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NFC SIGNALS BASED ON AN EFFECTIVE MOBILE ROBOT LOCALIZATION

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Abstract*— A Complete Localization system for an indoor self - ruled vehicle equipped with Near Field Communication (NFC) reader to Interrogate tags located on the environment. Phase Measurement for real time positioning of a single UHF tab, exploiting the fully coherent detection of NFC readers, which gets back to normal baseband phase of the coherently demodulated tag signal. The NFC reader can calculated the phase of the signals coming from responding NFC tags. Non-univocal dependence on the distance robot tag, but in the considered frequency, it is very sensitive to a change in the position of the robot. As the phase angle is very sensitive to the different in some way of the distance between a tag and the moving vehicle, about 1 degree/mm, the theoretical localization accuracy is in the order of a millimeter, whereas the accuracy achieved in the experimental activity is in the order of a centimeter. A significant improvement on the system proposed in is obtained by exploiting the phase of the tag signals. For such reason, a multi hypothesis Kalman filtering using NFC signalling approach provides a really satisfactory performance even in the case that a very small density of tags is used: A multi hypothesis EKF has been proposed to fuse the NFC and the Corresponding information associated with the encoders on the wheels of the vehicle. The motion should avoid singular paths to disambiguate the phase measurements. The shape of the path is, in general, not critical if more than two non-collinear tags are used.

***Index Terms*—NFC, Kalman Filtering, robot.**

1. INTRODUCTION

The world of electronics and through the move from one machine to all the multi-purpose devices, by moving from device to network devices. On the other hand, users do not face the complexities and problems of establishing a network of connections between devices and each other. Hence we can set multiple network functions are handled in the computer world, but not in the world of electronics. , Using the protocol (NFCIP-1), according to which users of electronic devices, which provide the use of secure means of communication between various devices without effort is considerable intellectual in the formation of their own network concept is simple striking: According also to communicate between two devices, and bring them together, using Protocol NFCIP-1 and the wireless network to deal with them in the peer Baland and here is the exchange of configuration data using NFC, and here you cannot continue with the devices, some of the longer and faster than protocols such as Bluetooth or wireless Ethernet (WiFi).

NFC is a very important technique. Among those companies Nokia and some other companies in the market today with the presence of NFC in mobile phones of their own. Will be part of mobile phones in the future. NFC has a lot of applications in everyday life. We will not be need to carry cards, different electronic such as access cards, debit cards / credit cards and identity will be the cards are already in the cell phone, and will use them anywhere we want and will not transfer data easily from any device to another. And also do not need to repeat the keys because we can use only one phone instead of keys. Even more, we can buy and store e-tickets on the cell phone and there is also a set of criteria to determine the work of smart phones and similar devices to be the wireless contact them by touching each other or make them side by side, and not more than the distance of a few centimeters. There is also the current and anticipated applications include data sharing, and simplified setup of more complex communication such as Wi-Fi. Communication is also possible between the device and the NFC chip unpowered NFC, which is named "tag". 2. Theoretical Consideration 2.1 NFC (Near Field Communication) Now become a technology shift from one machine to the network and the devices connected to a single concept from hardware to multiple devices purposes. It is important that consumers do not face complications in the hardware configuration for the establishment of a network, leading to near field communications, will be the NFC is a combination between identity and connectivity through technologies that contactless proximity between information and become easy communication between small electronic devices to be created to urge the magnetic induction when they are touching the devices or become closer to each other with a few centimeters to enable communication between them. Also been established and peer-to-peer network for data exchange. Once you create a communications network to other wireless technologies can be used such as Bluetooth
Wi-Fi to exchange a large amount of data and increasing the range of communications including.

Let's take an example if you have a laptop and cell phone equipped with NFC, then you can easily download data from Internet into your cell phone by simply touching your cell phone with laptop. Like that you may take pictures from your cell phone and if you want to show those pictures to your friends on big screen (TV) then you may just touch your phone with TV and show them. Or if you want to print those pictures then by touching the cell phone with NFC equipped printer will give you the prints of those pictures. This principle works with any kind of devices equipped with NFC to communicate with each other. There is no need to set up the communication link initially. Suppose you want to transfer a file from one laptop to other by using novel technologies, like Bluetooth or Wi-Fi. You need to manually set up the communication link between laptops. But if you are using NFC enabled laptops, then you may transfer the file by just touching both laptops. In another situation you may establish the link using NFC and once communication link is 94 IJCSNS International Journal of Computer Science and Network Security, VOL.12 No.2, February 2012 established Bluetooth or Wi-Fi can be used to transfer data. Advantage of using this

