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# A study of QR code for Identifying Location and Navigation in Mobile Robot

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**Abstract:** This paper investigates the feasibility of an integrated Android device system as an identifying location for navigation control unit of mobile robot. This work can add to the advancement for the field of embedded systems through the development of embedded Android application that show the current capacity of the Android device to execute complex navigation algorithms for the control unit of the mobile robot. In this work, we used a system consisting of a control component made by Android tablet (Samsung N5100) and a mobile robot component. The Android device is the embedded system that read and decode information from QR code, which have been implemented considering known limitations and mobility limits, such as memory capacity and processing speed. For the communication part between Arduino Uno and the Android device using the Bluetooth module (HC-06) as a transfer information device. There are nine stations used for position identification, each station being positioned by the QR code as position information. The mobile robot can start the process with any guided path, after obtaining information from the first QR code, a mobile robot system can know its position and calculation to find the way to reach the destination station.

**Keywords:** Identifying Location; Mobile Robot; QR Code; HC-06; Bluetooth; Navigation

## I. INTRODUCTION

In the field of automation, there are interesting fields that have been a consistent improvement. Automation system has become an essential factor in the production process because of the competition in the field of marketing [1]. The marketing imperative is to plan the delivery of the product and the quantity requested, what must be produced against the clock [2]. The benefits of automation are reducing the time needed to function normally in the form of a tool change, product transfer, and processes that human do not have access to. Handling is an important activity for the production system. As a result, material handling requires an automated handling system to reduce costs, increase production speed, accuracy, and prevent property damage [3]. Automation systems suitable for all manufacturing processes are transport systems and mobile robots. The transportation system includes a huge number of productions and a constant flow of output. For mobile robots, it is more versatile than the automatic transport system. The mobile robot is suitable for handling different types of materials and can be used in a different destination position. The manipulation of the equipment of mobile robots is replaced by human work [4]. There are many types of mobile robots based on utility. The mobile robot follows a wired line that corresponds to the ground that the mobile robot follows with sensors detected for navigation. The installation becomes very heavy in case of dynamic manufacturing is the main problem of the wired mobile robot follower line. The mobile robot follower of the wired line [5] is replaced by the navigation belt [xxx] in which the mobile robot uses the band for the navigation path. This guided path is black or colored, used to follow the path of the band to the mobile robot has been set with apt navigation sensors. The superiority of navigation tapes over wired navigation is that they are removable and replaceable [7].

Currently in the side of the customer company, where the manufactory looking for methods to improve the efficiency of the work process, reduce the costs of human operators in the handling process, and can also be scheduled on time, make use mobile robot can be use the process of simplification work. The advance of the mobile robot can operate without human interference. We have seen that a large mobile robot is growing in the manufacturing sector [8].

As the advances of innovation, many improvements, and developments, likewise the mobile robot has been accomplished on embedded systems. The size of hardware is shriveling but increasing in abilities providing more and increasingly computational power. Android device is the good example for that evolution, one of the major used embedded systems. The android device is a completely able little PC with awesome communication abilities, capable in processing, embedded camera and much more. From both of Android device and mobile robot evolution we can find that Moore's Law is in basis of the embedded systems market, the significant innovations in both fields which rapid developed [9].

In this thesis presented visual based mobile robot localization that used QR codes as positions, which is a flexible production system that can change the route. Method of mobile robot navigation which is constructed

  

using Arduino Uno R3 controller used for controlling and integrate all the components combined with android tablet. Two motor drivers are used for servo motors which are driven for mobile robot. For communication between the microcontroller unit and the Android tablet have selected HC-06 as Bluetooth module. QR-codes can be identified quickly which directions

