SIGNAL

lazik-alps

Our ultrasound ranging signals consist of a 50ms up-chirp between 20kHz and 21.5kHz followed by a 50ms period of silence to wait for any reverberations to decay significantly. The silence duration as well as the volume is adjustable based on the room size and is determined during the configuration process. In the following time slot we broadcast an orthogonal 50ms down-chirp between 21.5kHz and 20kHz to further minimize possible interference from reverberation from the previous time slot and to allow the periods of silence between transmission to be kept to a minim

Lazik-indoorPsuedo

Our proposed approach uses a modulation scheme similar to Chirp Spread Spectrum (CSS). A chirp is a linearly frequency modulated pulse that increases or decreases over time between two frequency ranges. Since the mobile device only knows the difference in arrival times with respect to each other and not an absolute point in time, this is called pseudoranging. A similar approach is used by GPS. This implies that the mobile devices do not need to synchronize (or explicitly communicate) with the infrastructure, which makes the approach highly scalable in the number of receivers and better for preserving privacy. Our system is also designed to work with standard speakers and ordinary mobile devices without additional hardware.

The receiver can be any mobile device that is able to record sound inside the 19−24kHz frequency range. The frequency range is limited by the sampling rate of the audio hardware, along with filtering on the microphone’s analog front-end.

After correlating the reflected signal with the original tone waveform, a signal with a broad base similar to that in Figure 3(a) can be seen. The magnitude as well as the breadth of this signal increase proportionally to the length of the pulse, therefore increasing the received signal magnitude, but decreasing its range resolution. Pulse Compression on the other hand employs chirp waveforms that linearly increase (or decrease) in frequency as ranging signals. Now when the received signal is correlated with the original chirp, the width of the intercorrelated signals is smaller than what you would see from a standard sinusoidal pulse. The peak value after filtering is identical, but the chirp appears to be compressed (hence the name Pulse Compression)

[Time-varying multichirp rate modulation for multiple access systems] introduces the use of chirp-rates as a mechanism to assign uniquely modulated chirp signals to users. This approach decomposes each chirp into two interconnected chirps with different frequency rates that change at the halfway point of the symbol. Figure 4 illustrates a scheme that supports four unique symbols across a shared bandwidth. Each rate represents a different signal waveform that is correlated with the received signal to extract the embedded sequences of data. We provide each transmitter with a unique ID, which is encoded as a series of up-chirps, each representing two bits. It is worth noting that [22] was based entirely on simulation. One contribution of this paper is a validation that such rate adaptation can work in practice.

lazik-ultrasonic Time The ultrasonic signals generated by the system must be able to provide accurate ranging information, support multiple access and encode data to identify the transmitter. . Chirps benefit from an effect known as Pulse Compression, which increases the SNR at the receiver by a factor T Δf over a sinusoidal signal at equal transmission power, where T is the signal duration and Δf is the bandwidth. This improves both the range resolution as well as the SNR of the data symbols for better detection.

[Ultrasonic multiple-access ranging system using spread spectrum and mems technology for indoor localization] using gold codes and FHSS/DSSS

[Improving the accuracy of ultrasound-based localisation systems]

