positioning process at indoor systems need to be performed using own (internal) positioning algorithms that depends on local sensors integrated with the mobile object itself.

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2 SIMULATION SETUP SYSTEM

Positioning system at indoor locality is suspected to the below challenges:

- Sensors calibration problem where the responses for same event can be differs. This is an electronic issue which impact the accuracy of the position that sensors are yielding. Utmost, no sensor can provide the location coordination as such. In more cases, infrared sensor is sued which shoot beams on the four directions and decide whither any of the direction is available i.e. (no obstacles are placed). Those sensors are big time consumers which apply extra payload to the positioning system.
- Other sensors alike accelerometer and gyroscope are also in use for location detection, such sensors are producing large amount of information, in other word, the accelerometer and gyroscope sensors are generating large amount of geographical coordination which need supper processing power for addressing the burst of information.
- Difficulty in integration of artificial intelligence (AI) i.e. machine learning and deep learning to the machinery systems in real-life especially while using the robot arm in surgeries and medical applications. There was a risk factor introduced in the literature where the AI technology cannot be relied at all real-life applications.
- Even-though, AI applications are intervened in location detection (positioning) systems, challenges are arisen since the data sources are limited where the training of AI models can not be complied.
- Training of AI model with particular data at known noise level may server the purpose unless more noise impact is applied to the data which increases the shift between the train and test data and hence trigger more errors at the results.

a. Network Topologies

After development of computing technologies, the demand has been dramatically increased where computers are associated with various life sectors in both personal and industrial levels. In order to utilize the power of computer and achieve more efficient operations from the said computational technology, the computer network is proposed. Network is firstly implemented using multiple (small number) of computers where each computer can receive information from the peer computer in the network. First network is made to enable the computers for sharing the information amongst them and to use the same terminal devices like office printers and fax machine [1] [2].

b. **Communication Channels**

For any network to operate, a path for exchanging data is mandatory so that network terminals can send and receive their payloads. The path used for carrying network traffics is termed as channel. Two types of channel can be recognized in the network context namely: wire channel and wireless channel. Wire channel is subdivided into three categories namely: copper coaxial channel, copper twisted pair channel and optical fibber channel as demonstrated in Figure 1.

Networks can transmit large amount of data in high data rate through the wire channel due to the high bandwidth availability. Broadband networks permit data rate up to one giga byte through wire channel (e.g. twisted pair cable). Optical networks involve holding the network payloads in form of light signals instead of traditional electrical signal. The propagation of data in form of optical signals is ensuring high speed propagation and hence, such networks are delivering data rate up to one tera byte per second. Data is transmitted in speed equal to 3*10^8 m/s (equal to the speed of light). Wireless networks are established to fulfil other facilities that are expected from networks such as mobility and coverage. The advancement of technology witness new generation of mobile handsets where data cannot be compromised, for that reason mobile networks is developed from first generation reaching to fifth generation [3].

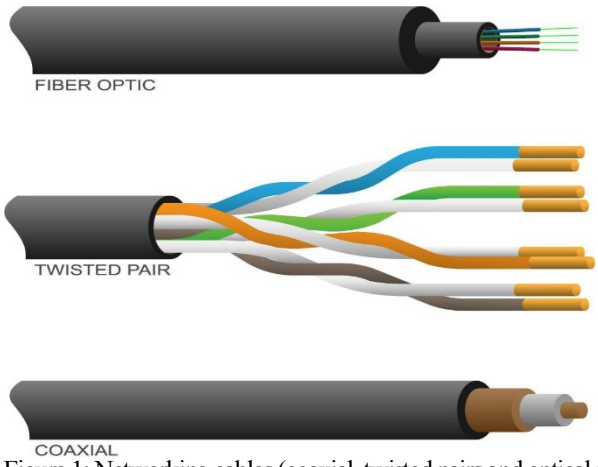

Figure 1: Networking cables (coaxial, twisted pairs and optical fiber).

c. Two-ways Hand Shaking

Data that generated in the source node heading towards its destination node in form of packets where the source node itself will define the destination node identification number as well as the paths that each packet need to use to flee towards that destination. The mechanism of path selection may be identified using the shortest-path-to-go theory where each node need to reveal its location and the status of its queuing process by broadcasting a signaling information. The broadcast of such message is also depending on the type of network infrastructure [4].

In seven-layer-TCP/IP network, each node reveal the traffic and location information to the concern node only using encrypted Hello message where only the concern node may receive this requires and accordingly reply (respond) for it. On the other hand, networks like adhoc networks are merely broadcasting a HELLO message for all the nodes sharing the location and traffic status, the concern node as well as other nodes will be receiving that information. In normal conditions, the concern node only will respond to the HELLO message unless any malicious node was present [5].

Two-ways-hand-shaking is one of the efficient approaches of sharing data between the source node and destination node. Prior to any data transmission, source node will generate a HELLO message and send it to the destination node requesting for new transmission session. Upon the receiving of back response for the HELLO request by the source node, data transmission session will be initiated by the source node [6] [7].