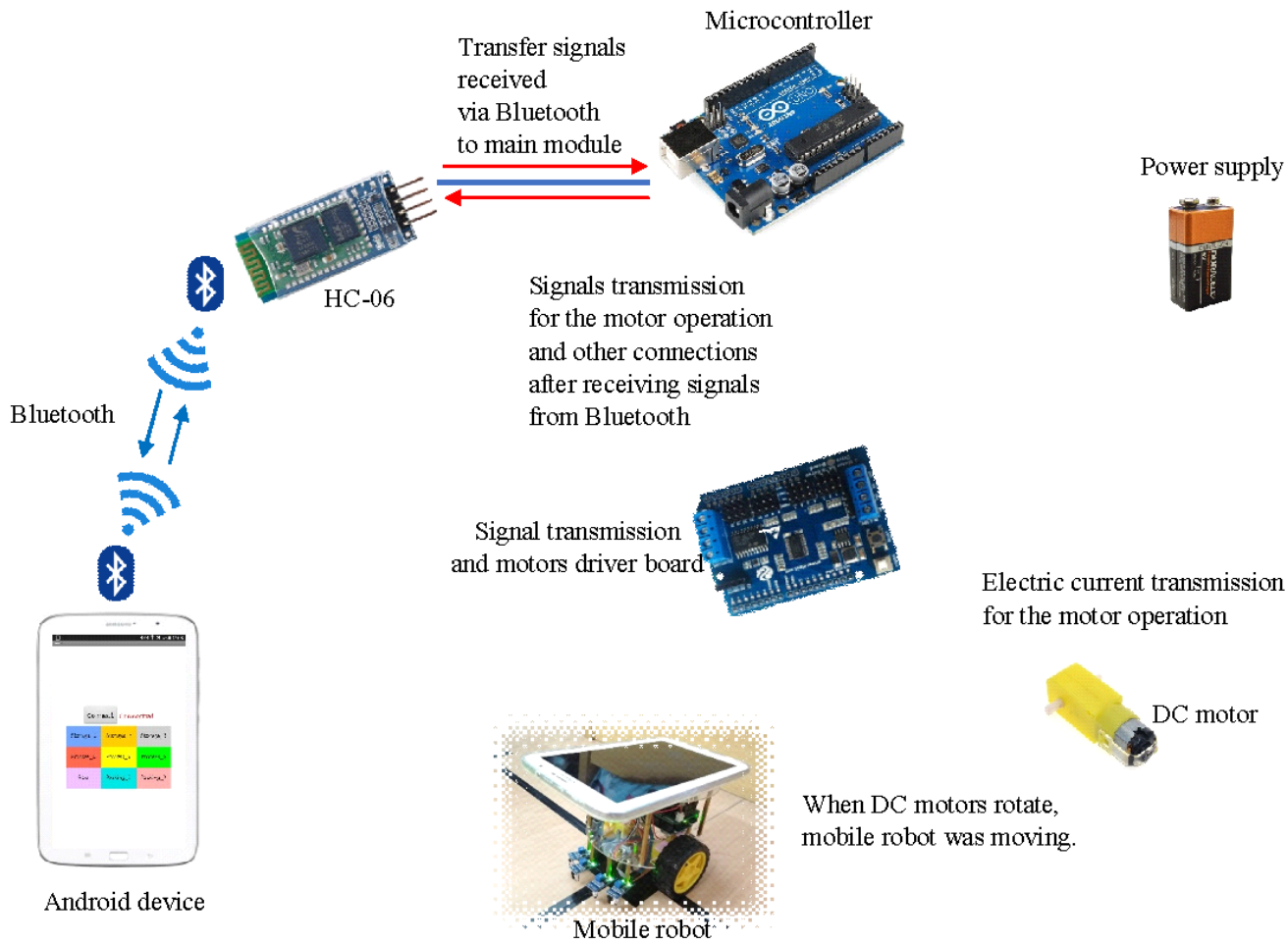


Fig.1 The system architecture of the mobile robot system

from the QR code scanner that available in an Android tablet. They are strategically put on the ground and used as the reference points to identify mobile robot localization. The actual x, y coordinates of each QR code are placed in an information, with their unique information. The utilization of the information capacitates users to manage the large amount of actual coordinate information in special with the unique information of the positions. The coordinates for the mobile robot are calculated by the stored QR code coordinates applied to the pixel position of the QR code by received image, aiming at supporting to the field of embedded systems by analyzing the actuation of Android device when operating mobile robot navigation algorithms.