The beacons simply sent a constant ultrasound ‘‘tone’’ for a short period of time. The receiver should ideally detect this tone right at its first ‘‘edge’’. In practice, it took the tone decoder several milliseconds to detect the incoming carrier tone. With this setup, the distance measurements had errors in the range of several tens of centimetres for perfectly aligned ultrasound transmitters and receivers. When the ultrasound parts were only slightly misaligned, we had even worse readings (see also [13]). We were able to improve the system by discarding the analogue tone decoder. Instead, we fed the amplified input signal to a comparator circuit. The output is a binary signal that was directly fed into a microcontroller’s capture unit. Tone detection was done in software [14]. We recently became aware that Cricket changed to the same technique [13, 15]. The results were promising for aligned ultrasound transmitters/receivers: all measurements were within ±2 cm of the actual distance. Measurement errors grew with the misalignment of the transceivers. When misaligned by more than 35, the measurements became completely unreliable. Our current approach is to use pulse compression on the ultrasound channel to get accurate distance measurements These are modulated using binary phase shift keying (BPSK). BPSK matches the computational abilities of our beacons and achieves a good coding efficiency of 1 baud Hz–1 of bandwidth. For our ultrasound transducers, this yields a maximum data rate of about 2,000 chips per second (as we have a usable bandwidth of about 2 kHz). The PN sequences must have the characteristic to provide a good autocorrelation function to get a sharp peak. Barker codes are a class of well-known codes that possess the required correlation properties (see Fig. 4). The disadvantage of Barker codes is the limited maximum code length of 13 chips. we briefly discussed the problem of improving the position update rate by coordinating beacons and by using orthogonal sequences that allow the ultrasound signals to be sent completely concurrently. The second method turned out to be feasible only with a high computational overhead and also, because the length of the sequences, the benefits are questionable.

[Indoor Global Localisation in Anchorbased Systems using Audio Signals]

In the approach presented in this paper, in which information concerning the anchor’s position travels through the channel embedded in the signal, successful data transmission is critical. Even if the MDP with respect to the anchors is precisely determined, if the anchor positions are wrong due to bad reception this will result in bad positioning, localisation estimation can be the wrong indoor infrastructure. Therefore, the data transmission problem must be assumed as one of the most important parts of this global localisation system. Therefore redundancy, error detection/correction and filtering techniques are employed to avoid significant errors. The Golay codeword has useful properties regarding its use in data transmission: . Cyclic Invariance. A 23-bit Golay codeword may be cyclically shifted by any number of bits and the result is also a valid Golay codeword; . Inversion. An inverted 23-bit Golay codeword is also a valid Golay codeword; . Minimum Hamming Distance. The Hamming distance between any two Golay [24,12] codewords is always eight or more bits; . Error Correction. The correction mechanism of Golay decoding can detect and correct up to three bit errors per codeword.

[An Efficient Zadoff-Chu Based Communication System]

A Zadoff–Chu (ZC) sequence, also referred to as Chu sequence or Frank–Zadoff–Chu (FCZ) sequence, is a complex-valued mathematical sequence which, when applied to radio signals, gives rise to an electromagnetic signal of constant amplitude, whereby cyclically shifted versions of the sequence imposed on a signal result in zero correlation with one another at the receiver. A generated Zadoff–Chu sequence that has not been shifted is known as a "root sequence". ZC sequences exhibits the property that cyclically shifted versions of itself are orthogonal to one another if each cyclic shift is greater than the combined propagation delay and multi-path delay-spread of that signal between the transmitter and receiver, in the time domain. ZC sequences are used in the 3GPP LTE [3] air interface in the Primary Synchronization Signal, random access preamble, uplink control channel, uplink traffic channel and sounding reference signals . The spectrum of the ZC sequence is shownn Fig.3. Fig.3. Spectrum of the ZC sequence Two modifications are required for using this spectrum as pilot. One is a spectrum that is constant in the centre is needed. For this the spectrum is shifted by letting the carriers having amplitude near zero be on the side lobes as shown in Fig. 4. Fig.4. Spectrum of the ZC sequence with FFT shift. The second modification is to create three cells equal to zero (to carry data) for every cell used by the pilot and spreading the overall spectrum over an 8k symbol. For this the time domain sequence obtained from the IFFT of the previous spectrum (Fig. 2.) is repeated four times

[Generalized Cross-Correlation Properties of Chu Sequences]

In this paper, we investigated detailed cross-correlation properties for Chu sequences and obtained that i) the possible values of the magnitude of the cross-correlation function depends only on the GCD between and , ii) the maximum magnitude distribution function among a given Chu sequence set in a closed form as in Theorem 3, which shows that the maximum magnitude distribution tends to spread out as the number of divisors increases, and iii) the upper and lower bounds on the maximum number of available Chu sequences satisfying a given cross-correlation constraint and the corresponding partial Chu sequence set construction algorithm. Numerical examples show that the proposed bounds are quite tight and the proposed construction algorithm is near-optimal up to fairly large value of .

