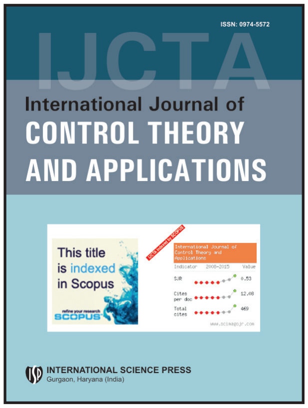

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Development of Assistive Agriculture Model Based on Cognive Models in Artificial Intelligence

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Abstract: This research is closely associated in finding solutions and methods for developing a Cognitive architectures for the intelligent robot in field of agriculture. Intelligent Robots that is capable of doing or assisting the farmer under any seasonal and climatically worst condition. The aim of the research is to develop a robot that can work like a labourer, and replace the human labour wherever and whenever required. The root cause of the idea is the picture of the labourers working in an agriculture land in the very hot sun, labourers working hard in laying the tar for the road, labourers working hard to rescue the survivors during some disaster, natural calamity, and labourers working without any safety equipment's in some hazardous chemical industry. The proposed agricultural robot using, remote-controlled power tiller, one need not get on the field, let alone walk with the tiller for hours on end to control its direction. Physical damage to the operator's knees and shoulders can be avoided. Even an unskilled person can use the power tiller with the touch of a button, besides saving the time and money required for skilled labour. The technology has enabled even women can plough fields.

Keywords: Agriculture, Artificial intelligence, human cognition, robotics.

1. INTRODUCTION

Agriculture and Industry are the backbone of the Indian economy and more than 60 % people work in the agricultural land day and night irrespective of season and climate. India is also a developing country where we can find a large population working below poverty line. So as to meet their ends every day they involve in some or the other hazardous labor work. This project was aimed at developing an intelligent Robot that could be capable of doing all the work of a labor under any seasonal and climatically worst conditional over the world construction workers are exposed to a number of hazards at work and due to work. The hazards can be

1. Physical hazards and injuries because of noise and vibration, extreme cold and heat, working in windy, rainy or foggy Conditions, exposure to ultra violet radiation and electric welding.
2. Chemical hazards such as dusts, fume, mists and gases.

3. Ergonomic issues and degenerative issues
4. Biological hazards
5. Psycho-social hazards

So there is a need to overcome the above mentioned few of the issues and the Labor Robots can be an alternative and of course a solution for the above said issues. It is not that we are changing the entire labor sector and providing an irreversible alternative. It is just an alternative which can be applied whenever and wherever required. In this context, this project was taken up to overcome hazardous labour work. Robotics is defined as a creation of intelligent mechanical devices which can cope with the complexities of the real world. (Brooks, 1986). Today's robots are systems which have high degree of complexity. The complexity depends on their function, components used, computer hardware and software designed (Dillmann, 2004).Test beds and benchmarks are mainly using in the field of robotics for comparing an architectures and outcomes. Robotics is one of the important areas of cognitive sciences. For example EM-ONE (Singh, 2005) architecture, in the cognitive architectures is also classic example for robotics. This research does not differentiate biological (human and non-human minds) or machine mind.

2. COGNIVE ARCHITECTURES AND ROBOTICS

Adaptive Control of Thought Rational (ACT-R)

ACT-R stands for Adaptive Control of Thought Rational, or alternatively Atomic Components of Thought – Rational [1, 12, 14]. ACT-R is a combined product of Anderson (1996), and Bower's existing model of declarative memory [2]. The ACT-R theory was formulated in 1983 by Anderson's "The Architecture of Cognition".

