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A Review on Today's Cognitive Radar Technology

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Abstract: **In this survey paper we have discussed about the new blooming technology which is Cognitive Radar. It has various advantages over our classical radar as it mimics our human brain and is adaptive to our environment. We have seen the basic structure and the components along with the working of this Cognitive Radar Systems.**

Keywords: **Cognitive Radar, Cognitive System, Principle Components, New Algorithms, Cognitive Radar Networks.**

1. INTRODUCTION

A growing area, cognitive science focuses on the idea of cognition from a variety of angles, including those of artificial intelligence, psychology, neurology, and many more. It is emerged from the human psychology which has its aim in examining a person's mental health and different processes.Is the definition of cognition stated by the National Institute of Mental Health (NIMH)National Institute of Health (NIH) [1-2]. In other words, cognition can be said to be the ability of a conscious mind that is aware of the environment. It includes tasks like thinking, reasoning, judging and problem solving [3-5]. Isn't this what makes humans intelligent than all other species. We do not understand its importance as we are unknowingly using it in every aspect of our day-to-day life [6-10]. So, this incorporated in Machines too for making our tasks easier [11-13]. New innovative ideas are implemented in engineering systems for making this successful. This is present in our industry since many years and has proven beneficial in fields of signal processing [14-16], telecommunication, control, radar systems and domestic applications like traffic control too [17-19]. This increases the performances of the systems by decreasing the time taken and helps us focus on the systems where human interactions are needed [20-21].Though the idea of cognitive systems is not yet developed, there are a lot of unanswered questions that includeproblems likepractical implementations in engineering and how beneficial they can be to us [21-23]. For the last fifteen years, cognitive principle has gotten a lot of attention and has become more significant in disciplines including signal processing, communications, and control. Some of the presumed factors are that the application of this radars can motivate us to build new integrative discipline, focused radar, control systems interlinked to humans and cognitive dynamic system [24-27]. It is cognitive when a dynamic system can perform all of the human cognition characteristics, such as acting based on the information we get, storing memory, paying attention to all the details and being smart [28-29]. Because of the cognitive function, cognitive dynamic systems often detect the environment intelligently and responds to it adaptively [30-34].

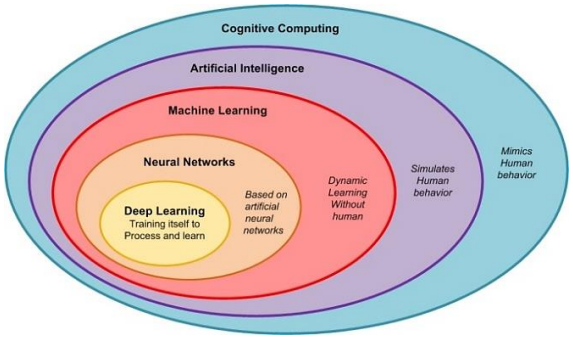

Fig. 1 Overview of cognitive technology

2. COGNITIVE RADAR

Cognitive Radar is defined as a smart conscientious system that takes the information from the world around it, includes the past as well as current interactions and then uses this information to achieve certain remote sensing goals in an effective and smart way [35-37].Fig. 1 shows the place of cognitive systems in artificial intelligence. Cognitive Radar adapts itself to the features humans, which are valuable to survival despite the significant physiological expense and concessions necessary to have them [38-40]. The fundamental operation may be described in very simple terms as continually detecting the environment, scanning the surrounds, and processing it to provide us with findings [41-43]. When comparing cognitive radar to conventional radar, we do not have previous knowledge of the target that we must detect [44-48]. Having prior experience offers us an advantage in surveillances [49-51].