RANGE

Range measurements: The measurements aim to find the differences of the TOA of the signals from the transmitter to the three receivers whose locations are known. Each range difference determines a hyperbola, and the intersection point of the two hyperbolas is the estimated location of the querying node. For each receiver, the relative TOA is determined by applying correlation between the received signal and the template signal.

[An Ultrasonic Multiple-Access Ranging Core Based on Frequency Shift Keying Towards Indoor Localization]

Distance estimation requires time synchronization, a correlator peak detector and a timer module. Time synchronization enables the devices to have a common time reference between transmitter and receiver, which is used to estimate the time of travel of an ultrasonic signal. In our implementation, we choose to synchronize the devices by means of wires. The transmitter pulls the wire to a logic “1” while sending and to “0” when idle. The receiver synchronizes itself against the transition from “0” to “1”, and the correlator calculates the signal equality against a given orthogonal code. When the signal shows a strong correlation with the code, a correlation peak occurs. The time difference between the time synchronization and the correlation peak is proportional to the distance between transmitter and receiver. In order to keep track of this time difference, a module keeps track of the highest correlation peak time.

[CSI-Based Indoor Localization]

RSSI-based schemes have been widely used to provide location-aware services in WLAN. However, in this paper, we observe that RSSI is roughly measured and easily affected by the multipath effect which is unreliable. We then use the finegrained information, that is, CSI, which explores the frequency diversity characteristic in OFDM systems to build the indoor localization system FILA. In FILA, we process the CSI of multiple subcarriers in a single packet as effective CSI value CSIeff , and develop a refined indoor radio propagation model to represent the relationship between CSIeff and distance. Based on the CSIeff , we then design a new fingerprinting method that leverages the frequency diversity

[Improving the accuracy of ultrasound-based localisation systems]

Distance is measured using the difference in time-offlight of RF signals and ultrasound signals. The time difference for travelling a distance d between the ultrasound signal and the radio signal is t ¼ tus trf ¼ d vultrasound d vradio : For a distance d of 10 m, the radio signal needs about trf 30 ns. The ultrasound signal, however, will need about tuf 30 ms. As trf << tus, trf can safely be omitted from the above term. Unfortunately, the speed of sound is not constant. Indoors it varies mainly with temperature.

The beacons simply sent a constant ultrasound ‘‘tone’’ for a short period of time. The receiver should ideally detect this tone right at its first ‘‘edge’’. In practice, it took the tone decoder several milliseconds to detect the incoming carrier tone. With this setup, the distance measurements had errors in the range of several tens of centimetres for perfectly aligned ultrasound transmitters and receivers. When the ultrasound parts were only slightly misaligned, we had even worse readings (see also [13]). We were able to improve the system by discarding the analogue tone decoder. Instead, we fed the amplified input signal to a comparator circuit. The output is a binary signal that was directly fed into a microcontroller’s capture unit. Tone detection was done in software [14]. We recently became aware that Cricket changed to the same technique [13, 15]. The results were promising for aligned ultrasound transmitters/receivers: all measurements were within ±2 cm of the actual distance. Measurement errors grew with the misalignment of the transceivers. When misaligned by more than 35, the measurements became completely unreliable. Our current approach is to use pulse compression on the ultrasound channel to get accurate distance measurements

[Improving the accuracy of ultrasound-based localisation systems]

Using a sampling rate of 160 kHz, a theoretical bestcase resolution of about 2 mm could be expected. However as the signal is phase coded, the resolution cannot be less than the wavelength of the ultrasound signal, which is about 8.6 mm. To achieve this accuracy in practice, very long PN sequences are needed, which would affect memory and CPU needs as well as the position update rate. The chip rate of the signal gives an absolute worst-case resolution (upper bound) of 20 cm. Multiple measurements may be obtained from various anchors and subsequently combined in an optimal or suboptimal way to obtain an estimate of the position of the mobile device. This process of obtaining a position estimate from multiple observations is usually referred to as multilateration. Whenever the number of observations reduces to three, then the process is referred to as trilateration, or triangulation, which corresponds to classical geometric concepts.