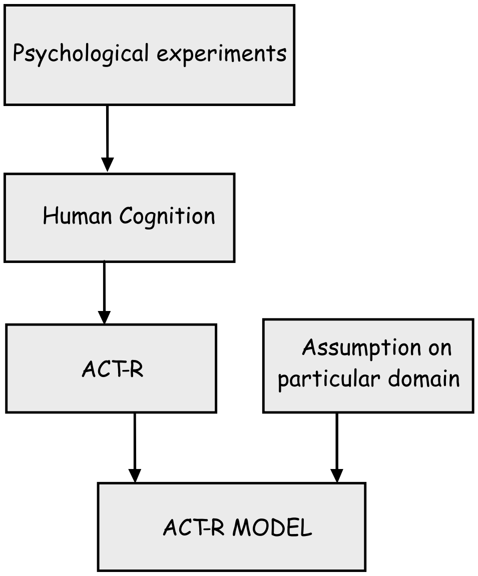

Figure 1: ACT- R Structure

Researchers working on ACT-R strive to understand how people organize knowledge, represent and produce intelligent behaviour in Figure 1 this is called as Human-Computer Interface (HCI). The embodiment of human cognition factors is modelled for Human-Computer Interface. HCI includes the human behaviour, and the hidden states behind the result. HCI combines the advanced work with perceptual recognition, machine learning, affective computing, computational modelling, etc. Many researchers in the area of HCI are working on cognitive architectures. For example, ACT-R and SOAR are the cognitive architectures which are used to implement more dynamic and complex HCI problems. HCI is not just concerned with ‘ed’ designing regular interfaces. Some applications require interfaces which give a virtual human feel on interacting with those machines. This implies that interfaces must exhibit the intelligence, which is built into the applications. For example, an pilot abilities could not be tested using a real aircraft. To test his abilities, he cannot use a real aircraft. The poor performance will result into fatal accidents and it is also very expensive to use a real aircraft. In this scenario, the pilot is trained with a simulated application. The designed interface gives a feel of real world environment. Here the interface works like an experienced pilot, and it generates situations through simulations where the pilot has to make decisions [3,14]. ACT-R has a complex cognition structure. A fundamental characteristic of ACT-R is that uses a production system theory. Production system theory uses a production rules for representing human knowledge. The basic premise of ACT-R is a cognitive task. The cognitive tasks are achieved by combining production rules and applying these rules on memory. There are two different categories of long-term memories: (1) procedural and (2) declarative memory. The procedural memory are stored with human mind. For example, the knowledge of swimming, “$2 \times 3 = 6$”, drive a car, speak English, etc. The declarative knowledge is represented in the ACT-R units called chunks. The chunk encodes the information. Each chunk consists of several slots or variables.

The ACT-R designers suggested that average slot should consist of three to four slots, and one must have an ISA slot. Miller’s “magic number” argues that chunk should not have more than seven slots. It can be plus or minus two slots [5]. Chunks have primarily two sources: (1) perceived objects in the environment; and (2) recorded solutions for the previously solved problems. The production rules specify when and how to retrieve the chunks to solve a problems. The ISA value of chunk plays an important role, such as matching the conditions in the production. The new production rules must be generated from chunks in memory called production compilation processes. The chunks are represented as follows [Chunk-Name: ISA Chunk type; slot1-label slot1-value; etc.].

ACT-R is applied on wide range of human cognitive tasks including knowledge compilation, problem solving, education, controlling of perceptions, etc. ACT-R allows much simpler programs for rapid construction of intelligent systems (Trafton, 2005). ACT-R evolves closer to the system that can perform a full range of human tasks like memory, learning, problem solving, and decision making. Finally it captures in great detail how we perceive, think about, and act on the world. Despite this, ACT-R has some errors and limitations: (1) ACT-R need to be updated millions of chunks for each execution cycle or fire (chunk problem); and (2) ACT-R productions fire serial, and it requires minimum fifty milliseconds for each fire. So, it takes hours together to complete the firing, and requires thousands of productions to its base knowledge (execution delay). ACT-R has certain limitations (Hochstein, 2002): (1) the basic ACT-R model is not very much applicable to HCI, but enhancements like ACT-R/PM addresses this issues. (2) ACT-R is not sophisticated for larger problems; it is only useful for small set of applications.