The request back response will be sent from the destination node back to the source node intimating it that destination node is open and available to receive the payload and it may ask for sending the packets. However, source node will be sharing the first packet with specific sequence number to the destination node. Source node will be expecting to receive acknowledgment from the destination node as the packet delivered successfully. Accordingly, source node may await for particular time until receiving the acknowledgment from the destination node [8] [9] [10].

Hence, two scenarios are to be anticipated which are as follow: either the destination node will reply back during the defined waiting time to the destination node with the acknowledgment number of which acts as a confirmation of successful delivery packet and seeking for the next possible packet. On the other hand, acknowledgment may not be generated from the destination node or even it might be delayed (generated after completion the configured waiting time), in this case, source node will consider failed delivery and will retransmit the packet once more. Figure 2 demonstrates the process of two-way hand shaking as described above.

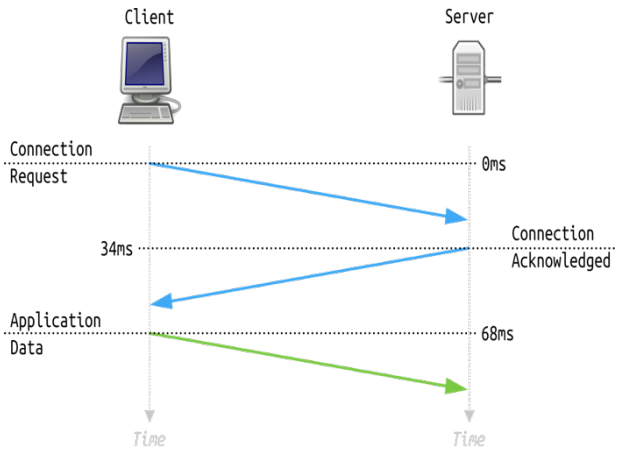

Figure 2: (Two-ways handshaking transmission).

3 SYSTEM OVERVIEW

The K-Nearest Neighborhood and distance equation with specified threshold are used to solve the uncertainty problem and to specify the node that is close to robot location. a mobile vehicle traverses an unknown environment; while doing so, distance meter and compass measure its own movement, and the laser detects external objects or features in this environment, with which all these sensors build nodes in the map. These nodes are concurrently used to get localized in it. The distance meter and compass are used to calculate the robot position in X and Y Cartesian coordinate by increase the meter when the compass mentions to the north or east and decrease the meter when the compass mentions to the south or west.

In this experiment, eight similarity measurement techniques were used for identifying the moving oath of the object namely Jaccard, Euclidean, Cityblock, Chebychev, Cosine, Correlation and Validation. The similarity of path is differing in each mentioned techniques in accordance to the x-axis and y-axis coordination as shown in Table 1.

Table 1: Time consumption by different tools of similarly detection.

Similarity measurement	Execution Time (Second)
Jaccard	0.000414
Euclidean	0.000528
Cityblock	0.000573
Chebychev	0.000361
Cosine	0.000405
Spearman	0.000661
Correlation	0.000234
Variation	0.000376

The mentioned approaches are made the similarity measure and hence the time taken by each technique for evaluation of the similarity of paths is illustrated in Table 1. The same can be illustrated in Figure 3.

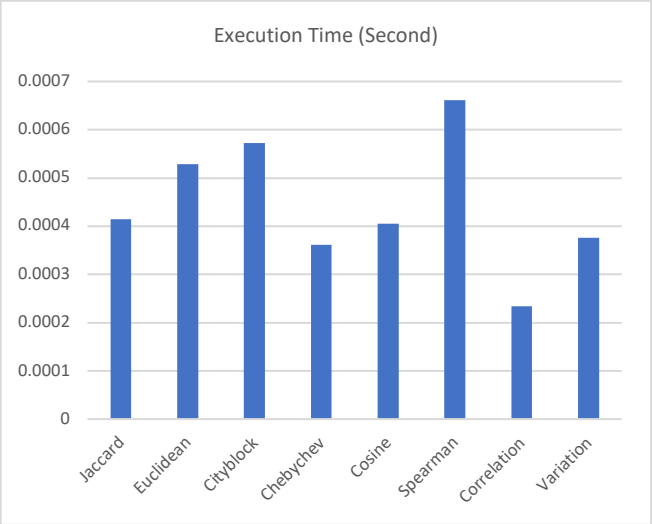

Figure 3: Time consumption by different path similarity detection approaches.

4 CONCLUSION

Path detection for moving objects such as robotics is vital for project success, with the development of machine learning approaches, the process of robotics are become more feasible and more accurate. In this project, path detection of moving objects is being made in order to avoid the collisions of the robots. Simulation of the same was performed in Matlab and this experiment, eight similarity measurement techniques were used for identifying the moving oath of the object namely Jaccard, Euclidean, Cityblock, Chebychev, Cosine, Correlation and Validation. The results shown that total consumption time (which was used as performance metric to judge the used algorithms) is maximum with Spearman method which was equal to 000661 seconds whereas it is far less when Correlation method is used (equal to 000234 second).

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