[Indoor Localisation Using a Context-Aware Dynamic]

We presented a context-aware tracking system that tracked users in an indoor environment. The context-aware system used a wireless smart metering network that consisted of power meter nodes placed throughout a building. A user carried a mobile node that tracked their current position. A smartphone could be used to view the mobile nodes current position, via a cellular or wireless LAN connection. The context-aware tracking system localised a person’s position by combining wireless trilateration, a dynamic position tracking model, and a probability density map. The integral use of these three factors allowed the context-aware tracking system to achieve reasonable localisation accuracy with a sparsely and irregularly dispersed wireless network.

[Profiling-Based Indoor Localization Schemes]

based on a given set of RSS readings Φ, this map is explored to search for a set of Knearest neighbors (KNN) of Φ in terms of minimizing the RSS distance.

RECEIVER

[Improving the accuracy of ultrasound-based localisation systems]

We use a modified BPSK demodulator (see Fig. 5) to limit the demand for computational power. First, the received signal is transformed from a pass band signal to a base band signal by the quadrature mixer. The signal is split into an in-phase and a quadrature component. Before a data reduction stage, the signals are low-pass filtered. The resulting signals are correlated with the stored Barker code using the schema in Fig. 6. These modifications to the BPSK demodulator reduce the computational requirements to about 10 MIPS. Of course, these modifications degrade accuracy. The overall accuracy we experienced is well within our requirements (see Sect. 4.2). The resulting signal of the receiver is an envelope, showing how good the received signal matches the stored signal. The best match and thus the time of arrival of the signal can be easily determined by a search for the global maximum. . This problem shows that a search for the global maximum cannot be used in practice. We are working on a heuristic method to find the first peak in the envelope. Subsequently, sending a 13-chip Barker code and waiting several milliseconds for it to fade away yields an update rate that is comparable to the method of simultaneously sending long codes. The increased effort in decoding simultaneously sent ultrasound signals does not achieve enough improvement to justify itself.

DFT[dftandsinusoids]

SYNC

The MIT cricket [The cricket location-support system.] localization system uses the difference between RF and ultrasonic signals. The system is capable of extremely accurate range measurements, but requires line-of-sight communication, careful node positioning and high node density. It also requires tight synchronization between the infrastructure and the mobile devices. since the ultrasonic signal is a pulse, the systems are allowed to have only one active ultrasonic transmitter at a given timeslot. This principle is also known as time division multiple access (TDMA)

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Ultrasonic Beacon Firmware: Each Ultrasonic Beacon

synchronizes with the Network Master over a single hop using its 802.15.4 radio. Once the beacon is synchronized, it plays back the ultrasonic signal stored in its flash memory at the beginning of its designated TDMA slot.

[Analysis of the Frequency Offset Effect on Zadoff-Chu Sequence Timing Performance]

Signals providing good timing estimation must possess a good autocorrelation property [1]. Wireless communication systems almost unexceptionally employ sequences that have good autocorrelation properties to fulfill such a goal. A ZC sequence is well known for its perfect autocorrelation properties. As a result, ZC sequences have found their wide applications in modern cellular systems as synchronization sequences, such as the LTE Primary Synchronization Signal (PSS) and the Random Access Channel (RACH) signal. However, the perfect time autocorrelation is in general not true in practical applications when a frequency synchronization error is present between the transmitter and the receiver. That is, the perfect autocorrelation property is lost under non-zero frequency offset, consequently degrading the timing performance of a ZC sequence. The severity of the degradation depends on both the root parameter of a ZC sequence and the time uncertainty

[Coarse Time Synchronization Utilizing Symmetric Properties of Zadoff-Chu Sequences]