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method is to transfer larger data or continuing the communication session if devices go away after touching each other [1]. NFC enables two way communications between electronic devices. And has the capability to write to the RFID (Radio Frequency Identification) chip. Therefore bidirectional communication between NFC-equipped cell phone and NFC reader can be established. That makes the possibility to develop complex applications like payment, secure exchange of data and identity's authentication [4]. NFC implements touching paradigm. Touching is a famous and interactive method in human lives. This makes NFC technology easy to learn and use. This touching paradigm was initially used in RFID(Radio Frequency Identification) technology. In RFID technology items marked with tags contain transponders which emit messages in the form of signals. RFID readers were used to read those messages. NFC is now integrated with this RFID technology. The tags to be readable by NFC reader should have 4 to 10 byte unique ID. This unique ID is used for the identification of the tag. There are multiple manufacturers in the industry, so ID's length may vary in size [5]. From the technical point of view, NFC is blend of contactless smart card technology and cell phone. NFC equipped devices normally operate in three different modes. Card emulation mode, peer-to-peer mode, and reader-writer mode. In card emulation mode NFC device behaves like a reader e.g. NFC tag. This tag has the capacity to store data securely and the applications of this mode are electronic ticketing and payments. In peer topeer mode two devices equipped with NFC can exchange data directly by touching each other. Applications of P2P mode are transferring data between laptop and cell phone. Printing of data by touching laptop with printer. In reader writer mode NFC device can read or write the tags in similar fashion like RFID tags [6]. NFC can read and write data on RFID chip. And RFID (Radio Frequency Identification) chip can be embedded in everything starting from paper to machinery. RFID is manly used for tracking and identification through radio waves [04]. NFC core applications include connecting electronic devices, Accessing digital contents and making contactless transactions.

2. EXISITING SYSTEM

A novel method for wheel-slippage detection and correction based on motor current measurements. Our proposed method estimates wheel slippage from motor current measurements, and adjusts encoder readings affected by wheel slippage accordingly [1]. A comprehensive model of the complex reflection coefficient of UHF NFC tags during modulation. [3]. The use of stereovision for motion estimation and segmentation is being especially investigated. Improving the reactivity of the system to unforeseen environmental variations. [2]. Apart from a lower computational complexity, this approach has the advantage over traditional grid based methods that in-complete and topological world model information can be utilized. [4] The optimal solution of the nonlinear filtering problem is then obtained as the weighted average of an ensemble of Kalman filters operating in parallel. The Kalman-type correction reduces the risk of ensemble collapse, which enables the filter to efficiently operate with fewer particles than the particle filter. Running an "ensemble of Kalman filters" [5]. While these experiments were performed in an indoor setting, the proposed localization approach is general enough to be widely applicable. [6]. The vehicle has two driving wheels and the angular velocities of the two wheels are independently controlled. When the vehicle is moving towards the target and the sensors detect an obstacle or slopes, an avoiding strategy and velocity control are necessary [7]. Two typical indoor settings are considered, one based on laser range finder readings and the other one on the distances gathered by the robot from a set of artificial landmarks. In the second setting, the sensitivity of the estimation error on the number of landmarks has been numerically investigated. Based on these results, a rule of thumb for the filtering approach and for the deployment of the landmarks in the environment is proposed [8], [10]. The concept is based on an object carrying an NFC reader module, which reads low-cost passive tags installed next to the object path. A positioning system using a Kalman filter is proposed. The inputs of the proposed algorithm are the measurements of the backscattered signal power propagated from nearby NFC tags and a tag-path position database [9]. The received signal strength indicator obtained by the readers from the reference NFC tag, the precise position of the moving vehicle can be obtained. The experiments prove the effectiveness of the proposed method in accurately estimating the vehicle position [10]. On the contrary, the use of a single tag would not allow complete localization under any motion of the robot due to the circular symmetry of the measurements.