3. STATE OPERATOR ACTION AND RESULT (SOAR)

SOAR is a cognitive architecture based on computational theory of human cognition and is the major work of Allen Newell [9]. The SOAR addresses many theoretical, methodological and functional issues of human cognition by using the same set of mechanisms. The cognitive models developed using SOAR can exhibit flexible and goal driven behaviour as human. The knowledge of the model is continuously learned by experience. The soar does not allow the model to carry the irrelevant knowledge. Like human the degree of freedom and problem of identifiable is addressed in SOAR. SOAR uses physical symbol system hypothesis, which is the best way to implement flexible and intelligent behaviour by manipulating and composing symbols. SOAR as a cognitive architecture specifies a fixed set of a process, memory and control structures. The memory of SOAR is classified into long term memory called as procedural memory where the productions are stored in short term memory called declarative memory or working memory. Control structures are initially loaded in working memory. The productions are in the form of "IF condition THEN action" which are fine grained and independent in nature. The working memory is loaded with initial state and the operators that are desired for the current state. The control process updates the content of the working memory by firing the matching productions from the search space, by using an appropriate operator. This takes the working memory to the next state. This process continues until the goal state is reached or there are no matching productions available in the search space. The mapping of a production in SOAR model takes approximately 10ms. The searching process in SOAR is done in two phases. the first is recognizing phase and the second is decide and act phase. The problem space is prepared by loading the initial state and the desired operators in to the working memory. Search in human is always a deliberate cognitive activity which is also adopted by SOAR called as problem space hypothesis [10]. This technique will allow the search in the right direction that converges to the goal state, by adopting the strategies: (i) knowledge-intensive processing (ii) knowledge-lean processing [9]. The process of problem solving is a step by step procedure where in each step an appropriate operator must be selected to move to the next state. The productions stored in procedural memory are properly indexed so that the retrieval of a production becomes faster on mapping. In the recognition phase, the productions that match the working memory content are selected. Out of which only one production will be fired by selecting the correct operator In each step there may be many operators desired for the current state. The decision phase sorts these operators into preferences. Among these preferences the best operator must be selected which leads to the goal state more efficiently. It may be possible that there may be two or more operators which can lead to the goal state approximately with equal efficiency or there may not be any operator that can be selected, in which case the system is not defined with what has to be done next? This state is called as an impasse**.** There are four different types of impasse: Tie Impasse: A scenario in which there is a collection of operators, which are desired and cannot be discriminated. No-Change Impasse: A scenario in which there are no acceptable operators among the preferences, which can be applied for the current state. Reject Impasse: A scenario in which the only preference is to backtrack by rejecting the previously made decision. Conflict Impasse**:** A situation where the decisions that can be made in the current state are contradicting with each other. Each time an impasse is arising, the SOAR setup has a sub goal to overcome the current impasse. The decision processes again setup another problem spaces by saving the current content of the working memory as super state. This leads to a cascade of sub goals. The learning technique adopted in soar is called as chunking. That happens each time an impasse is overcome. Learning is actually adding new productions to the long term memory (or more precisely adding productions to the procedural memory) in an elaboration phase. A chunk is a by-product of an impasse. All the productions that are fired and the operators that are applied to overcome an impasse are stored as a single entity called as a chunk. Each of these chunks is added to the procedural memory by creating an index. The chunk is said to be collapsed when the similar problem or situation arises in the problem space before reaching the goal state. This leads a SOAR model from knowledge–lean processing to knowledge-intensive processing model (knowledge–lean processing and knowledge-intensive processing are two strategies gave by Allen Newell. The soar model begins with minimum knowledge and evolved to good knowledge system by enhancing the production system through learning). Chunking in SOAR overcome the problem of knowledge indexing.

4. EM-1 ARCHITECTURE

EM-ONE architecture originated from Marvin Minsky's "emotion machine" architecture [13]. EM-ONE architecture was proposed by Minsky and his student Singh (2005), from MIT media lab. According to Singh, EM-ONE architecture is an example for its predecessors Minsky and Sloman, and hence he called Minsky-Sloman Architecture. Main goal of EM-ONE cognitive architecture is to support human-level intelligence in systems. According to Singh his architecture refers to the "structure and arrangement of common-sense knowledge and processes". EM-ONE architecture for common sense computing, that is capable of reflective reasoning about situations involving physical, social, and mental dimensions. EM-ONE architecture involves complex interactions among the several "actors" along with physical, social, and mental dimensions.