This thesis proposed the development of QR-code based localization algorithm by an android app in tablet. The utilization of Android tablet for this app to be suitable because it can be combining the great computation power, with multiple external and internal sensors including high resolution camera, and great communication system. Another primary advantage of utilizing Android tablet as the mobile robot control stage is its moderately light weight, low – power using, and little physical measurements that make it reasonable to effortlessly mount on mobile robot moving.

## II. SYSTEM AND EXPERIMENTS

For finding the best performance and making the things to be understood we have developed an algorithm system given below.

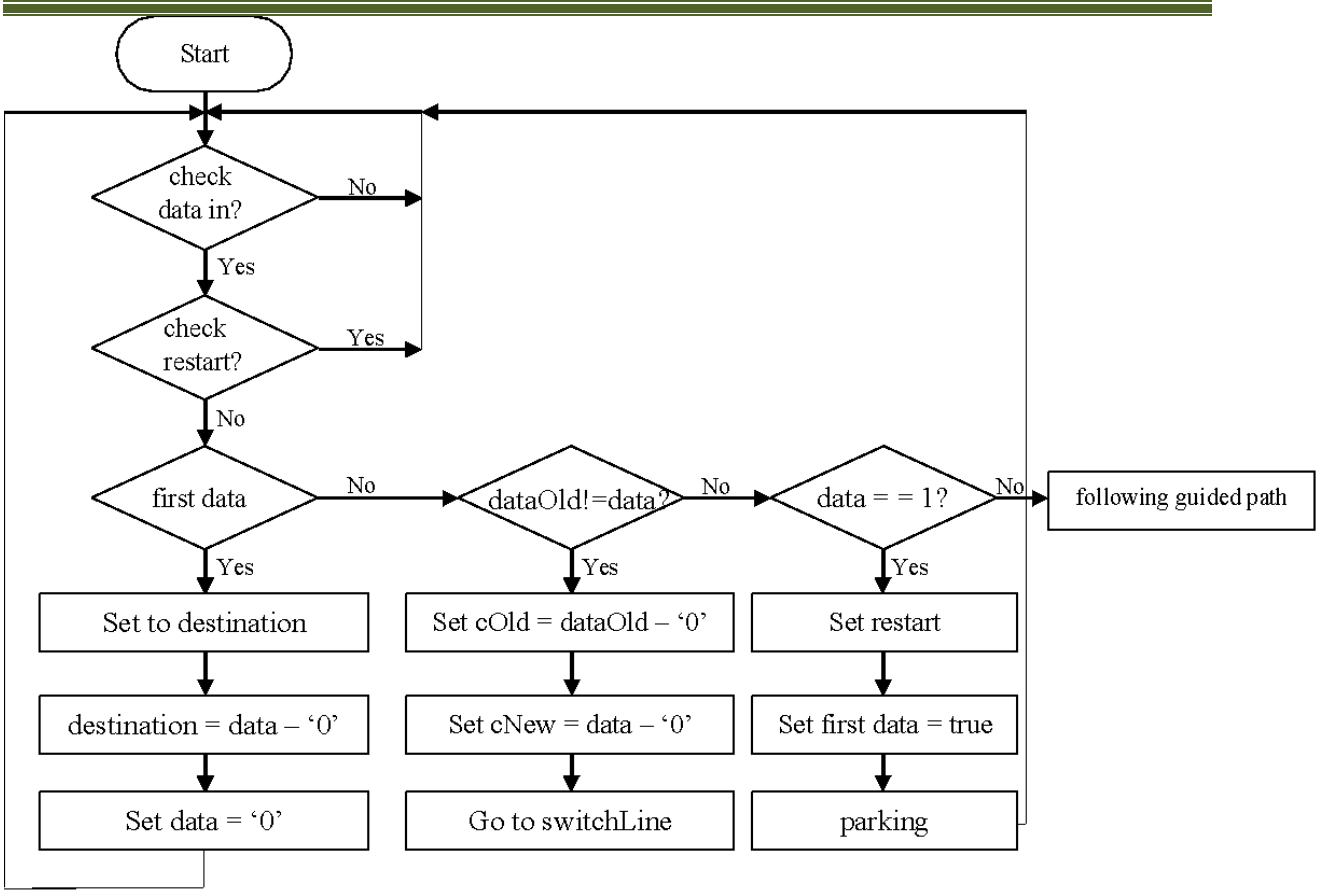


Fig.2 Algorithm of mobile robot

**A. Initiating the functions in idling mode**

This process is done as soon after switched on. In this process mobile robot remain in idling position waiting for constant and variable values to be read and set. In this position the navigating system does not dispatch the mobile robot without command to the destination. It keeps the mobile robot idle on the guided line, ready to get the command on a certain path to a destination. In this system every station's area to the others is known by QR code. Considering, nine stations and possible destinations for each station, there are many paths between the nine existing stations which are known by a coordinate method. All of these paths act like a deliver to the mobile robot giving the priorities of turning (like addressing to a vehicle in a city with many streets). In addition, the position information of each station is stored in a QR code. At the point when all the required data for dispatching is given, the controlling system changes the idle mode to path following mode. Therefore, the mobile robot goes ahead and tracking the line to the reach a QR code for searching the path to go a destination. In the meantime, the navigating system will be checking and controlling movement of mobile robot constantly.

**B. Tracking the black line**

The movement control of a mobile robot is straight forward. This mobile robot has the capacity to detect a black line on the floor depending on the contrast. The mobile robot estimates whether the black line underneath them is shifting to their left side or right side as they drive over. Based on that idea, mobile robot sends the signals to the motors to turn left or turn right to drive a regular center with according to the black line.