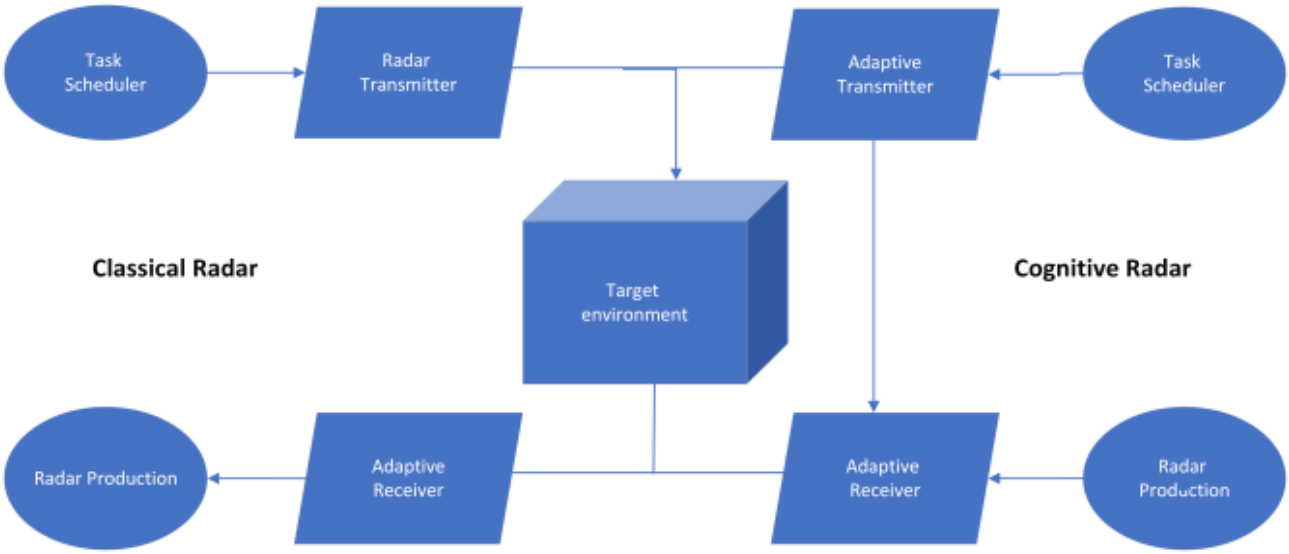

Fig. 2 Block Diagram of Cognitive and Classic radar system

Fig. 2 depicts the fundamental structures of Classical radar and Cognitive radar. There two main types found in our research which are Decision Theoretic approach and Feedback process. A decision-theoretic Approach is used by radars since long ago so that many knowledge-based system used for the application like trackers, target identification and classification system, surveillance of radar and intelligent system for working and flow were investigated [52-55]. The knowledge-based system uses both past and present information. As a result, a radar system might draw inferences not just from the past knowledge on which issue solution is based, but also from the algorithms themselves [56-59]. Finally, the system enhances its efficiency by utilizing a knowledge database from the past. Scientists and engineers have been researching learning algorithms for digital computers since a long time ago [60-62]. Thus, machine may be put in several situations and then measured for adaptability at any time interval [63-67].If the techniques are shows good results with time, then we say that machine learning can train itself without worrying about the process Learning.

3. PRINCIPLE COMPONENTS

Some of the technologies that are required to assist the other components of cognitive radar systems are Digital Hardware with memory[68-72], signal processing algorithms for processing the inputs that we get from our environment. [73-77]. And lastly the reconfigurable analogue hardware like receiver & transmitter [78-79].

Fig. 2 depicts a generalized cognitive radar framework that includes the principle & supporting components [80-85]. The important point to take into consideration is that the information is gained by transmitters, receivers and environmental sensors [86-90].

1. Sensors for the environment: Sensors help in providing the detailed information so that the working is improved. These are not used for target identification. But the receivers and transmitters are the hardware used for target detection [91-94]. The reconfigurable hardware allows for transmission and receiving of flexible waveforms and architecture required forthese radars [95-99].

2. Computer Hardware: Some examples of analogue or digital architecture are mixers, filters, ADC, DAC, amplifiers, etc. Furthermore, a classic radar system often has an analogue hardware fixed design [100-103]. This reduces usefulness and limits the waveform's versatility [104-106]. Cognitive radar is said to be reconfigurable because we can it can use alternative components too.