3. PROJECT DESCRIPTION

3.1 MODULE DESCRIPTION

Let $s_{r,0}$ be the string of tags observed at the beginning, and let $C_{s_{r,0}}$ be the corresponding cell. For each discretized point $(x_i,y_i) \in C_{s_{r,0}}$, which is characterized by expected phases differing from the measured ones for less than σ_{φ}, introduce n_θ EKF instances, having as initial conditions: $\hat{x}_0^h = x_i$, $\hat{y}_0^h = y_i$ and $\hat{\theta}_0^h = h.{}^{2\pi}/_{n_\theta}$, h = 0, 1, ……. $n_\theta - 1$ (in our simulations and experiments, n_θ = 8). The covariance matrix of all the EKF instances is initialized diagonal with elements ${}^{q_x^2}/_{12}$, ${}^{q_y^2}/_{12}$ and $\frac{(2\pi/n_\theta)^2}{12}$, being q_x and q_y the discretization steps adopted in the *x* and *y* coordinates. Denote with M_p,0 the total number of EKF instances: The initial conditions and the initial covariance matrix of the of the l^{th} EKF instance will be denoted by $\hat{x}_r^l, 0 = (\hat{x}_0^l, \hat{y}_0^l, \hat{\theta}_0^l)$ and P_0^l, respectively. The weights of the EKF instances are initialized uniform, i.e., $w_0^l = 1/M_{p,0}$. Finally, let *t* = 1.

At each time step *t*, for each EKF instance$l$, perform the operations presented here.

where *f* has been defined in (1), T denotes transposition, $F_{x,t-1}^l$ and $F_{u,t-1}^l$ are, respectively, the Jacobians of *f* with respect to the robot pose x_r and to vector $[u_R, u_R]^2$ evaluated at

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$(\hat{x}^l_{r,t-1},\ u^e_{R,t-1},\ u^e_{L,t-1})$. Q_{t-1} is the covariance matrix associated with the noise in the odometry readings: It is diagonal with elements $K_R\left|u^e_{R,t-1}\right|$ and $K_L\left|u^e_{L,t-1}\right|$.

EKF correction: Assume that a string $s_{r,t}$ of tags has been observed at time *t*. Let $\emptyset_t$ be the vector of the phases observed and denote with $\emptyset(\hat{x}^{l,-}_{r,t})$ their expected values (computed according to with $n_\theta = 0$). Then, the estimate after integrating these measurements and its covariance P^l_t are given.

where I_3 is the 3 × 3 identity matrix; H_t is a $\left|s_{r,t}\right| \times 3$ matrix, whose rows are the derivatives of the functions φi given (for each $i \in s_{r,t}$) with

Respect to $\hat{x}^{l,-}_{r,t}$; and $K^l_t = P^{l,-}_t H^T_t (H_t P^{l,-}_t H^T_t + R_\emptyset)^{-1}$ the Kalman gain, the diagonal covariance matrix of the noise in the phase measurements.

If $w^l_t < \gamma$ for all l (where γ is a small number; in our applications, $\gamma = 10^{-13}$), reinitialize the algorithm (i.e., go to the initialization step with the current time step *t* in place of 0).

After computing $w^l_t < \gamma$ for all the $M_{p,t}$ EKF instances, normalize to 1 the sum of w^l_t. If $w^l_t < \beta \cdot \max_j\{w^j_t\}$, where β is a small positive number (in our applications, $\beta = 0.001$), delete the EKF instance l. Let $M_{p,t+1}$ denote the number of surviving EKF instances.

Take as total estimate at time *t* the average of all the EKF instances, i.e., $\hat{x}_{r,t} = \sum_l \omega^l_t\, \hat{x}^l_{r,t}$.

3.2 HARDWARE SETUP

Multipath contributions can be mitigated using high-directive tags. In this case, the read region is bounded near the LOS between the reader's and tag's antennas, and Multipath contributions coming sideways are weakened by the low directivity of the tag's antenna in such directions. In addition, high directive antennas allow radiating low power to detect tags, and this further lowers the multipath contribution. Another improvement has been introduced to weak multipath (in addition to the high directivity antenna). Tags are supplied with circular polarized antennas similar to that of the reader.

This permits to mitigate the first-order multipath (i.e., the first reflected contributions, which are typically the strongest) because, after a reflection, the handedness of polarization is reversed (i.e., a right-hand polarized wave becomes left handed and vice versa). Thus, the reflected wave has a polarization mismatch with the receiving antenna and cannot be received (at least in principle). The tag's antenna has been realized with a stacked annular ring micro strip antenna having right-hand circular polarization. This is a low profile antenna (its thickness is less than 1 cm) well suited to be mounted on the ceiling by means of a square metallic ground plane (see Figs.1 and 2).