As Figure 2 depicts, table building environment is an example for AI architecture, and uses artificial environment called Roboverse. This is simulated world with rigid body physics, and populated by several actors. These actors are guided by EM-ONE cognitive architecture. These actors work together to build a tables and chairs, by using simple and modular components like sticks and boards. Components looks like small toys, and they can attach one another with their corner and endpoints. The actors are simulated robots, and possess a perceptual system to take physical actions. They roughly looks like a human in shape, with a single arm. The hands can be turned off and on. These hands will act like magnets by attracting the nearer objects. Singh demonstrated the common sense mechanism, using as an illustration, the building a table in Roboverse In Figure 2 Green (left side) wants to build a table; Green watches there is any partly built table to attach more legs to complete a table building. Green moves and grabs a stick, and then moves nearest to the table. Green tries to build a table by using its single arm. It tries to match and attach the table legs, but it fails. Green immediately realizes that it needs help. Afterwards, Green calls the Pink. Until that, Pink has been involved with its own project, and has not been paying attention towards Green. The Pink looks over a Green, and realizes that Green is trying to disassemble the partially built table. Pink comes nearer, and removes the one of the table leg. Green realizes Pink does not understand the intention of Green, and then complains. Green realizes that Pink did not see Green attaching a stick. Afterwards, Green again tries to attach a stick to the partly built table. This time, the Pink watches the construction. Pink realizes that the Green's intention is to complete a table, rather disassemble the table. Green expects help from the Pink. Green expects Pink to hold a table, so that Green can attach a table leg. Pink holds a table and Green inserts the stick. This mechanism proposes a course of action and intentions of other actors for reflecting upon repairing mistaken errors. It shows the aspects of physical, social, and mental actions.

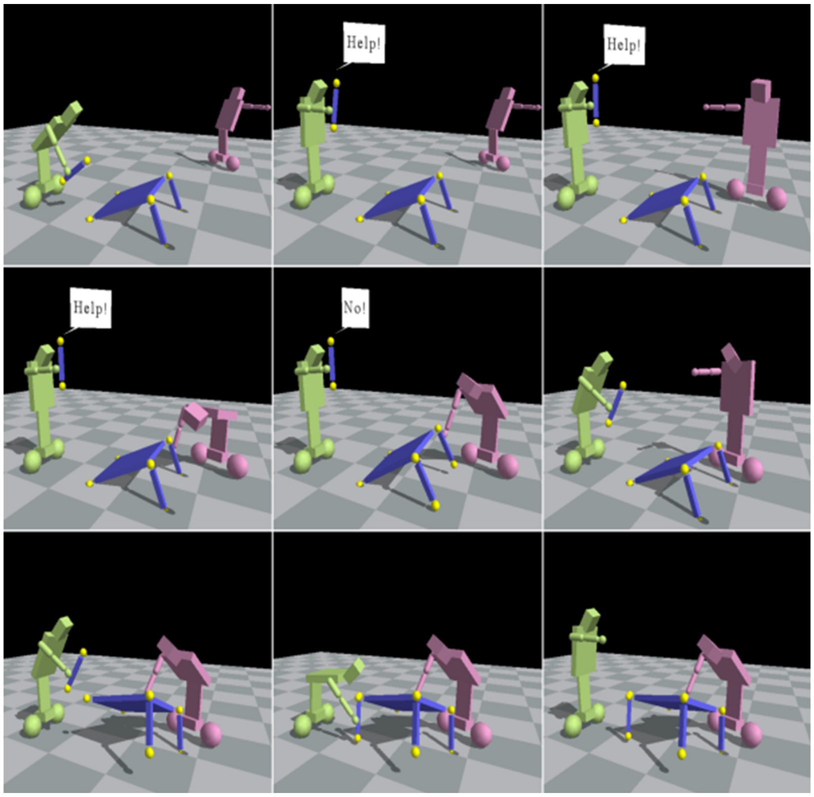

Figure 2: Singh's Table Building Mechanism

EM-ONE architecture was proposed and designed for six layers, but was implemented for the first three layers. Each of the layers is represented by terms called mental critics. The mental critics are encoded in the form of frame-based knowledge, and support a description of connected actors (two wooden one-armed robots) with actions, situations, events (moving, picking, attaching), objects (table sticks), and their properties Singh considered each layer as mental critics: (1) reactive critics; (2) deliberative critics; and (3) reflective critics. The reactive critics interact with the environment. The deliberative critic's reasons about the circumstances, actions and consequences. Deliberative critics interact and coordinate with actors, and objects in the environment through, deliberative actions. For example, knowing the exact positions, picking the right object, connecting the exact position or edge, and so on. The reflective critics assess the effectiveness of deliberative layer. The reflective layer is used for correcting the incorrect predicted actions. The self-reflection, self-conscious, and self-idea critics are self-reflection layers. According to Singh, EM-ONE architecture has meta-managerial critics. This has been supported with top-level critics. The EM-ONE architecture has a great flexibility for critics to activate. The central idea of having critical-sector model is that, when the system encounters a problem, it brings knowledge of reasoning

5. SOCIALLY INTERACTIVE ROBOTICS

The term socially interactive robotics (SIR) was first used by Fong [14] to describe robots whose main task was *some form of interaction. The term* was introduced to distinguish social interaction from teleportation in human robot interaction (HRI). Fong conducted a survey of socially interactive robots and evaluated them along social interaction principles, categorizing them by the aspects of social interaction (speech, gestures, etc.) they used. Concerns regarding human perception of robotics, particularly the difference in social sophistication between humans and social robots, were addressed, and field studies, evaluation, and long-term interaction were all noted as areas worthy of future research.