3. The multifunction radar:To work efficiently with its targets in the surroundings this type of radar is used. And this uses a single function at a single time [107-111]. Each radar employs different processing algorithms to get the extract target & cluster information which is shown in Fig. 3 [112-113]. Then this data of the target is sent to do the decision making [114-116].

4. The decision process: The decision process consistsof many functions for which needs digital hardware with memory for signal processing [117-120]. It also makes use of decision theoretic and feedback learning algorithms to handle prior and current target information through different radar functions such as the knowledge database and memory [121-124]. The moving target indication radar function makes use of location and velocity information. The characteristics are then sent to the decision process for target evaluation [125-129].

Cognitive Radar Networks to maximize radar performance in various situations faced by existing operating systems while avoiding interference [130-133]. As a result, a cognitive radar network may be optimized by fully using the existing radar resources, such as exchanging information across network components and taking into consideration past environments and experience into consideration [134-139].

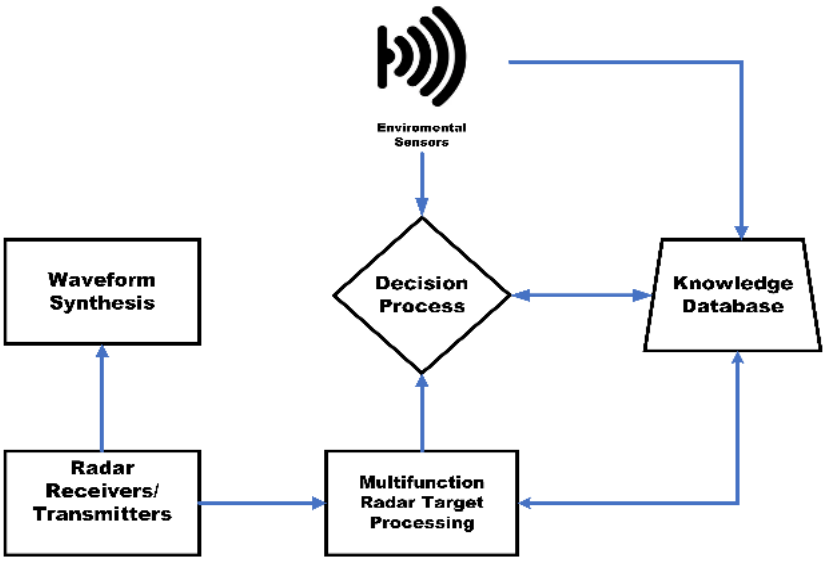

Fig. 3 Basic working of Cognitive Radar

4. NEW COGNITIVE ALGORITHMS

The adaptive transmitter is the main and important differentiator between cognitive radar and conventional radar. The fast degree of freedom algorithm is responsible for the best waveform design, while the spatial freedom algorithm is responsible for the ideal beam design, in accordance with the transmitter's degree of freedom from a detection aspect, the accuracy of radar detection is closely associated with the radar receiver's output signal to noise ratio [140-143]. Conventional radar assumes that the target is a point target and that the noise is Gauss white noise. The output signal to noise ratio of the matching filter has no relation with the emitted waveforms, it only concerns the energy of the transmitted waveforms [144-146]. Signal Output to noise ratio is maximized by adjusting its parameters such as transmission bandwidth and others and broadcasting the waveform that corresponds to the desired response. [147-150]. Target tracking capability and accuracy may be improved by adaptively altering parameters of the input waveform in response to Receiver input.

Cognitive beam optimization is a traditional processing that suffers greatly due to the receiving section's limited degree of freedom in a complex electromagnetic environment with a larger source of interference. The risk of reconnaissance is decreased, and the number of interference sources is proportionally decreased if the zero point is used by the free degree of the transmitter of the emission pattern [151],[152].

5. CONCLUSION

With the help of the knowledge of subject-matter experts, terms like Cognitive Radar, Cognitive System, Technologies Required for Cognitive Radar, and new algorithms were discussed in this paper. To put it all together, this work combines all the fundamental ideas required to comprehend how to use a cognitive radar.

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