This mobile robot for the most part utilizes of IR (infrared) sensors to detect the reflectance of the floor underneath them. The fundamental standard is that the black line has a low reflectance value (black absorbs light) from the lighter surface around it. The low reflectance value is the parameter used to detect the black line by the mobile robot through IR sensors. The higher reflectance value will be the floor around the black line. For the linear array of the IR sensor, if the furthest left or furthest right IR sensor shown the low reflectance value, the black line towards the left or right of the mobile robot continues. The controller remunerates for this by sent the signal for motors control to go in the opposite guidance of the black line.

**C. Station detection and localization using QR code**

Whenever the guided path detected by the second and third IR sensors, it means for the supervisory system that the mobile robot has reached the station. Therefore, The Android tablet performs to read QR code and digit to Arduino via Bluetooth, then calculate by coordinate to reach the way to go the destination station. Figure 3 shows QR code image which using for placed on to the floor to identify the station.


Fig.3 QR code

The QR-code attached on to the floor is divided into several regions in the range from 1 to 9. When the Android tablet detects a QR code, it obtains the coordinates located information of the station which stopping. These are helpful information that allows the mobile robot to infer its own location in the world coordinate system from the pixel coordinates of the QR-code as well as the stored real-world coordinates of the recognized QR-code. Whenever a mobile robot recognizes and decode the information from a QR-code, it stops for a while to decide its real-world coordinates, heading guidance and to find a solution how to get to the next destination station by another QR-code.

When the mobile robot is navigating in a given area, it determines to drive direction followed on its current location and the location and orientation of the next QR-code on its path as determined. After this computation is completed the mobile robot will executes the motion commands to drive towards its next station.

**D. Station detection and localization using QR code**

This is the method for searching path at the outcomes of the QR code scanning and looking for the order of actions that will control the mobile robot to the destination station [30]. It involves founding a path from the current station to the destination station that commanded. There are nine stations for localization as shown in the figure 4.