A. Socially Assistive Robotics

We define socially assistive robotics (SAR) as the intersection of AR and SIR. SAR shares with assistive robotics the goal to provide assistance to human users, but it specifies that the assistance is through social interaction. Because of the emphasis on social interaction, SAR has a similar focus as SIR. In SIR, the robot's goal is to develop closeand effective interactions with the human for the sake of interaction itself. In contrast, in SAR, the robot's goal is to create close and effective interaction with a human user for the purpose of giving assistance and achieving measurable progress in convalescence, rehabilitation, learning, etc. The motivation for defining SAR is not to create a schism within SIR but rather to expand assistive robotics to include robots that operate via social interaction and to better understand the key unique challenges of this growing field. In the following sections, we will discuss the motivation for and the definition of socially assistive robotics. We will define a taxonomy of interaction components that augments the definition of socially interactive robotics toward assistive domains and uses. Finally, throughout the discussion, we will provide a comprehensive summary of related work.

B. Role of the Assistive Robot

Social assistive robots have worked as caregivers alongside doctors, nurses, and physical therapists. They have been used as therapy aids for children dealing with grief and loss as well as social mediators for children with autism. Robots have been used as companions in nursing homes and elementary schools. Correctly defining the role of the robot in these interactions is important for crafting its appearance and interaction modalities. The role may be defined by the task that robot is assisting with [10] and the user population is working with [33], and by the impression it gives through its appearance and behaviour. For example, a hospital robot may act like a nurse or a medical instrument depending on the task and the nature of the interaction. While a robot may serve multiple purposes, human user bonding preferences may mandate more specialized and individualized behaviour.

6. EVALUATION

Socially assistive robotics must address a spectrum of novel challenges in terms of performance.

A. User Task Performance

A SAR system must engage the user effectively, achieve the goals of the domain-specific activity (recovery, training, etc.), and be responsive to the needs and requirements of not only the user but also the caretaker and health care/educational staff. For example, a robot may prompt a patient to do a given task properly, yet the patient may still not perform the task [25]. A robot may be appealing to a user but ineffective at achieving measurable outcomes in rehabilitation or vice versa. The requirement of achieving multiple potentially conflicting goals and concurrently "serving many masters" with varying needs and requirements presents novel and complex challenges for socially assistive robotics.

B. Level of Autonomy

Ideally, a SAR system requires no expert operator or extensive training for use. It should be self-explanatory and capable of being started, stopped, and configured by people already providing care with a minimum burden placed upon them. It must also conform with the changing routines and demands of the user and caretakers, another challenge inherent to SAR.

C. Embodiment v. Non-embodiment

SAR brings the question of the role of embodiment to the forefront. If the robot does not need to engage in a physical contact task, what is the reason for using a robot at all Would a computer or personal digital assistant (PDA) suffice Social robotics relies on the inherently human tendency to attribute goals and intentions to even the simplest physical mobile entities. While embodiment has a key role to play in engagement, how that role translates into measurable outcomes in robot assisted therapy, convalescence, and learning is yet to be addressed and is one of our major areas of pursuit.

Socially assistive robots can engage in assistive human-robot interactions (HRI) by providing rehabilitation of cognitive, social, and physical abilities after a stroke, accident or diagnosis of a social, developmental or cognitive disorder. This paper defines the research area of socially assistive robotics, focused on assisting people through social interaction. While much attention has been paid to robots that provide assistance to people through physical contact (which we call contact assistive robotics), and to robots that entertain through social interaction (social interactive robotics), so far there is no clear definition of socially assistive robotics. We summarize active social assistive research projects and classify them by target populations, application domains, and interaction methods. While distinguishing these from socially interactive robotics endeavours, we discuss the grand challenges and opportunities that are specific to the growing field of socially assistive robotics. The field of socially assistive robotics is growing but has not yet been properly defined and circumscribed. There has been significant attention given to and great progress made in contact assistive robotics. Yet it is crucial to note that hands on assistive robotics are only part of the total composition of assistive robotics. Currently there is no clear definition of robots that provide assistance through interaction and without physical contact, namely *socially assistive robotics*. We begin by distinguishing these categories.