A circular annular ring patch antenna is placed above the ground plane (i.e., toward the floor), it is etched on a circuit board together with a feeding network that connects the microchip to the antenna ports. The annular ring has inner and outer radii of 20.8 and 34 mm, respectively; whereas the feeding network is shaped as an equal-split power divider (without isolation resistor) with branches of different lengths to obtain a phase shift of 90◦ at the antenna's ports.

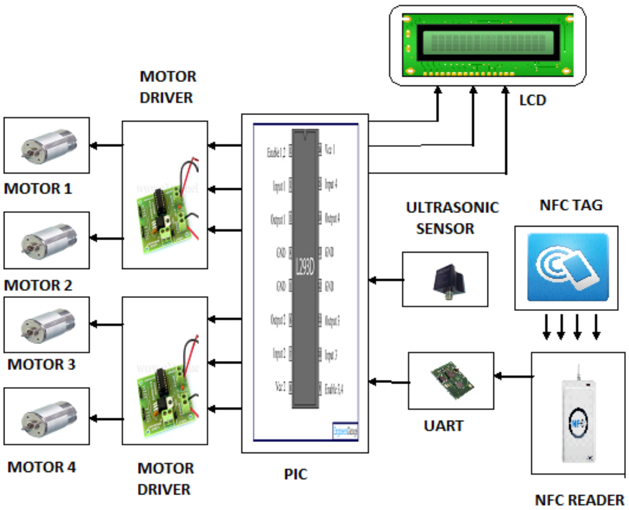

Fig.1 Basic Architecture of NFC Reader

The parasitic patch, which is suspended above the annular ring, improves the impedance matching and the bandwidth of the whole antenna. The material of the whole antenna is FR4 0.8 mm, and the values of the geometrical parameters are chosen so that its impedance is conjugate matched with the input impedance of the microchip, which is 15−j135 Ω at the frequency of 868 MHz. The antenna has been designed with CST Studio, and its simulated gain is about 8 dBi. However, the tags used in the experimental activity may have Different features, being handmade.

3.3 MULTI HYPOTHESIS KF APPROACH

The phase of the NFC signal coming from a tag linearly depends on the tag–reader distance [see (4)]. In this sense. Comparison between the measured and theoretical phases on a line path corresponding to x = 0. The average offset value is used for calibration. Phase of the NFC signal can be considered as a measurement of the tag–reader distance (i.e., of the tag–robot distance).

When the distance from a set of known landmarks is available, an EKF approach is shown (see [19]) to provide excellent results also compared with filters specific for nonlinear and/or non- Gaussian problems like the unscented Kalman filter or the particle filter (PF). However, the phase of NFC signals has periodic dependence on the tag–reader distance [because of the modulus operation in (6)] and can be considered a reliable measurement of this distance only locally, when the correct cycle is known.

If an EKF is initialized in the proximity of the actual robot (i.e., reader) pose, its behavior is indistinguishable from the behavior of an EKF, which directly uses the distances from known landmarks. However, if the EKF is initialized far from the actual robot pose, it is usually characterized by a poor performance. Given that we are dealing with a global localization problem, where the initial robot is how a satisfactory EKF initialization can be guaranteed.

The detection of a string of tags so implies, as mentioned, that the robot is located in a small region (cell), it is enough to initialize a bunch of EKF instances (differing only for the initial conditions) in such a small region. This can be easily done due to the availability of a database (constructed offline adopting a discretization of the environment) that, for each string of tags SR that can be observed, provides the list of the points (xi, yi) that, in the discretized space, form the cell CSR corresponding to sr.

Only the points characterized by phases near the ones actually measured are finally selected as initial conditions for the various EKF instances. Each EKF instance evolves in autonomy and, at each time step, as it happens in a PF, it is assigned an importance factor. The importance factor of each EKF instance is computed by evaluating the likelihood of the string of the tags detected with their phases, with respect to the estimation provided by that EKF instance at that time step.

4. PROJECT DESCRIPTION

In this section, we present experimental results aimed at assessing the overall effectiveness of the I Comp method. In all experiments described in this section, we performed some runs on homogenously sandy terrain, and other runs on nonhomogeneous sandy terrain that had fist-sized rocks embedded in the sand A straight-line path over sandy terrain, which had just one single terrain feature: a sandy mound. For different runs, we changed the height of the mound in fixed increments, in order to assess the effect of the controlled slope on the accuracy of the I Comp method.