  

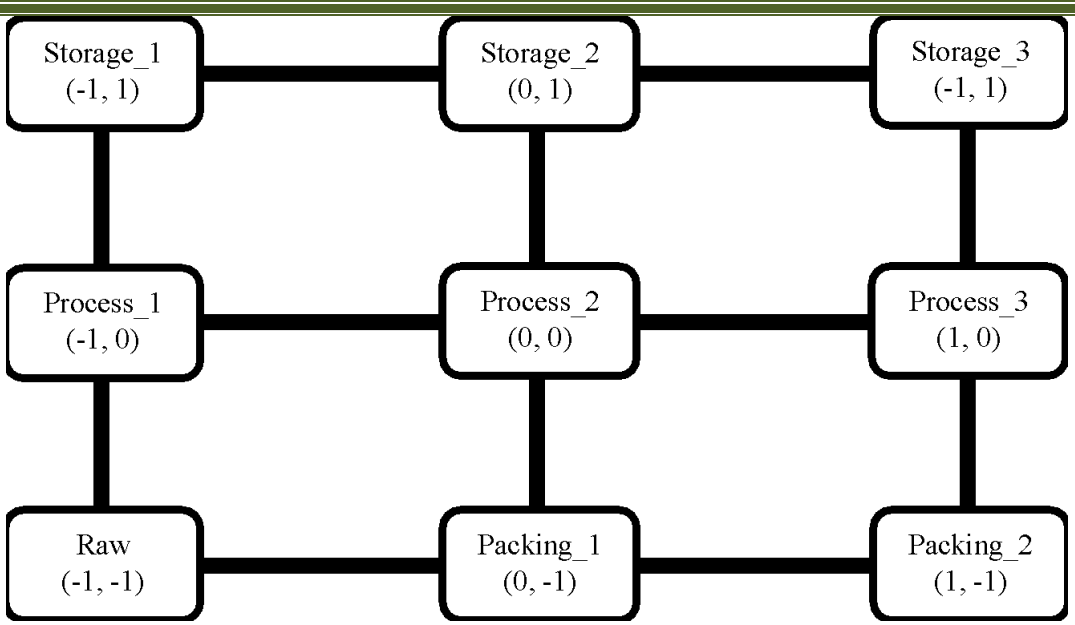


Fig.4 Coordinate determination

**E. Distance calculation**

Each facility target is surveyed from Android tablet and given a unique 'X, Y' coordinate. These coordinates are contained to QR code. To be obtain the station information by QR code and comparing them to reach the destination station, the mobile robot can calculate its position. The mobile robot compares its calculated position to a coordinate map of the destination station and determines it driving navigation.

First, the processing system compares the locations between the current station and the previous station, then compare the locations between the destination stations and current station, use all results to be condition of navigation.

Example of how to make decision for mobile robot navigation, if the system is compared between

(Xn, Yn) – (Xo, Yo) = (-1, 0) and (Xd, Yd)-(Xn, Yn)=(0, >0 ) will command the movement of mobile robot to spin right.

```
If ((xn-xo) == -1 && (yn-yo) == 0 && (xd-xn) == 0 && (yd-yn) > 0)
{
spin_right();
}
```

Xo Previous station in horizontal
Yo Previous station in vertical
Xn Current station in horizontal
Yn Current station in vertical
Xd Destination station in horizontal
Yd Destination station in vertical

*F. Android app and communicating by Bluetooth module*

There are three main parts to start, read QR code and receive command from the user, that is an Android tablet. The system designed 9 stations for the mobile robot as shown in the image 5.

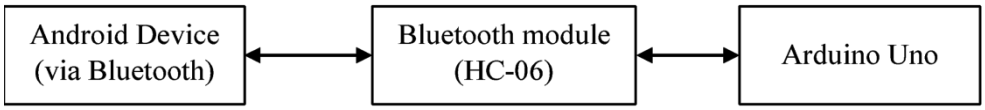


Fig.5 Block diagram of mobile robot communication

HC-06 used for serial communications. The application for Android is designed to send serial information to the Android device by the Bluetooth module when the command is received on the application. The Arduino HC-06 Bluetooth module at the device to receives and sends the information to the Arduino Uno

by the TX pin of the Bluetooth module (the device connected to pin RX of the microcontroller board). The programming code transferred to the microcontroller board, checks the received data and compares them.