D. Assistive Robotics

In the past, assistive robotics (AR) has largely referred to robots that assisted people with physical disabilities through physical interaction. This definition is no longer appropriate as it is lacking in scope: it does not cover assistive robots that assist through non-contact interaction, such as to interact with convalescent patients in a hospital or senior citizens in a nursing home. Assistive robotics itself has not been formally defined or surveyed. An adequate definition of an assistive robot is one that gives aid or support to a human user. Research into assistive robotics includes rehabilitation robots [6][9][18][20][26], wheelchair robots and other mobility aides [1][16][34][38], companion robots [3][31][35], manipulator arms for the physically disabled [17][15][24], and Educational robots [21]. These robots are intended for use in a range of environments including schools, hospitals, and homes.

E. Socially Interactive Robotics

The term socially interactive robotics (SIR) was first used by Fong [14] to describe robots whose main task was some form of interaction. The term was introduced to distinguish social interaction from teleportation in human robot interaction (HRI). Fong conducted a survey of socially interactive robots and evaluated them along social interaction principles, categorizing them by the aspects of social interaction (speech, gestures, etc.) they used. Concerns regarding human perception of robotics, particularly the difference in social sophistication between humans and social robots, were addressed, and field studies, evaluation, and long-term interaction were all noted as areas worthy of future research.

Figure 3: Socially assistive robot

F. Socially Assistive Robotics

This paper defines socially assistive robotics (SAR) as the intersection of AR and SIR. In Figure 3 SAR shares with assistive robotics the goal to provide assistance to human users, but it specifies that the assistance is through social interaction. Because of the emphasis on social interaction, SAR has a similar focus as SIR. In SIR, the robot's goal is to develop close and effective interactions with the human for the sake of interaction itself. In contrast, in SAR, the robot's goal is to create close and effective interaction with a human user for the purpose of giving assistance and achieving measurable progress in convalescence, rehabilitation, learning, etc. The motivation for defining SAR is not to create a schism within SIR but rather to expand assistive robotics to include robots that operate via social interaction and to better understand the key unique challenges of this growing field. In the following sections, we will discuss the motivation for and the definition of socially assistive robotics. We will define a taxonomy of interaction components that augments the definition of socially interactive robotics toward assistive domains and uses. Finally, throughout the discussion, we will provide a comprehensive summary of related work.

7. DEVELOPING AGRICULTURAL ROBOT (REMOTE CONTROLLED POWER TILLER)

Power tiller is a farm machine which is used for ploughing the field. Draw back with the technology is someone has to walk behind continuously with the machine controlling its direction 8 hours/day on an average. This result in lot of strain, since one has to walk under hot sun rain and all elemental condition. Further there is safety issue of people get injured by getting in contact with the blades and some case even death. Using remote controlled system for power tiller farmers can now peacefully stand away from the field and operate the power tiller using a hand he inFig.4The tiller's remote control system has two units - a hand-held remote unit and a controller unit which is attached to the tiller. The clutch and brake levers are engaged using a pneumatic system. The electronic radio transmitter on the remote unit sends signals which are picked up by the controller unit on the tiller to perform desired operations. The electronic and pneumatic systems are housed inside a weather-proof casing. The remote unit uses rechargeable batteries which run up to 10 hours. The controller unit also uses a battery which is constantly charged by the power tiller's dynamo.

Figure 4: Agricultural robot

8. EXPERIMENTAL RESULTS (FIELD TESTING)

Agricultural Robot has been tested in the different environments, using remote controlled system for power tiller farmers can now peacefully stand away from the field and operate the power tiller using a hand held remote control unit. The experiment has been conducted in different areas such Dr.Ambedkar institute of technology, white field near to Bangalore in wet land, and dry land for five days.

9. CONCLUSIONS

With the remote-controlled power tiller, one need not get on the field, let alone walk with the tiller for hours on end to control its direction. Physical damage to the operator's knees and shoulders can be avoided. Even an unskilled person can use the power tiller with the touch of a button, besides saving the time and money required for skilled labour. The technology has enabled even women can plough fields.

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