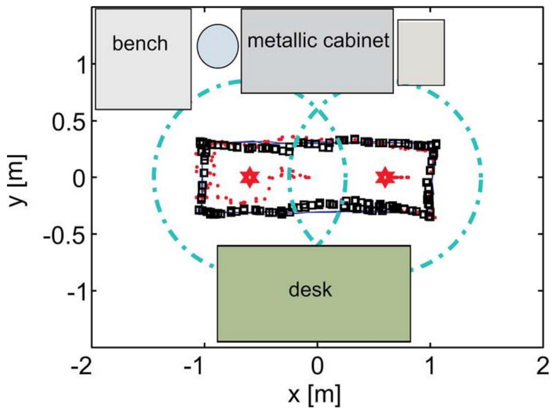

Fig.2 Cell partition in the case of three tags

A closed-loop path inside a large sandbox, in which the robot encountered several mounds of sand, as well as 90, turns in the four corners of the rectangular path, contributed to the overall errors. The effectiveness of the proposed localization setup has been numerically investigated by performing a comparison with the method proposed in considering the same scenario of that paper. In particular, unless otherwise specified: The robot moves in a room of dimensions 4 × 4 m2 with the NFC tags located on a regular grid n × n on the ceiling of the environment (n = 2, 3, 4, 5).

A perturbation on the detection range has been considered for each NFC reading with the perturbed range ˜r = r · |1 + nr|, where r is the nominal radius of the detection area, and nr is a zero-mean Gaussian random variable with standard deviation σr = 0.05.

The robot path has been taken as a random walk of about 88mcovered in 10 000 simulation steps: The robot moves at constant speed on straight lines and stops performing a random turn when the distance from the walls in the direction of motion becomes less than 100 cm. If et := [(xt − ˆxt)2 + (yt − ˆyt)2]1/2 is the distance between the actual robot position [xt, yt] at time t and its estimate [ˆxt, ˆyt], the average position estimation error is defined by J = 1/T _ T t=1 et.The value observed in the experimental tests of the system, The average position estimation error J of the proposed approach (PEKF), which is executed with the initial pose of the robot completely unknown and under different choices of n (characterizing the density of the n × n grid of tags) and r (the radius of the nominal detection area), is reported in Table.I (each value in the table has been obtained as the average of 100 independent simulation runs). Comparing this table with. The first 2000 steps of the simulation with n = 4 and range r = 80 cm

5. CONCLUSION

A complete localization system based on the phase of the signals coming from a group of action less NFC tags gave position of in certain positions on the top of the general condition. A multi hypothesis EKF has been proposed to fuse the NFC and the information associated with the encoders on the wheels of the vehicle. A significant improvement is achieved with respect to other methods available in the literature in terms of accuracy versus tag density; In particular, with respect to those methods, a lower steady-state error is obtained, and the time required to localize the robot is significantly shorter. From simulative and testing tests, it has been made clear that the approach has can be successfully localized robot with precision of about 4 cm even if only two tags are considered: clearly, in this example, the motion should keep from one paths (i.e., lines) to disambiguate the phase measurements. In general, it is fine unless more than two non collinear tags are used.

6. FUTURE ENHANCEMENT

A Complete Localization system based on the phase of the signals coming from the group of action less NFC tags in certain positions which are known on the top of the environment. A multi hypothesis EKF has been proposed to fuse the NFC and the odometry information associated with the encoders on the wheels of the vehicle. A significant improvement is achieved with respect to other methods available in the literature in terms of accuracy versus tag density; In particular, with respect to those methods, a lower steady-state error is obtained, and the time required to localize the robot is significantly shorter. From simulative and testing tests, it has been made clear that the approach has can be successfully localized robot with precision of about 4 cm even if only two tags are considered; clearly, in this example, the motion should keep from one paths (i.e., lines) to disambiguate the phase measurements. In general, it is fine unless more than two non collinear tags are used. On the contrary, the use of a single tag would not allow complete localization under any motion of the robot due to the circular symmetry of the measurements. Future

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research could be devoted to the advanced NFC tag arrangement in relation to the accuracy required in different areas of the environment or the optimal tag arrangement in relation to the accuracy required in different areas of the environment.

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