Fig.6 Bluetooth connection in Android tablet

Table-1 show the communication code between Android tablet and ArduinoUno R3.

| Android app (byte) | Android to Arduino (char) | Arduino (int) | Meaning |
|---|---|---|---|
| 49 | ‘1’ | 1 | Connect Bluetooth |
| 50 | ‘2’ | 2 | Raw |
| 51 | ‘3’ | 3 | Packing_1 |
| 52 | ‘4’ | 4 | Packing_2 |
| 53 | ‘5’ | 5 | Process_1 |
| 54 | ‘6’ | 6 | Process_2 |
| 55 | ‘7’ | 7 | Process_3 |
| 56 | ‘8’ | 8 | Storage_1 |
| 57 | ‘9’ | 9 | Storage_2 |
| 58 | ‘’’ | 10 | Storage_3 |

Due the communication between Android app and Arduino Uno are not same, makes it necessary for both devices to communicate in the same sense. The detail shown in the table-1.

## III. RESULT AND DISCUSSION

The main purpose of the experimental setup is to define the accuracy of the position identification algorithm. For this experimental setup an indoor environment in a room is used. The experimental navigation path area is clear of any obstacles.

There are nine QR codes are used to define a map of the experimental guided path. The first movement of mobile robot can be started from any location of guided path for scan the first QR-code. When the system detected the first QR code, the mobile robot has to calculate its own location and moving to next station for reach the destination station. The locations totally 9 stations are computed when the mobile robot is on guided path then detected the each QR code.

  

Fig.7 Mobile robot while starting operation

For example, if the mobile robot gets start of the navigation towards the first QR-code, Process_2 (0, 0), but it detects Process _2 for the first time when it gets at fifth point. At the fifth point the QR code recognized algorithm then the data from QR code sent to the mobile robot, and then the movement command is sent from the main controller to control the mobile robot.

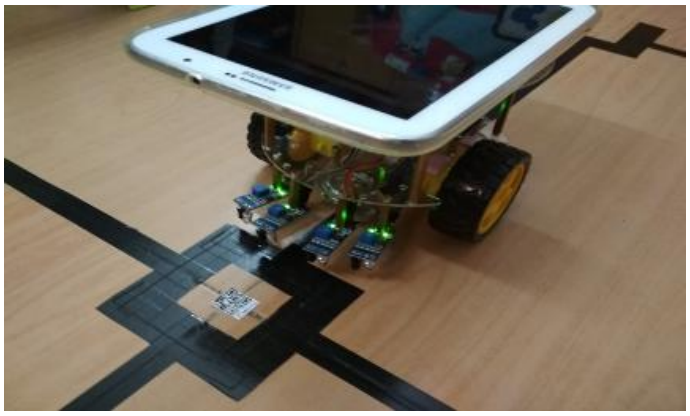

Fig.8 Mobile robot while stopping and reading QR-code

Figure 9 shows the mobile robot detected QR-code and turn to the left.

Fig.9 Mobile robot detected QR-code and turn to the left

  

Figure 10 shows the mobile robot detected QR-code and turn to the right.

Fig.10 Mobile robot detected QR-code and turn to the right

The mobile robot controlling is operated automatically according to the set path. In terms of movement, the black line detected is fast and precise for driving control. In the other hand, the recognize of the QR code from the camera of the Android tablet is not precise, must stop the mobile robot at the station to reading QR code. The camera embedded in the Android tablet cannot read the QR code in a timely.

## IV. CONCLUSION

The navigation of mobile robot is a main area of robotics field. This thesis finds the use the feasibility of the system, composed by an Android device (Samsung N5100) and a mobile robot which communicate via Bluetooth technology. They represent a mobile robotic module that is controlled by the Android device, which guarantees the handling of the navigation algorithms. Communication between two system components by using Bluetooth was an effective method, and reliable method to transfer data between components. This study is to develop and implement the Intelligent control system for mobile robot using coordinate navigation system, which is a flexible groove that can be easily adjusted to the production line. Using Arduino Uno as a controller on the mobile robot, using the Android tablet as the command receiver and QR code reader of intelligent control for mobile robot. The study is begun with the positional coordinate system. The design of the program was then developed by the Arduino IDE for mobile robot with the MIT App Inventor for Android app.

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